MECHANIC AUTO BODY PAINTING

NSQF LEVEL - 3

TRADE THEORY

SECTOR: AUTOMOTIVE

(As per revised syllabus July 2022 - 1200Hrs)

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 : **1 Year**

Trade : **Mechanic Auto Body Painting - Trade Theory - NSQF Level-3 (Revised 2022)**

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FOREWORD

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

The National Instructional Media Institute (NIMI), Chennai has now come up with instructional material to suit the revised curriculum for **Mechanic Auto Body Painting - 1 Year - Trade Theory - NSQF Level - 3 (Revised 2022) in Automotive Sector under annual Pattern.** The NSQF Level - 3 (Revised 2022) Trade Theory will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 3 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 3 (Revised 2022) the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

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

Jai Hind

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

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

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

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 Theory)** for the trade of **Mechanic Auto Body Painting** under **Automotive** Sector for ITIs.

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

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

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

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intented to be used in practical workshop. It consists of a series of practical exercises to be completed by the trainees during the Course of the **Mechanic Auto Body Painting** Trade supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF level - 3 (Revised 2022) syllabus are covered.

Module 1 Workshop Safety Practice

Module 2 Measuring and Marking Practice

Module 3 Fastening and Fitting

Module 4 Basic Workshop Practice

Module 5 Basic Electrical and Vehicle Construction Technology

Module 6 Air Compressor and Refinishing Materials

Module 7 Body Fillers and Corrosion Protection

Module 8 Refinishing Equipment Technology

Module 9 Vehicle Masking and Refinishing

Module 10 Paint Colour Matching and Trouble shooting

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

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

TRADE THEORY

The manual of trade theory consists of theoretical information for the Course of the Mechanic Diesel Trade. The contents are sequenced according to the practical exercise contained in NSQF Level - 3 (Revised - 2022) syllabus on Trade practical. Attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This correlation is maintained to help the trainees to develop the perceptional capabilities for performing the skills.

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

It will be preferable to teach/learn the trade theory connected to each exercise atleast 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	Exercise No
1	Check & perform Measuring & marking by using various Measuring & Marking tools(Vernier Calliper, Micrometer, Telescope gauges, Dial bore gauges, Dial indicators, straightedge, feeler gauge, thread pitch gauge, vacuum gauge, tire pressure gauge.) following safety precautions	1.1.01 to 1.2.12
2	Plan & perform basic fastening & fitting operation by using correct hand tools, Machine tools &equipment.	1.2.13 to 1.4.19
3	Trace and Test all Electrical & Electronic components & circuits and assemble circuit to ensure functionality of system.	1.5.20 to 1.5.21
4	Check & Interpret Vehicle Specification data and VIN Select & operate various Service Station Equipments.	1.5.22 to 1.5.26
5	Identify various vehicle parts and Service, Repair and Maintenance of Air compressor and Air Lines.	1.5.27 to 1.5.30 1.6.31 to 1.6.40
6	Demonstrate proper paint shop equipment and pre-paint preparation steps such as proper final sanding, masking, buffing, and detailing skills.	1.6.41 to 1.6.49
7	Acquire skills on the use of basic auto body hand and power tools and application and finishing of body filler materials and undercoats.	1.7.50 to 1.7.56
8	Demonstrate understanding of the causes and effects of corrosion on automobile bodies and methods of corrosion protection.	1.7.57 to 1.7.59
9	Demonstrate how to use different painting tools and equipment including how to disassemble, assemble, and clean paint guns.	1.8.60 to 1.8.65
10	Demonstrate knowledge of correct paint application techniques and be able to identify paint problems along with troubleshooting skills.	1.8.66 to 1.8.75 1.9.76 to 1.9.82
11	Demonstrate finishing process.	1.9.83 to 1.9.87
12	Demonstrate the use of computer color matching systems and the use of tinting solid and metallic colors.	1.10.88 to 1.10.92
13	Demonstrate how to remove minor paint imperfections.	1.10.93 to 1.10.97

SYLLABUS FOR MECHANIC AUTOBODY PAINTING

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 105Hrs; Professional Knowledge 25Hrs	Check & perform Measuring & marking by using various Measuring & Marking tools (Vernier Caliper, Micrometer, Telescope gauges, Dial bore gauges, Dial indicators, straight-edge, feeler gauge, thread pitch gauge, vacuum gauge, tire pressure gauge) following safety precautions	1. Familiarization with institute, Job opportunities in the automobile sector.(5 hrs.) 2. Machinery used in Trade.(08 hrs.) 3. Types of work done by the students in the shop floor.(10hrs.)	**Admission & introduction to the trade:** Introduction to the Course duration, course content, study of the syllabus. General rule pertaining to the Institute, facilities available- Hostel, Recreation, Medical and Library working hours and time table (05 hrs)
		4. Practical related to Safety and Health.(10hrs.) 5. Importance of maintenance and cleanliness of Workshop.(5hrs.) 6. Use of fire extinguishers.(10hrs.) 7. Demonstration on safe handling and Periodic testing of lifting equipment. (5hrs.) 8. Safety disposal of Used engine oil/ Paints etc. (05hrs.) 9. Energy saving Tips Usage.(02hrs.)	**Occupational Safety & Health** Importance of Safety and general Precautions to be observed in the shop. Basic first aid, safety signs - for Danger, Warning, caution & personal safety message. Safe handling of Fuel Spillage, Fire extinguishers used for Different types of fire. safe disposal of toxic dust, safe handling and Periodic testing of lifting equipment, Safety disposal of Used engine oil, Electrical safety tips. Hazard identification, spatter hazard etc. and countermeasure to eliminate them & importance of usage of PPEs. (7 hrs)
		10. Practice using all marking aids, like steel rule with spring calipers, dividers, scriber, punches, Chisel etc.(10hrs.) 11. Practice on General workshop tools & power tools and equipments (15hrs.)	**Hand Tools** Marking scheme, Marking material-chalk, Prussian blue. Cleaning tools-Scraper, wire brush, Emery paper, Description, care and use of Surface plates, steel rule, measuring tape, try square. Calipers-inside and outside. Dividers, surface gauges, scriber, punches-prick punch, center punch, pin punch, hollow punch, number and letter punch. Chisel-flat, cross-cut. Hammer- ball pein, lump, mallet, Different type of -body hammers, pick hammers, , Bumping hammers, finishing hammers, dolly block, and body spoon, body picks, body pullers and pull rods, suction cup, scratch awl,Screw drivers-blade screwdriver, Phillips screw driver, Ratchet screwdriver. Allen key, bench vice & C-clamps, Spanners- ring spanner, open end spanner & the combination spanner, universal adjustable open-end spanner. Sockets & accessories, Pliers -Combination pliers, multi grip, long nose, flat-nose, Nippers or pincer pliers, Metal cutting shears- Tin snips, sheet metal cutting pliers, (Aviation snips), panel cutters, trim

			and upholstery tools, Door handle tool (clip pullers), Metal files-reveal file, surform file, sanding board, sanding block, spreaders and squeegees. (8 hrs)
		12. Measuring practice on engine components with aid of instrument studied.(20 hrs.)	**Systems of measurement:** Description, care & use of Micrometers- Outside and depth mirometer, Micrometer adjustments, Vernier calipers, (05 hrs)
Professional Skill 70 Hrs; Professional Knowledge 15Hrs	Plan & perform basic fastening & fitting operation by using correct hand tools, Machine tools &equipment.	13. Practice on General cleaning, checking and use of nut, bolts, & studs etc.(10 hrs.)	**Fasteners-** Study of different types of screws, nuts, studs & bolts, locking devices, Such as lock nuts, cotter, split pins, keys, circlips, lock rings, lock washers and locating where they are used. Washers & chemical compounds can be used to help secure these fasteners. Description of Riveting tools (05 hrs)
		14. Practice on cutting tools like Hacksaw, file,chisel, OFF-hand grinding with sander, safety precautions while grinding.(20 hrs.) 15. Practice on Hacksawing and filing to given dimensions.(25hrs.)	**Cutting tools:-** Study of different type of cutting tools like Hacksaw, File- Definition, parts of a file, specification, Grade, shape, different type of cut and uses., chisel, OFF-hand grinding with sander, safety precautions while grinding. (05 hrs)
		16. Practice on Marking and Drilling clear and Blind Holes. (05 hrs.) 17. Safety precautions to be observed while using a drilling machine.(05 hrs.) 18. Practice on Tapping a Clear and Blind Hole. (02 hrs.) 19. Reaming a hole/ Bush to suit the given pin/ shaft, scraping a given machined surface.(03 hrs.)	**Drilling machine-** Description and study of Bench type Drilling machine, Portable electrical Drilling machine, drill holding devices, Drill bits. **Taps and Dies:** Hand Taps and wrenches, Different type of Die and Die stock. Screw extractors. **Hand Reamers -** Different Type of hand reamers, Lapping, Lapping abrasives, type of Laps. Function of Gaskets, Selection of materials for gaskets and packing, oil seals. (05 hrs)
Professional Skill 20Hrs; Professional Knowledge 05 Hrs	Test various electrical/ electronic components using proper measuring instruments and compare the data using standard parameters.	20. Measuring of current, voltage and resistance. (10 hrs.) 21. Using digital multimeter, practice continuity test for fuses, jumper wires, fusible links, circuit breakers. (10hrs.)	**Basic electricity,** Electricity principles, Ohm's law, Voltage, Current, Resistance, Power, Energy. Voltmeter, ammeter, Ohmmeter Multimeter (05 hrs)
Professional Skill 25 Hrs; Professional Knowledge 05Hrs	Check & Interpret Vehicle Specification data and VIN Select & operate various Service Station Equipment.	22. Identification of different type of Vehicle. (5 hrs.) 23. Demonstration of vehicle specification data; (5 hrs.) 24. Identification of vehicle information Number (VIN). (5 hrs.) 25. Demonstration of Garage, Service station equipment.(5 hrs.) 26. Vehicle hoists - Two post and four post hoist, Engine hoists, Jacks, Stands.(5 hrs.)	Auto Industry- History, leading manufacturers, development in automobile industry, trends, new product. Brief about Ministry of Road transport & Highways, The Automotive Research Association of India (ARAI), National Automotive Testing and R&D Infrastructure Project (NATRIP), & Automobile Association. Definition: - Classification of vehicles on the basis of load as per central motor vehicle rule, wheels, final drive, and fuel used, axles, position of engine and steering transmission, body and load. Brief description and uses of Vehicle hoists - Two post and four post hoist, Engine hoists, Jacks, **Stands**. (05 hrs)

Professional Skill 70 Hrs; Professional Knowledge 12 Hrs	Identify various vehicle parts and Service, Repair and Maintenance of Air compressor and Air Lines.	27. Washing of vehicle.(5 hrs.) 28. Identification of different type body, chassis, Drive lines.(05 hrs.) 29. Identify the location of parts and panels. (5hrs.) 30. Practice on use of computer-based service information, service manuals, refinishing guides, vehicle dimension manual, color matching guides, parts interchange guides. (20 hrs.)	I**ntroduction to Engine:** Description of internal & external combustion engines, Classification of IC engines, Principle & working of 2&4-stroke diesel engine (Compression ignition Engine (C.I)), Principle of Spark Ignition Engine(SI), differentiate between 2-stroke and 4 stroke, C.I engine and S.I Engine, Technical terms used in engine, Engine specification. Body shop & paint shop safety procedures. **Vehicle construction Technology** Definition of body shop, classification of body shop, Description of vehicle Body and Chassis. **Service information, Specifications, and Measurements** Study of Service Information, basic steps to using refinishing materials information, Vehicle paint code, study of service symbols, diagnosis charts. (07 hrs)
		31. Identify the parts of a piston type stationary compressor. (04hrs.) 32. Overhauling of service (FRL) unit. (02 hrs.) 33. Drain the air receiver and the moisture separator/regulator or air transformer. (03 hrs.) 34. Check the level of the oil in the crankcase, replace of compressor oil, clean air filters. (05hrs.) 35. Clean or blow off fins on cylinders, heads, intercoolers, After coolers. (03 hrs.) 36. Check the oil filter in the air line and change the filter element if necessary, Adjust the pressure switch cut-in and cut-out settings if needed. (03hrs.) 37. Check the relief valve for exhausting of head pressure each time the motor stops. (02hrs.) 38. Tighten belts to prevent slippage. (03 hrs.) 39. Check and align a loose motor pulley or compressor Flywheel. (05 hrs.) 40. Check for air leaks on the compressor outfit and air piping system. (05 hrs.)	**Compressor Air system:** Basic requirement for compressed air systems, Type of Compressor- Description and construction of Diaphragm compressor, piton type compressor-single stage and two stage, rotary screw air compressor, Performance of air compressor- Description of Horse power, delivery volume, displacement, Free air delivery, compressor volumetric efficiency, tank size, Air and Fluid Control Equipment - In take air filter, Distribution system, regulator, lubricator, different type air purification method, Compressor Accessories -Hose type, hose size, maintenance of hose, connectors, adapters and couplings, Air System Maintenance . Study the typical piping arrangement found in a body/paint shop, colour coding of airline, water line and fuel line. (05 hrs)
Professional Skill 100Hrs; Professional Knowledge 17 Hrs	Demonstrate proper paint shop equipment and pre-paint preparation steps	41. Identify the different type of refinishing material- paint binders, paint solvents, Paint additives. (10hrs.) 42. Select the right repair materials for a particular job. (5hrs.) 43. Select the right type of primer and paint. (10hrs.) 44. Identify various type masking material available in body shop. (10hrs.)	**Refinishing Materials:-** Merge with using body filters paint material types-Lacquer, enamel, water base, Content of paint-pain pigments, paint binders, paint solvents, Paint additives, Definition of Drying, curing, flash, retarder, accelerator, catalyst, adhesion promoter, blending solvent, Toners, Primers & sealers- self-etching primer, UV primer Primer-surfacer, Epoxy primers, Other paint

		45. Identify different type of body filler, (10hrs.) 46. Identify various type masking material available in body shop. (10hrs.) 47. Identify various type of grit rating available in the workshop. (10hrs.) 48. Identify the open and closed coat grit. (10hrs.) 49. Practice Cleaning, Pre-Treatment, surface conditioning, ED coating of any given panel.(25hrs.)	materials- prep solvent, flattener, fish-eye eliminator, flex agent, Antichip coating (Vinyl coating), Metal conditioner, Paint stripper, tack cloth, Masking materials- Masking paper, Primer masking paper, paint masking paper, masking plastic, masking tape, Fine line masks, Wheel masks. Abrasives- Abrasive material, grit, grit Ratings, open and closed coat grit, Grinding discs, sand paper- dry and wet type, scuff pads, Compounds-Rubbing compound, polishing compound, Adhesives, Epoxies. Composition of Paints, Paint Types. Impact of paint & paint paint component on plastic and rubber parts. Latest paint Techniques. (17 hrs)
Professional Skill 75 Hrs; Professional Knowledge 10 Hrs	Acquire skills on the use of basic auto body hand and power tools and application and finishing of body filler materials and undercoats.	50. Identify the different type of body filler, hardeners, and putties, used in industry. (10 hrs.) 51. Practice on a mixing board for applying Body filler. (15 hrs.) 52. Practice on preparation of damaged surface area of sheet metal. (10 hrs.) 53. Practice on applying the body filler on a damaged sheet metal area. (10 hrs.) 54. Using Hand-block sanding to smooth and level a repair area properly. (10 hrs.) 55. Practice repairing paint surface imperfections, (10 hrs.) 56. Perform Repairing ofpaint scratches, repairing nicks, repairing dings, preparing surface rust free. (10 hrs.).	**Using Body Fillers** Description of Body Fillers (Plastic filler), Body filler ingredients, Body filler hardeners, Putties, light weight fillers, premium fillers, spot putties, polyester glazing putty, applying body filler, preparation surface for filler, Ingredient, characteristics and application of body filler & putties, Rust repair procedures.(10 hrs)
Professional Skill 45 Hrs; Professional Knowledge 06 Hrs	Demonstrate understanding of the causes and effects of corrosion on automobile bodies and methods of corrosion protection.	57. Practice on corrosion treatment of sheet metal, interior and exterior surface. (15hrs.) 58. Preparation of repair estimate information by using an estimating guide book. (15hrs.) 59. Identify how an estimating guide gives part pricing and labour time information. (15 hrs.)	**Corrosion Protection** What Is Corrosion, Causes for Loss of Factory protection, Anticorrosion Materials, Basic Surface Preparation, Corrosion Treatment Areas, Exposed Exterior Surfaces, Exterior Accessories, **Estimating Repair** Costs Description of estimate, Direct repair programs, Estimate time factor, work orders, Using Estimate Guides, Part prices, Labor costs, Job overlap, and Included operation.(06 hrs)
Professional Skill 65 Hrs; Professional Knowledge 15 Hrs	Demonstrate how to use different painting tools and equipment including how to disassemble, assemble, and clean paint guns.	60. Practice on different ways to mix paint or other materials paint mixing sticks, (11 hrs.) 61. Practice on use of viscosity cup. (10 hrs.) 62. Testing Spray Pattern, Effect of Spray on Gun stroke, Gun Speed, Gun Triggering, Gun Direction, Spray	Refinishing equipment Technology Painting environment variable, Steps to keep dirt from finish during body repairs, Description of spray gun and its parts, basic stages of Atomization, High-Volume, Low-Pressure (HVLP) Spray Gun, Type of air spray gun-Gravity feed, Suction (siphon) feed, Pressure feed, Pressure-

		Overlap, Gun Handling Problems - Heeling, Arcing. (13 hrs.) 63. Practice on spray gun cleaning tank, manual spray gun cleaning, and spray gun lubrication. (11 hrs.) 64. Practice on maintains on spray booth. (10 hrs.) 65. Practice on use of Air-supplied respirators. (10 hrs.)	assist feed (gravity or suction cup spray guns) and their paint feed method, advantage and disadvantages. Spray gun air supply system, importance of spraying material viscosity, other spray systems,- airless spray gun system, electrostatic spraying system, touch-up guns, airbrushes, spray booths- one- and two-room spray booths, air makeup or air replacement system-Regular flow booth , Reverse flow booth, Cross draft booth, Downdraft booth, Air Filtration Systems- wet filtration system and the dry filtration system, spray booth maintenance, Description of drying room- types of infrared drying equipment- Near drying equipment. Far drying equipment. Description of Air-supplied respirators, type of air-supplied respirators- hood type and the face shield type. Other paint shop equipment and tools- wet sanding stand, Paint hangers, Panel drying ovens,Paint shakers, blade agitator, Churning knives, Paint scales, Paint cabinets, Tack cloths, purpose of strainer, Masking tape.(15 hrs)
Professional Skill 115 Hrs; Professional Knowledge 20 Hrs	Demonstrate knowledge of correct paint application techniques and be able to identify paint problems along with troubleshooting skills	66. Practice to correcting of an Air Spray Gun- Spray pattern top heavy or bottom heavy, Spray pattern heavy to right or to left, Spray pattern heavy at center, Spray pattern split, Pinholes, Blushing or a whitish coat, Orange peel (surface looks like orange peel), (12 hrs.) 67. Troubleshoot Excessive spray fog or overspray, No control over size of pattern, Sags or runs, (12 hrs.) 68. Troubleshoot Streaks Gun sputters constantly, Uneven spray pattern, Fluid leaks from spray gun, (08 hrs.) 69. Troubleshoot Fluid leaks from packing nut, Fluid leaks through fluid tip when trigger is released, (05 hrs.) 70. Troubleshoot Excessive fluid, Fluid will not come from spray gun, Fluid will not come from fluid tank or canister, (05 hrs.) 71. Troubleshoot Sprayed coat short of liquid material, Spotty, uneven pattern, slow to build,Unable to get round spray, Dripping from fluid tip, (05 hrs.) 72. Troubleshoot Excessive overspray, Excessive fog, will not spray on pressure feed, will not spray on suction feed, (05 hrs.)	Probable causes and remedies for Spray pattern top heavy or bottom heavy, Spray pattern heavy to right or to left, Spray pattern heavy at center, Spray pattern split,Pinholes,Blushing or a whitish coat, Orange peel (surface looks like orange peel), Excessive spray fog or overspray, No control over size of pattern, Sags or runs, Streaks Gun sputters constantly, Uneven spray pattern, Fluid leaks from spray gun, Fluid leaks from packing nut, Fluid leaks through fluid tip when trigger is released, Excessive fluid, Fluid will not come from spray gun, Fluid will not come from fluid tank or canister, Sprayed coat short of liquid material, Spotty, uneven pattern, slow to build, Unable to get round spray, Dripping from fluid tip, Excessive overspray, Excessive fog, Will not spray on pressure feed, Will not spray on suction feed, Air continues to flow through gun when trigger has been released (on non bleeder guns only), Air leak at canister gasket, Leak at setscrew in canister top, Leak between top of canister cover and gun body.(05 hrs)

		73. Troubleshoot Air continues to flow through gun when trigger has been released (on non-bleeder guns only), (05 hrs.) 74. Troubleshoot Air leak at canister gasket, (05 hrs.) 75. Troubleshoot Leak at set-screw in canister top, Leak between top of canister cover and gun body. (05 hrs.)	
		76. Practice on Checking Paint Thickness, (05hrs.) 77. Practice on paint removal using chemical stripping, (12 hrs.) 78. Practice Media blasting, Practice on Preparing Bare Metal using metal conditioners, preparing hard chrome Surfaces, preparing metalReplacement parts, (10hrs.) 79. Practice on applying spot putty, or glazing putty. (10hrs.) 80. Practice on final sanding, using the right grit, power sanding, hand sanding, dry sanding, wet sanding, (05hrs.) 81. Carry out Surface Cleaning. (08 hrs.) 82. Practice to mask the parts of a vehicle by using different masking techniques. (08 hrs.)	**Vehicle surface preparation and masking** Importance of surface preparation, Evaluate Surface Condition, Checking Paint Thickness, Paint Removal method- Chemical stripping, Media blasting- procedure for operating a blaster, type of grit and numbering system. Sanding or grinding, Importance of Preparing Bare Metal-using metal conditioners, preparing hard chrome Surfaces, preparing metal Replacement parts, using self-etch primer, apply seam sealer Prime coat Selection, applying prime coats applying spot putty, or glazing putty. final sanding, using the right grit, Masking, surface sanding methods, power sanding, hand sanding, dry sanding, wet sanding, comparison between wet and dry sanding, surface scuffing, Surface Cleaning. Masking, basic ways to mask the parts of a vehicle, liquid masking material, liquid masking system, Procedure, plastic sheet masking. masking paper and tape, masking aids-wheel masks, masking panel gaps, masking openings, Reverse masking, or blend masking, Masking rope, (aperture tape), surface cleaning, using wax-and-grease remover.(15 hrs)
Professional Skill 50 Hrs; Professional Knowledge 10 Hrs	Demonstrate finishing process.	83. Identify different type of paint for topcoat refinishing, paint used for refinishing. (10 hrs.) 84. Practice on applying Prime coats, Refinishing Plastic Parts, Basecoat/ Clearcoat Repairs. (10hrs.) 85. Practice on applying Single Stage Paints, Panel Repairs, Overall Refinishing. (10hrs.) 86. Removal of Masking Materials. (05 hrs.) 87. Practice paint polishing. (15 hrs.)	**Refinishing Procedures:** Functions of paint, OEM paint finishes procedures, different between OEM and refinish painting types of paint for topcoat refinishing, properties of paint used for refinishing. Topcoats, Prime coats, Preparing Refinish Materials,Pre-painting Preparations, Applying Prime coats, Refinishing Plastic Parts, Flash Times, Basic Spray Coats, Methods of Refinishing, Basecoat/Clearcoat Repairs, Applying Single Stage Paints, Panel Repairs, Overall Refinishing, Removal of Masking Materials.(10 hrs)
Professional Skill 50 Hrs; Professional Knowledge 10Hrs	Demonstrate the use of computer color matching systems and the use of tinting solid and metallic colors.	88. Practice on colour evaluations using sunlight & colour corrected light bulb. (10 hrs.) 89. Practice on matching Basic Paint Colors. (10 hrs.) 90. Practice on Spraying Metallic Colours, Practice on let-	**Color matching and Customized painting** Introduction, ColorTheory, Lighting-colour evaluations using sunlight & colour corrected light bulb, dimensions of colour- Value-lightness or darkness, Hue-color, cast, or tint, Chroma saturation, richness, intensity, or muddiness, standard colour chips, variance colour chips, Matching Basic

		down test panel for a three-stage finish. (10 hrs.) 91. Practice on a repair with a multistage mica or pearl finish. (10 hrs.) 92. Practice on use of Spectrophotometer or electronic colour Analyzer, use of Computerized Paint Matching Custom. (10 hrs.)	Paint Colors- use of colour test panel, spray-out test panel procedure, color spraying variables in the shop, positive and Negative variable, matching solid colors and metallic finishes, Spraying Metallic Colours-Wet Coats of Metallic Colour, Dry Coats of Metallic Colour, importance of metallic colour mixed, Metallic Colour Variables to darken & lighten, steps for spot repair with a fluorine clearcoat system, procedure for a letdown test panel for a three-stage finish, method for a spot or partial repair on a three-stage paint system, steps for a panel repair with a multi-stage mica or pearl finish, mica mid-coat blending procedure for a three-stage paint, Tinting, basic reasons for tinting a paint colour, three angles to determine whether a colour adjustment is necessary, Spectro-photometer or electronic colour Analyzer, Computerized Paint Matching Custom Painting.(10 hrs)
Professional Skill 50 Hrs; Professional Knowledge 10 Hrs	Demonstrate how to remove minor paint imperfections.	93. Practice on removing foreign matter in wet paint, wet sanding between coats. (05 hrs.) 94. Practice to correcting of - paint colour mismatch, orange peel, runs and sags, sand scratch swelling, bull's-eye featheredge , featheredge splitting, water spotting, chemical spotting, curing or drying failure, paint fish-eyes, blushing, bleeding, prime coat show-through, blistering, solvent popping, paint cracking, line checking, crazing, micro checking, lifting, paint wrinkling, mottling, pin holing, peeling, chalking, paint colour fade, dulled finish, debris in the finish, rust under the finish. (20 hrs.) 95. Repairing paint runs, repairing chipped paint, panel detail sanding. (10 hrs.) 96. Practice on visualizing of painted surface in three different angles for final detailing. (10 hrs.). 97. Practice Paint defect identification and area wise defect ranking and tolerance. (5 hrs.)	Paint Problems and Final Detailing Repairing Paint Problems-problems in wet paint, removing foreign matter in wet paint, wet sanding between coats, Causes, prevention and correcting of - paint colour mismatch, orange peel, runs and sags, sand scratch swelling, bull's-eye featheredge , featheredge splitting, water spotting, chemical spotting, curing or drying failure, paint fish-eyes, blushing, bleeding, prime coat show-through, blistering, solvent popping, paint cracking, line checking, crazing, micro checking, lifting, paint wrinkling, mottling, pin holing, peeling, chalking, paint colour fade, dulled finish, debris in the finish, rust under the finish. Final detailing-Detail sanding procedure, Repairing paint runs, repairing chipped paint, panel detail sanding procedure, Paint compounding- purpose, rubbing compound, machine compounding, using buffers and polishers, avoiding paint burn-through, machine buffing procedures, hand and machine Glazing and polishing procedure, Final cleaning, steps for caring for a new finish.(10 hrs)

Organization of ITI's and scope of the mechanic auto body painting trade

Objectives: At the end of this lesson you shall be able to
- **state brief introduction about Industrial Training Institutes (ITI)**
- **state about the organized structure of the Institute.**

Brief Introduction of Industrial Training Institute (ITIs)

Industrial Training Institute plays a vital role in economy of the country, especially in terms of providing skilled manpower.

The Directorate General of Training (DGT) comes under **Ministry of Skill Development and Entrepreneurship (MSDE)** offers a range of vocational training trades in different sectors based on economy /labour market. The vocational training programmes are delivered under the aegis of **National Council of Vocational Training (NCVT).** Craftsmen Training scheme (CTS) and Apprenticeship Training Scheme (ATS) minimum eligibility for admission in ITIs 8th, 10th and 12th pass with respect to the trades and admission process will be held in every year in July.

Scope of the mechanic auto body painting trade

Objectives: At the end of this lesson you shall be able to
- **importance and scope of the mechanic auto body painting trade training**
- **general discipline in the institute.**

Scope of the mechanic auto body painting trade training: Mechanic auto body painting trade is one of the most popular trade delivered nation wide through the network of ITI. This trade training is one year duration and 8 hours per day excluding lunch hour.

- Identify the various types of tools equipment, raw materials, spares used in mechanic auto body painting trade,
- Practice to measuring, fitting, welding, sheet metal works, mechanical and electrical and hydraulic system fault diagnosis and rectification
- Practice to indent and repairing various type of equipments.

Carrier Progress Pathways: Can join the apprenticeship training in different types of industries and often National Apprenticeship Certificate (NAC)

Can join Craftsman Instructor Training Scheme (CITS) to become an instructor in ITIs

Job Opportunities

- Mechanic auto body painting can join in central and state government establishments, like railway, airport, marine, military, joins as a service technician in dealer of agricultural machinery mining, trucks, bus, car, stationary engines, compressors, diesel generators, construction equipments, etc.
- Employment. opportunities in overseas.

Self-employment opportunities

- Auto body painting in rural and urban areas.
- Painting contractor
- Manufacturer of paint
- Dealership/agency for automobile paints
- Own auto body repair & painting.

General discipline in the institute: Always be polite, courteous while in institute.

Do not arguments with others, on matters of related to your training or with the office while seeking clarifications

Do not bring bad name to your institute by your improper habitude.

Do not waste your precious time in gossips with your friends and on activities other than training.

Do not be late to the theory practical and other classes.

Do not unnecessarily interfere in other's activities.

Do very attentive and listen to the lecture carefully during the theory classes and practical demonstration given by the training staff.

Give respect to your trainer and all other training staff, office staff and co-trainees.

Be interested in all the training activities.

Do not make noise while undergoing training.

Keep the institute premises neat and clean.

Do not take away any material from the institute which does not belong to you.

Be regular to attend the training classes without fail.

Prepare well before writing a test/examination.

Avoid any malpractice during the test/examination.

Write your theory and practical records regularly and submit them on time for correction

Take care of your safety as well as other's safety while doing the practicals.

Knowledge of personal safety

Objectives: At the end of this lesson you shall be able to
- **state the is personal protective equipment and its purpose**
- **name the two categories of personal protective equipment**
- **list the most common type of personal protective equipment**
- **list the conditions for selection of personal protective equipment.**

Personal Protective Equipment (PPE)

Devices, equipment, clothing are used by the employees, as a last resort, to protect against hazards in the workplace. The primary approach in any safety effort is that the hazard to the workmen should be eliminated or controlled by engineering methods rather than protecting the workmen through the use of personal protective equipment (PPE). Engineering methods could include design change, substitution, ventilation, mechanical handling, automation, etc.

The Factories Act, 1948 and several other labour legislations 1996 have provisions for effective use of appropriate types of PPE.

Ways to ensure workplace safety and use personal protective equipment (PPE) effectively.

- Workers to get up-to-date safety information from the regulatory agencies that workplace safety in their specific area.
- To use all available text resources that may be in work area and for applicable safety information on how to use PPE best.
- When it comes to the most common types of personal protective equipment, like goggles, gloves or bodysuits, these items are much less effective if they are not worn at all times, or whenever a specific danger exists in a work process. Using PPE consistent will help to avoid some common kinds of industrial accidents.
- Personal protective gear is not always enough to protect workers against workplace dangers. Knowing more about the overall context of your work activity can help to fully protect from anything that might threaten health and safety on the job.
- Inspection of gear thoroughly to make sure that it has the standard of quality and adequately protect the user should be continuously carried out.

Categories of PPEs

Depending upon the nature of hazard, the PPE is broadly divided into the following two categories:

1 **Non-respiratory:** Those used for protection against injury from outside the body, i.e. for protecting the head, eye, face, hand, arm, foot, leg and other body parts

2 **Respiratory:** Those used for protection from harm due to inhalation of contaminated air.

They are to meet the applicable BIS (Bureau of Indian Standards) standards for different types of PPE.

The guidelines on 'Personal Protective Equipment' is issued to facilitate the plant management in maintaining an effective programme with respect to protection of persons against hazards, which cannot be eliminated or controlled by engineering methods listed in table1.

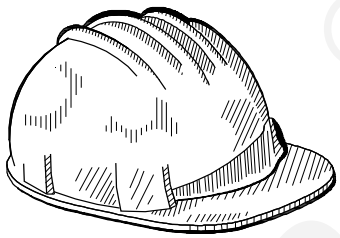
Table1

No.	Title
PPE1	Helmet
PPE2	Safety footwear
PPE3	Respiratory protective equipment
PPE4	Arms and hands protection
PPE5	Eyes and face protection
PPE6	Protective clothing and coverall
PPE7	Ears protection
PPE8	Safety belt and harnesses

Common type of personal protective equipments and their uses and hazards are as follows:

Types of protection	Hazards	PPE to be used
Head protection (Fig 1)	1. Falling objects 2. Striking against objects 3. Spatter	Helmets
Foot protection (Fig 2)	1. Hot spatter 2. Falling objects 3. Working wet area	Leather leg guards Safety shoes Gum boots
Nose (Fig 3)	1. Dust particles 2. Fumes/ gases/ vapours	Nose mask
Hand protection (Fig 4)	1. Heat burn due to direct contact 2. Blows sparks moderate heat 3. Electric shock	Hand gloves
Eye protection (Figs 5 & 6)	1. Flying dust particles 2. UV rays, IR rays heat and High amount of visible radiation	Goggles Face shield Hand shield Head shield
Face Protection (Figs 6 & 7)	1. Spark generated during Welding, grinding 2. Welding spatter striking 3. Face protection from UV rays	Face shield Head shield with or without ear muff Helmets with welders screen for welders
Ear protection (Fig 7)	1. High noise level	Ear plug Ear muff
Body protection (Figs 8 & 9)	1. Hot particles	Leather aprons

Fig 1



HELMET

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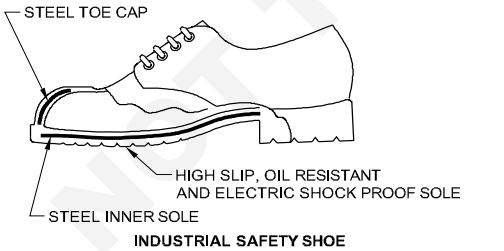
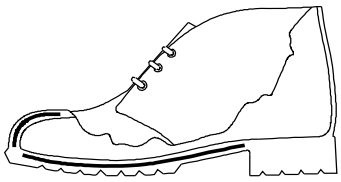
Fig 2



INDUSTRIAL SAFETY SHOE

STOUT LEATHER PREVENTS
INJURY TO THE ANCHILIES TENDON



INDUSTRIAL SAFETY BOOT

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Fig 3

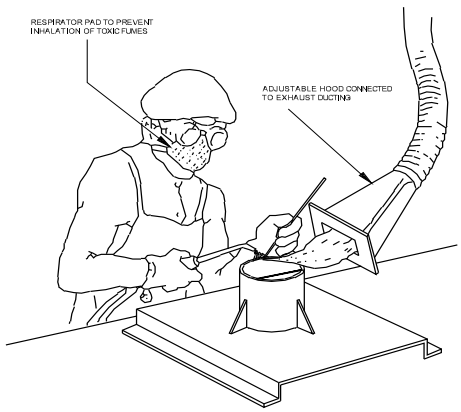

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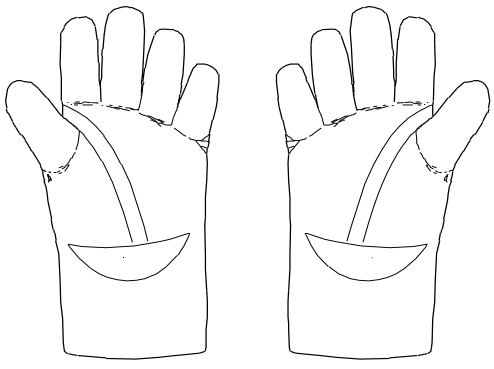
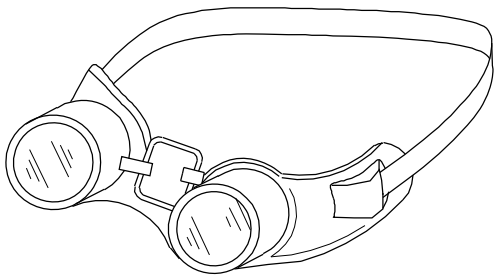
Fig 4



GLOVES

APN110414

Fig 5



GOGGLES

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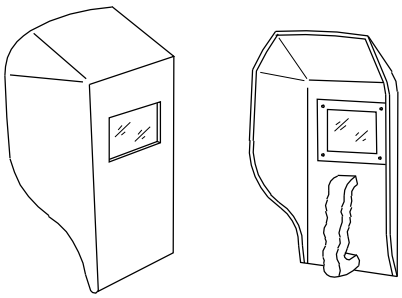
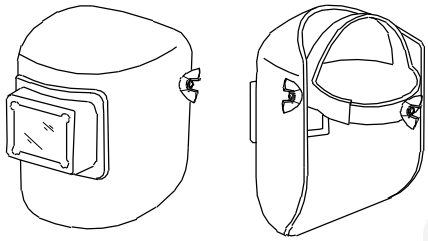
Fig 6



HAND SCREEN

APN110416

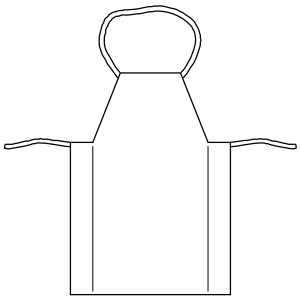
Fig 7



WELDING HELMET

APN110417

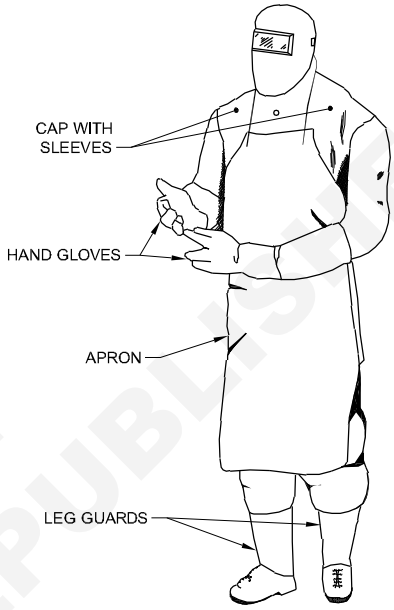
Fig 8



APRON

APN110418

Fig 9



LEG GUARDS

APN110419

Concept of house keeping & 5 'S' method in work place

Objectives: At the end of this lesson you shall be able to
- **elements of house keeping and cleanliness at work place**
- **state the concept of 5'S' techniques.**

Concept of house keeping

House keeping is the systematic process of making home/ work place neat and clean. House keeper is responsible for systematic administration of activities that provide segregation, storage, transfer, processing treatment and disposal of solid waste (which is collected during cleaning)

Scope of house keeping maintenance

The scope of work highly depend on where the house keeping activity is performed in general, maintains clean lines and orderliness.

Elements of housekeeping and cleanliness at workplace

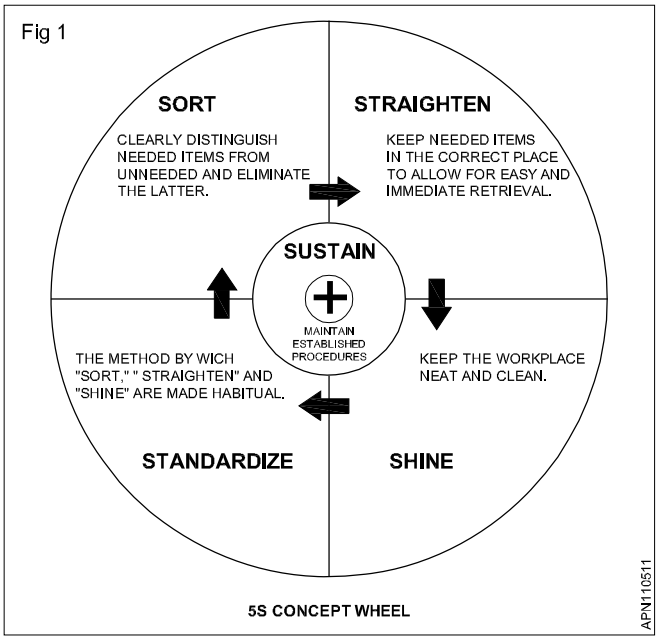
The major elements which are normally included in the housekeeping and cleanliness practices at the workplace are described below.

- **Dust and dirt removal:** Working in dusty and dirty area is unhygienic as well as unhealthy for the employees, regular sweeping the workplace for the removal of dust and dirt is an essential housekeeping and cleanliness practice. Further, compressed air is not to be used for removing dust or dirt off employees or equipment. Compressed air can caused dirt and dust particles to be embedded under the skin or in the eye.
- **Employees facilities:** Adequate employees facilities such as drinking water, wash rooms, toilet blocks, and rest rooms are to be provided for the employees at the workplace.
- **Flooring:** Floors are to be cleaned regularly and immediately if liquids or other materials are spilled. Poor floor conditions are a leading cause of accidents in the workplace. It is also important to replace worn, ripped or damaged flooring that poses a trip hazard.
- **Lighting:** Adequate lighting reduces the potential for accidents. It is to be ensured that inoperative light fixtures are repaired and dirty light fixtures are cleaned regularly so that the light intensity levels are maintained at the workplace.
- **Aisles and stairways:** Aisles and stairways are to be kept clear and not to be used for storage. It is also important to maintain adequate lighting in stairways. Further stairways need to have railings preferably round railings for adequate grip.
- **Spill control:** The best method to control spills is to prevent them from happening. Regular cleaning and maintenance on machines and equipment is an essential practice. When cleaning a spill, it is required to use the proper cleaning agents or absorbent materials. It is also to be ensured that the waste products are disposed of properly.
- **Waste disposal:** The regular collection of the waste materials contribute to good housekeeping and cleanliness practices. Placing containers for wastes near the place where the waste is produced encourages orderly waste disposal and makes collection easier. All recyclable wastes after their collection are to be transferred to their designated places so that the waste materials can be dispatched to the point of use or sold.
- **Tools and equipment:** Tools and equipment are required to be inspected prior to their use. Damaged or worn tools are to be taken out of service immediately. Tools are to be cleaned and returned to their storage place after use.
- **Maintenance:** One of the most important elements of good housekeeping and cleanliness practices is the maintenance of the equipment and the buildings housing them. This means keeping buildings, equipment and machinery in safe and efficient working condition. When a workplace looks neglected means there are broken windows, defective plumbing, broken floor surfaces and dirty walls etc. These conditions can cause accidents and affect work practices.
- **Storage:** Proper storage of materials is essential in a good housekeeping and cleanliness practice. All storage areas need to be clearly marked. Also it is important that all containers be labeled properly. If materials are being stored correctly, then the incidents of strain injuries, chemical exposures and fires get reduced drastically.
- **Clutter control:** Cluttered workplaces typically happen because of poor housekeeping practices. This type of workplace can lead to a number of issues which include ergonomic as well as injuries. It is important to develop practices where items like tools, chemicals, cords, and containers are returned to their appropriate storage location when not in use.
- **Individual workspace:** Individual workspace need to be kept neat, cleared of everything not needed for work. It is necessary to make a checklist which is to be used by the employees to evaluate their workspace.

It can be said that a clean work area demonstrate the pride employees have with the job and the culture of safety at the workplace.

5 Steps (5s) - Concept (Fig 1)

Fig 1



5s is a people-oriented and practice-oriented approach. 5s expects every one to participate in it. It becomes a basic for continuous improvement in the organisation.

The terms (5s) 5 steps are

Step 1: SEIRI (Sorting out)

Step 2: SEITON (Systematic arrangement)

Step 3: SEISO (Shine cleanliness)

Step 4: SEIKTSU (Standardization)

Step 5: SHITSURE (Self discipline)

Fig 1 shows the 5s concept wheel.

The list describes how to organize a work space for efficiency and effectiveness by identifying and storing the items used, maintaining the area and items and sustaining the new order.

Benefits of 5s

- Work place becomes clear and better organised.
- Working in working place becomes easier.
- Reduction in cost.
- People tend to be more disciplined.
- Delay is avoided.
- Less absenteeism.
- Better use of floor space.
- Less accidents.
- High productivity with quality etc.

Elementary first-aid

Objectives: At the end of this lesson you shall be able to
- **define first aid**
- **list out the first aid key points**
- **describe the responsiveness**

First aid is defined as the immediate care and support given to an acutely injured or ill person, primarily to save life,

First aid procedure often consists of simple and basic life saving techniques that an individual performs with proper training and knowledge.

The key aims of first aid can be summarized in three key points:

- **Preserve life:** If the patient was breathing, a first aider would normally place them in the recovery position, with the patient leant over on their side, which also has the effect of clearing the tongue from the pharynx. The first aider will be taught to deal with this through a combination of 'back slaps' and 'abdominal thrusts'. Once the airway has been opened, the first aider would assess to see if the patient is breathing.
- **Prevent further harm:** Also sometimes called prevent the condition from worsening, or danger of further injury, this covers both external factors, such as moving a patient away from any cause of harm, and applying first aid techniques to prevent worsening of the condition, such as applying pressure to stop a bleed becoming dangerous.
- **Promote recovery:** First aid also involves trying to start the recovery process from the illness or injury, and in some cases might involve completing a treatment, such as in the case of applying a plaster to a small wound.

ABC of first aid

ABC stands for airway, breathing and circulation.

- **Airway:** Attention must first be brought to the airway to ensure it is clear. Obstruction (choking) is a life-threatening emergency.

  Breathing: Breathing if stops, the victim may die soon. Hence means of providing support for breathing is an important next steps. There are several methods practiced in first aid.

- **Circulation:** Blood circulation is vital to keep person alive. The first aiders now trained to go straight to chest compressions through CPR methods.

When providing first aid one needs to follow some rule. There are certain basic norms in teaching and training students in the approach and administration of first aid to sick and injured.

Important guideline for first aiders

Evaluate the situation

Are there things that might put the first aider at risk. When faced with accidents like fire, toxic smoke, gasses, an unstable building, live electrical wires or other dangerous scenario, the first aider should be very careful not to rush into a situation, which may prove to be fatal.

Avoid moving the victim

Avoid moving the victim unless they are immediate danger. Moving a victim will often make injuries worse, especially in the case of spinal cord injuries.

Call emergency services

Call for help or tell someone else to call for help as soon as possible. If alone at the accident scene, try to establish breathing before calling for help, and do not leave the victim alone unattended.

Determine responsiveness

If a person is unconscious, try to rouse them by gently shaking and speaking to them.

If the person remains unresponsive, carefully roll them on the side (recovery position) and open his airway.

- Keep head and neck aligned.
- Carefully roll them onto their back while holding his head.

First aid

- Call EMERGENCY number.
- Check the person's airway, breathing, and pulse frequently. If necessary, begin rescue breathing and CPR.
- If the person is breathing and lying on the back and after ruling out spinal injury, carefully roll the person onto the side, preferably left side. Bend the top leg so both hip and knee are at right angles. Gently tilt the head back to keep the airway open. If breathing or pulse stops at any time, roll the person on to his back and begin CPR.
- If there is a spinal injury, the victims position may have to be carefully assessed. If the person vomits, roll the entire body at one time to the side. Support the neck and back to keep the head and body in the same position while you roll.

- Keep the person warm until medical help arrives.
- If you see a person fainting, try to prevent a fall. Lay the person flat on the floor and raise the level of feet above and support.
- If fainting is likely due to low blood sugar, give the person something sweet to eat or drink when they become conscious.

DO NOT

- Do not give an unconscious person any food or drink.
- Do not leave the person alone.
- Do not place a pillow under the head of an unconscious person.
- Do not slap an unconscious person's face or splash water on the face to try to revive him.

Occupational health and safety

Objectives: At the end of this lesson you shall be able to
- **define safety**
- **state the goal of occupational health and safety**
- **explain need of occupational health and safety**
- **state the occupational hygiene**
- **list types of occupational hazards.**

Safety

Safety means freedom or protection from harm, danger, hazard, risk, accident, injury or damage.

Occupational health and safety

- Occupational health and safety is concerned with protecting the safety, health and welfare of people engaged in work or employment.
- The goal is to provide a safe work environment and to prevent hazards.
- It may also protect co-workers, family members, employers, customers, suppliers, nearby communities, and other members of the public who are impacted by the workplace environment.
- It involves interactions among many related areas, including occupational medicine, occupational (or industrial) hygiene, public health, and safety engineering, chemistry, and health physics.

Need of occupational health and safety

- Health and safety of the employees is an important aspect of a company's smooth and successful functioning.
- It is a decisive factor in organizational effectiveness. It ensures an accident-free industrial environment.
- Proper attention to the safety and welfare of the employees can yield valuable returns.
- Improving employees morale
- Reducing absenteeism
- Enhancing productivity
- Minimizing potential of work-related injuries and illnesses
- Increasing the quality of manufactured products and/ or rendered services.

Occupational (Industrial) Hygiene

- Occupational hygiene is anticipation, recognition, evaluation and control of work place hazards (or) environmental factors (or) stresses
- This is arising in (or) from the workplace.
- Which may cause sickness, impaired health and well being (or) significant discomfort and inefficiency among workers.

Anticipation (Identification): Methods of identification of possible hazards and their effects on health

Recognition (Acceptance): Acceptance of ill-effects of the identified hazards

Evaluation (Measurement & Assessment): Measuring or calculating the hazard by Instruments, Air sampling and Analysis, comparison with standards and taking judgment whether measured or calculated hazard is more or less than the permissible standard

Control of Workplace Hazards: Measures like Engineering and Administrative controls, medical examination, use of Personal Protective Equipment (PPE), education, training and supervision

Occupational Hazards

"Source or situation with a potential for harm in terms of injury or ill health, damage to property, damage to the workplace environment, or a combination of these"

Types of occupational health hazards

- Physical Hazards
- Chemical Hazards
- Biological Hazards
- Physiological Hazards
- Psychological Hazards
- Mechanical Hazards

- Electrical Hazards
- Ergonomic Hazards.

1 Physical Hazards

- Noise
- Heat and cold stress
- Vibration
- Radiation (ionising & Nonionising)
- Illumination etc.,

2 Chemical Hazards

- Inflammable
- Explosive
- Toxic
- Corrosive
- Radioactive

3 Biological Hazards

- Bacteria
- Virus
- Fungi
- Plant pest
- Infection.

4 Physiological

- Old age
- Sex
- ill health
- Sickness
- Fatigue.

5 Psychological

- Wrong attitude
- Smoking
- Alcoholism
- Unskilled
- Poor discipline
  - Absentism
  - Disobedience
  - Aggressive behaviors
- Accident proneness etc,
- Emotional behaviors
  - VIOLENCE
  - Bullying
  - Sexual harassment

6 Mechanical

- Unguarded machinery
- No fencing
- No safety device
- No control device etc.,

7 Electrical

- No earthing
- Short circuit
- Current leakage
- Open wire
- No fuse or cut off device etc,

8 Ergonomic

- Poor manual handling technique
- Wrong layout of machinery
- Wrong design
- Poor housekeeping
- Awkward position
- Wrong tools etc,

Safety Slogan

A safety rule maker is an accident maker

Safety practice

Objectives: At the end of this lesson you shall be able to
- **state the causes for accidents in general terms**
- **state the safe attitudes**
- **list out the four basic categories of safety signs.**

Causes for accidents: Normally accidents do not just happen. They are caused.

Causes for accidents are many. Some of the important causes are listed below.

- Unawareness of danger
- Disregard for safety
- Negligence

- Lack of understanding of proper safety procedures
- Untidy condition of workplace
- Inadequate light and ventilation
- Improper use of tools
- Unsafe conditions

Safe attitudes: People's attitudes govern what they do or fail to do. In most cases where someone is working with unsafe equipment or in an unsafe situation, somebody has allowed that state of affairs to come about by something they have done or failed to do.

Most accidents don't just happen; they are caused by people who (for example) damage equipment or see it is faulty but don't report it, or leave tools and equipment lying about for other people to trip over.

Responsibilities: Safety doesn't just happen - it has to be organised and achieved like the work-process of which it forms a part. The law states that both an employer and his employees have a responsibility in this behalf.

Employer's responsibilities: The effort a firm puts into planning and organising work, into training people, into engaging skilled and competent workers, maintaining plant and equipment, and checking, inspecting and keeping records- all of this contributes to the safety in the workplace.

The employer will be responsible for the equipment provided, the working conditions, what employees are asked to do, and the training given.

Employee's responsibilities: You will be responsible for the way you use the equipment, how you do your job, the use you make of your training, and your general attitude to safety.

A great deal is done by employers and other people to make your working life safer; but always remember you are responsible for your own actions and the effect they have on others. You must not take that responsibility lightly.

Rules and procedures at work: What you must do, by law, is often included in the various rules and procedures laid down by your employer. They may be written down, but more often than not, are just the way a firm does things - you will learn these from other workers as you do your job. They may govern the issue and use of tools, protective clothing and equipment, reporting procedures, emergency drills, access to restricted areas, and many other matters. Such rules are essential; they contribute to the efficiency and safety of the job.

Safety signs: As you go about your work on a construction site you will see a variety of signs and notices. Some of these will be familiar to you - a 'no smoking' sign for example; others you may not have seen before. It is up to you to learn what they mean - and to take notice of them. They warn of the possible danger, and must not be ignored.

Safety signs fall into four separate categories. These can be recognised by their shape and colour. Sometimes they may be just a symbol; other signs may include letters or figures and provide extra information such as the clearance height of an obstacle or the safe working load of a crane.

The four basic categories of signs are as follows. (Fig.1)

- Prohibition signs
- Mandatory signs
- Warning signs
- Information signs

Prohibition signs

Shape Circular.
Colour Red border and cross bar. Black symbol on white background.
Meaning Shows it must not be done.
Example No smoking.

Mandatory signs

Shape Circular.
Colour White symbol on blue background.
Meaning Shows what must be done.
Example Wear hand protection.

Warning signs

Shape Triangular.
Colour Yellow background with black border and symbol.
Meaning Warns of hazard or danger.
Example Caution, risk of electric shock.

Information signs

Shape Square or oblong.
Colour White symbols on green background.
Meaning Indicates or gives information of safety provision.
Example First aid point.

Prohibition signs (Fig 2)

Fig 2

Mandatory signs (Fig 3)

Fig 3

MANDATORY SIGNS

Warning signs (Fig 4)

Fig 4

WARNING SIGNS

Questions about your safety

Do you know the general safety rules that cover your place of work?

Are you familiar with the safety laws that cover your particular job?

Do you know how to do your work without causing danger to yourself, your workmates and the general public?

Are the plant, machinery and tools that you use really safe? Do you know how to use them safely and keep them in a safe condition?

Do you wear all the right protective clothing, and have you been issued with all the necessary safety equipment?

Have you been given all the necessary safety information about the materials used?

Have you been given training and instruction to enable you to do your job safely?

Do you know who is responsible for safety at your place of work?

Do you know who are the appointed `Safety Representatives'?

- Stop the machine before changing the speed.
- Disengage the automatic feeds before switching off.
- Check the oil level before starting the machine.
- Before starting the machine, move the ram by hand to ensure that the ram or tool-handler does not strike the workpiece or table.
- Never start a machine unless all the safety guards are in position.
- Take measurements only after stopping the machine.
- Use wooden planks over the bed while loading and unloading heavy jobs.
- Do not stop the machine before the finish of the cutting stroke.

Safety is a concept, understand it.

Safety is a habit, cultivate it.

Safety practice - Fire extinguishers

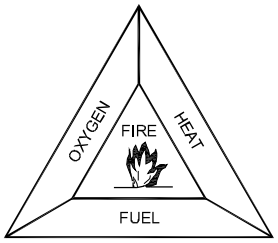
Objectives: At the end of this lesson you shall be able to
- **state the effects of a fire break out.**
- **state the causes for fire in a workshop**
- **state the general precautionary measures to be taken for prevention of fire.**
- **state the types of fire and different extinguishing agent**

Fire is the burning of combustible material. A fire in an unwanted place and on an unwanted occasion and in uncontrollable quantity can cause damage or destroy property and materials. It might injure people, and sometimes cause loss of life as well. Hence, every effort must be made to prevent fire. When a fire outbreak is discovered, it must be controlled and extinguished by immediate corrective action.

Is it possible to prevent fire? Yes, fire can be prevented by eliminating anyone of the three factors that causes fire.

The following are the three factors that must be present in combination for a fire to continue to burn. (Fig 1)

Fig 1



Fuel: Any substance, liquid, solid or gas will burn, if there is oxygen and high enough temperatures.

Heat: Every fuel will begin to burn at a certain temperature. It varies and depends on the fuel. Solids and liquids give off vapour when heated, and it is this vapour which ignites. Some liquids do not have to be heated as they give off vapour at normal room temperature say 15^0C, *eg.* petrol.

Oxygen: Usually exists in sufficient quantity in air to keep a fire burning.

Extinguishing of fire: Isolating or removing any of these factors from the combination will extinguish the fire. There are three basic ways of achieving this.

– **Starving** the fire of fuel removes this element.

– **Smothering** - ie. isolate the fire from the supply of oxygen by blanketing it with foam, sand etc.

– **Cooling** - use water to lower the temperature.

Removing any one of these factors will extinguish the fire.

Preventing fires: The majority of fires begin with small outbreaks which burn unnoticed until they have a secure hold. Most fires could be prevented with more care and by following some simple common sense rules.

Accumulation of combustible refuse (cotton waste soaked with oil, scrap wood, paper, etc.) in odd corners are a fire risk. Refuse should be removed to collection points.

The cause of fire in electrical equipment is misuse or neglect. Loose connections, wrongly rated fuses, overloaded circuits cause overheating which may in turn lead to a fire. Damage to insulation between conductors in cables causes fire.

Clothing and anything else which might catch fire should be kept well away from heaters. Make sure that the heater is shut off at the end of the working day.

Highly flammable liquids and petroleum mixtures (thinner, adhesive solutions, solvents, kerosene, spirit, LPG gas etc.) should be stored in the flammable material storage area.

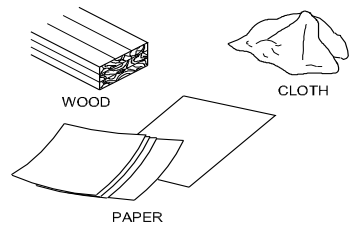
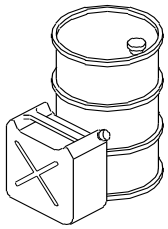
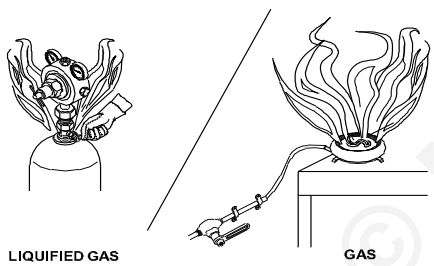
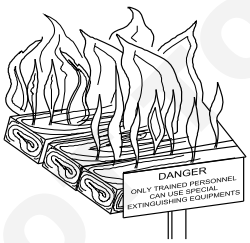
Blowlamps and torches must not be left burning when they are not in use.

Extinguishing fires: Fires are classified into four types in terms of the nature of fuel.(Figs 2,3,4 & 5)

Different types of fire have to be dealt with in different ways and with different extinguishing agents.

An extinguishing agent is the material or substance used to put out the fire, and is usually (but not always) contained in a fire extinguisher with a release mechanism for spraying into the fire.

It is important to know the right type of agent for extinguishing a particular type of fire; using a wrong agent can make things worse. There is no classification for 'electrical fires' as such, since these are only fires in materials where electricity is present.

Fuel	Extinguishing
Fig 2 CLASS 'A' FIRE  	Most effective ie. cooling with water. Jets of water should be sprayed on the base of the fire and then gradually upwards.
Fig 3 CLASS 'B' FIRE  	The aim is to cover the entire surface of the burning liquid. This has the effect of cutting off the supply of oxygen to the fire. Water should never be used on burning liquids. Foam, dry powder or CO2 may be used on this type of fire.
Fig 4 CLASS 'C' FIRE  	Extreme caution is necessary in dealing with liquefied gases. There is a risk of explosion and sudden outbreak of fire in the entire vicinity. If an appliance fed from a cylinder catches fire - shut off the supply of gas. The safest course is to raise an alarm and leave the fire to be dealt with by trained personnel. Dry powder extinguishers are used on this type of fire. Special powders have now been developed which are capable of controlling and/or extinguishing this type of fire.
Fig 5 CLASS 'D' FIRE  	The standard range of fire extinguishing agents is inadequate or dangerous when dealing with metal fires. Fire on electrical equipment. Halon, Carbon dioxide, dry powder and vapourising liquid (CTC) extinguishers can be used to deal with fires in electrical equipment. Foam or liquid (eg. water) extinguishers must not be used on electrical equipment under any circumstances.

Types of fire extinguishers

Objective: At the end of this lesson you shall be able to
- **determine the correct type of fire extinguisher to be used based on the class of fire.**

Many types of fire extinguishers are available with different extinguishing 'agents' to deal with different classes of fires. (Fig 1)

Water-filled extinguishers: There are two methods of operation. (Fig 2)

- Gas cartridge type
- Stored pressure type

With both methods of operation the discharge can be interrupted as required, conserving the contents and preventing unnecessary water damage.

Fig 1

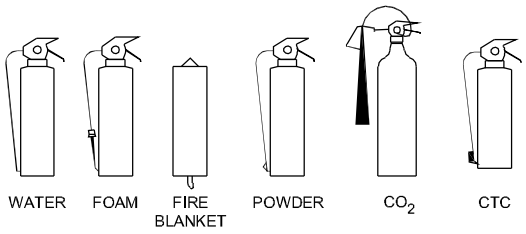
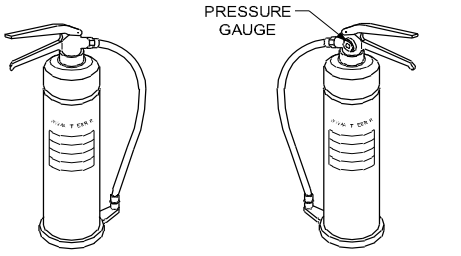
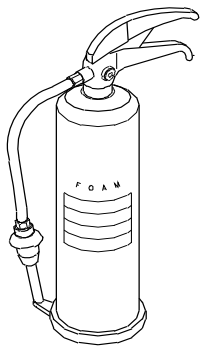


Fig 2



Foam extinguishers (Fig 3): These may be stored pressure or gas cartridge types. Always check the operating instructions on the extinguisher before use.

Fig 3



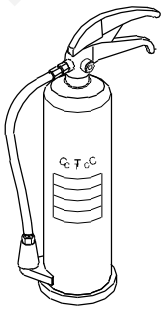
Most suitable for

- Flammable liquid fires
- Running liquid fires.

Must not be used on fires where electrical equipment is involved.

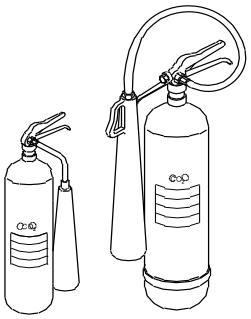
Dry powder extinguishers (Fig 4): Extinguishers fitted with dry powder may be of the gas cartridge or stored pressure type. Appearance and method of operation is the same as that of the water-filled one. The main distinguishing feature is the fork shaped nozzle. Powders have been developed to deal with class D fires.

Fig 4



Carbon dioxide (CO_2): This type is easily distinguished by the distinctively shaped discharge horn. (Fig 5).

Fig 5

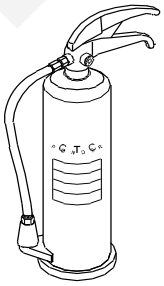


Suitable for Class B fires. Best suited where contamination by deposits must be avoided. Not generally effective in open air.

Always check the operating instructions on the container before use. Available with different gadgets of operation such as - plunger, lever, trigger etc.

Halon extinguishers (Fig 6): These extinguishers may be filled with carbon-tetrachloride and Bromochlorodifluoro methane (BCF). They may be either gas cartridge or stored pressure type.

Fig 6



They are more effective in extinguishing small fires involving pouring liquids. These extinguishers are particularly suitable and safe to use on electrical equipment as the chemicals are electrically non-conductive.

The fumes given off by these extinguishers are dangerous, especially in confined space.

The general procedure in the event of a fire

– Raise an alarm.

– Turn off all machinery and power (gas and electricity).

– Close the doors and windows, but do not lock or bolt them. This will limit the oxygen fed to the fire and prevent its spreading.

– Try to deal with the fire if you can do so safely. Do not risk getting trapped.

– Anybody not involved in fighting the fire should leave calmly using the emergency exits and go to the designated assembly point. Failure to do this may mean that some person being unaccounted for and others may have to put themselves to the trouble of searching for him or her at risk to themselves.

Safe handling and periodic testing of lifting equipments

Objectives: At the end of this lesson you shall be able to
- **state the periodic testing of lifting equipments**
- **state the handling of lifting equipments**

Safe and successful lifting operations depends on periodical testing of lifting equipment, maintenance and handling of operation, failure of this equipment may result in significant loss and fatal accident.

Lifts and cranes

Safety precautions for handling of lifts and cranes

- Never exceed the safe working load (SWL) of the equipment you are using.
- Always support vehicles with axle stands before working underneath them.
- There is always a danger when loads are lifted or suspended. Never work under an unsupported, Suspended or raised load such as a suspended engine.
- Always ensure that lifting equipment such as jacks, hoists, axle stands, slings, etc, are adequate and suitable for the job, In good condition and regularly maintained.
- Never improvise lifting tackle.

Periodic testing of lifting equipment

- Visually inspect the component of the lifting equipment such as lifting chain, slings chain hoist before operating the equipment.
- In Hydraulic function of lift (or) cranes check the oil level and top up the oil level periodically.
- The Hydraulic oil used in the lifts or cranes should be replaced periodically.
- The lifting equipment should be over hauled once (or) twice a year.
- Check the electrical connections of the lifting equipment periodically.
- The calibration of the lifting equipment should be done once in a year and calibration certificate must to obtained from the authorized testing center.

Safety disposal of used engine oil

Objectives: At the end of this lesson you shall be able to
- **state the purpose of used oil disposal**
- **state the method of safety disposal of used oil**

Waste oil: The waste oil, derived from fuels or lubricants, originally come from petroleum oil, sometimes known as mineral oils.Many lubricants may also contain synthetic components.

Waste oil is harmful to the environment and some, for example used engine oils, may cause cancer. so it needs to be managed carefully. You may need to account for Health and Safety guidance as well as the environment.

Purpose: Oils are defined as greasy, viscous substances from plant, animal, mineral sources (petroleum), and synthetics that are not soluble in water, and are usually flammable. These oils which have been used could be contaminated by physical or chemical impurities such as dirt, metal scrapings, and water. Oils that enter storm drains or waterways are a serious environmental hazard. used oil can pollute fresh water. The purpose of this procedure is to describe the proper means for handling and disposing of used oil from equipment maintenance operations, process procedures, and any other activities where used oils are generated.

This procedure applies to the disposal of any used oil that is collected during normal work functions at work place. Used oil may include:

1 **Gasoline:** Volatile, flammable, it can be ignited by sparks and flames even at cold temperatures. Vapors can migrate to distant ignition sources and in poorly ventilated spaces, can accumulate to explosive levels. Typical gasoline contains about 150 different chemicals including benzence, toluene and xylene.

2 **Fuel oils:** Fuel oils such as diesel fuel are petroleum based fluids which are some what volatile and flammable and can be ignited only when heated above 100°F. Vapors can travel and flash from ignition sources and can accumulate to explosive levels in poorly ventilated areas. All fuel oils consist of complex mixtures of aliphatic and aromatic hydrocarbons such as kerosene, benzene, and styrene.

3 **Lubricating oils:** Lubricating oils such as motor oil and hydraulic fluids are not volatile but are combustible. For lubricating oil to catch fire some other intense heat source (i.e., other materials on fire, hot engine manifold, etc.) must be present. Mineral-based lube oils are refined from petroleum or crude oil and contain additives such as lead or metal supplied and other polymers.

4 **Transformer oil:** Transformer oil conducts heat away from and insulates equipment used to convert electricity from high amperage to low amperage lines. Transformer oil is a liquid by product of the distillation of petroleum to produce gasoline.

Cooking oils and grease: Cooking oils and grease are not volatile but they are combustible. With a 400°F flash point, another heat source must be present for cooking oils or grease to catch fire. Vegetable oils contain chemical solvents that are strong enough to dissolve engine seals and gaskets.

Note: for all other waste chemicals, please refer SOP regarding Used Chemical Disposal.

Used Oil Disposal

Procedures: Products saturated with petroleum products require special handling and disposal by licensed transporters. During the collection of used oil for disposal, some basic principles should be followed:

1 Wear gloves because oil contains chemicals and contaminants that are not good for skin contact.

2 Put used oil in a clean plastic or metal container in good condition and with a tight lid.

3 If the oil is hot, avoid sudden contact with other substances because mixing may cause ignition or the receiving container to fracture due to thermal shock.

4 Do not allow used fuel and used oils to mix with any other substances because unknown and dangerous chemical reactions may occur.

5 Keep used oils away from gas cylinders and gasoline.

6 Do not fill container to the top but allow a couple inches below the rim.

7 Label the container with contents, and department.

Safe handling of fuel spillage

Objectives: At the end of this lesson you shall be able to
- **state the safe handling of fuel spillage**
- **state the effect of fuel spillage in workplace.**

Diesel fuel is a flammable liquid and fuel spillage or leaks in work place maybe cause for slippage or fire hazard.

Safe handling of fuel:

1 Improper handling of fuel may cause for fuel spillage and explosion, so fuel handling should be use appropriate method.

2 Fuel should not be stored near the working hot engine

3 Don't refueling, when it is hot, fuel tank vapor may cause for fire.

4 No smoking is allowed when refueling to the engine.

5 Don't spill the fuel during refilling the fuel in fuel tank or fuel container.

6 Use funnel during filling the fuel in fuel tank to avoid fuel spillage

7 Use tray during air bleeding from the fuel system to avoid fuel spillage

8 Fuel leaks and spills near the engine may cause for accident so it should be clean and mopped up quickly as soon as the spillage.

9 Stationary engine fuel tank should be position away from any source of direct heat to the fuel tank

Safe disposal of toxic dust

Objectives: At the end of this lesson you shall be able to
- **list the waste material in a work shop**
- **explain the methods of disposal of waste material.**

Introduction

The Automobile produces fumes containing unburnt gases such as carbon-monoxide, nitrogen oxide and other gases which are harmful to human health. Hence a systematic and scientifically designed methods are adopted for safe disposal of such toxic waste.

Dust from vehicle components to be blown into the air, since such dust floating in air for many hours, may cause harm to people who breath unknowingly.

Brake and clutch components produces dust, when used compressed air jet to clean them. While cleaning conforming the PPE to safety regulation & policies. This includes overall coat, Face mask, safety goggles for eyes earmuffs & earplug for ear protection, rubber gloves &barrier cream for hand and valued respirator for breathing.

Some auto parts having asbestos, is a toxic material, which cause lung cancer. Airborne dust in workshop leads to asthma and throat infections. Do not use compressed air to clean dust from various components & parts of the

Vehicle. Solvent used for cleaning can also form a toxic waste. Wash work cloths separately from other cloths so that toxic dust does not get transfer to other clothes. After cleaning a vehicle, there are certain chemicals present in this vehicle diet which turns toxic. To eliminate the toxic waste, create small diet piles and dispose them spontaneous rather than waiting for big diet pile till the end of the day. Workshop diet is best cleaned using a water hose, which does not allow diet to fully. But the waste water must be caught in a sledge pit and not into the storm water drain. Vacuum cleaner is a best device control toxic waste. Providing high speed exhaust ventilation can solve toxic diet.

Use grease which can not re-used is stored in a separate container and stored with unique identification. In a similar manner waste oil is stored in separate container, labeled 'Waste oil' and stored in different location, meant for disposal used diesel oil and kerosene are also stored in separate containers and kept at disposal area.

Electrical safety tips

Many injuries occur as the result of contact with electrical equipment or appliances. If the part of the body comes in contact with the electrical circuit, a shock will occur. The current will enter the body at one point and leave at another and this passage of electricity can cause severe pain, burning of skin at the point of contact, and even death. So it is need safe and free from electrical hazards.

Safety tips

1 Use only properly grounded or double insulated items/ equipments.

2 Do not overload outlets.

3 Do not plug multi-outlet bars to other multi outlet bars.

4 Only use equipment that has been approved by national testing laboratory.

5 Minimize the use of extension cards.

6 Do not cover power cords with rugs or mats.

7 Do not run electrical cord through pedestrian aisles.

8 Disconnect the power before servicing the equipment.

9 Do not ignore warning signs.

10 Replace the defective cords immediately.

11 Cover or guard any exposed electrical components or wire.

12 Don't use electrical equipment when your hands or equipments are we and don't use it near wet surface/ water.

13 Don't pull cord from a distance.

Marking material

Objectives: At the end of this lesson you shall be able to
- **name the common types of marking material**
- **select the correct marking material for different applications.**

Common types of Marking Materials

The common marking materials are Whitewash, Cellulose Lacquer, Prussian Blue and Copper Sulphate.

White wash

White wash is prepared in many ways.

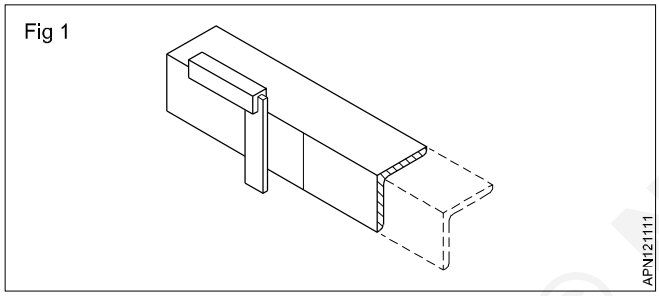
Chalk powder mixed with water

Chalk mixed with methylated spirit

White lead powder mixed with turpentine

Whitewash is applied to rough forgings and castings with oxidised surfaces. (Fig 1)

Fig 1



Whitewash is not recommended for workpieces of high accuracy.

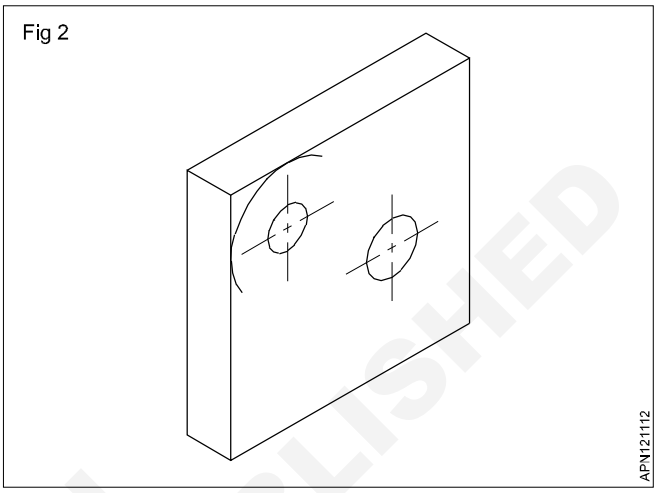
Cellulose Lacquer

This is a commercially available marking medium. It is made in different colours, and dries very quickly.

Prussian Blue

This is used on filed or machine-finished surfaces. This will give very clear lines but takes more time for drying than the other marking media. (Fig 2)

Fig 2



Copper Sulphate

The solution is prepared by mixing copper sulphate in water and a few drops of nitric acid. The copper sulphate is used on filed or machine-finished surfaces. Copper sulphate sticks to the finished surfaces well.

Copper sulphate needs to be handled carefully as it is poisonous. Copper sulphate coating should be dried well before commencing marking as, otherwise, the solution may stick on the instruments used for marking.

The selection of marking medium for a particular job depends on the surface finish and the accuracy of the workpiece.

Cleaning tools

Objectives: At the end of this lesson you shall be able to
- **state the different types of Cleaning Tools and their use**
- **state the precautions to be observed in the use of Cleaning Tools.**

Mechanical Cleaning Involves, brushing and abrasive Cleaning. It should be used very carefully on soft metals. Heavy deposits that exists even after chemical Cleaning can be removed by mechanical cleaning.

The General Cleaning Tools are

1 Wire brushes

2 Emery sheets.

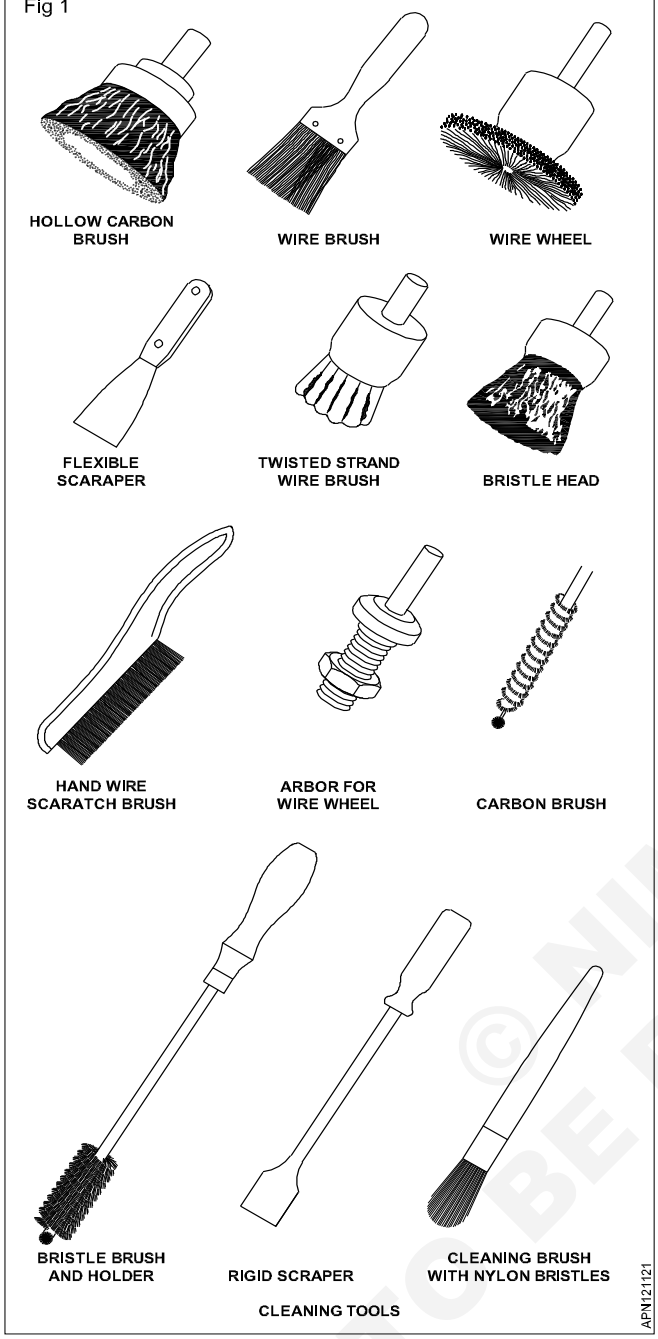
Wire Brushes

Wire brushes are generally used for cleaning the work surfaces.

It is made of steel wires (or) Nylon bristles fitted on a wooden piece.

The steel wires are hardened and tempered for long life to ensure good cleaning action. Different types of wire brushes is shown in Fig 1.

Fig 1



CLEANING TOOLS

Applications

1 Wire brushes can be used for cleaning uneven Surfaces

2 A hand wire brush can be used on exterior of the block and on the head.

3 A round wire brush fixed with a hand drill motor spindle can be used for cleaning of combustion chamber and parts of the head.

4 A wire wheel can be used to clean the valves.

5 Nylon bristles with impregnated abrasive brush can be used for Engine boring

6 A washing brush can be used to clean the cylinders by using Soap and Water.

7 Oil passages of cylinder block can be cleaned by running a long bottle type brush through all holes in the cylinder block.

8 It is used to clean work surface before and after welding

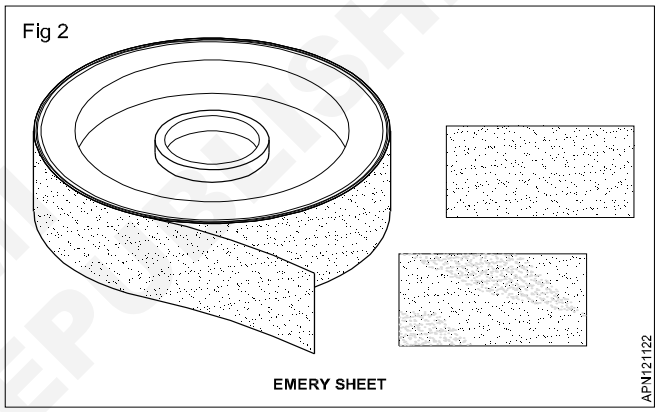
Safety precautions

Steel wire brushes should be used carefully on soft metals.

It should not make any scratches on the finished surface.

EMERY Sheet (Fig 2)

Fig 2



This is a type of paper used for sanding down hard and rough surfaces and also used for resistant technology purposes to give a smooth, shiny finish to manufactured products.

Emery paper is defined as a paper coated with abrasive particles in one side and used to produce smooth, shiny finish to manufactured products.

The emery is graded by numbers and the Common sizes are from coarse to fine: 40, 46, 54, 60, 70, 80, 90. 100. 120, F and FF.

Safety Precautions

After cleaning with emery paper, component should be rinsed properly.

Scrapper

Objectives: At the end of this lesson you shall be able to
- **name the different type of scrappers**
- **state the features of each type of scrapper**
- **state the precaution to be observed while uses scrapper.**

Scrapper is a hand tool which is used to scrap the workpiece surface by removing the smallest metal particles.

Application

It is used to obtain a smooth non scored and uniformly bearing surface which is required for sealing, sliding and guiding surface.

In automobiles it is used to remove carbon particles from cylinder head, piston head and manifold pipes

It is also used to scrap the bearings of cranks shaft and sometimes the cylinder liner.

Type of scrappers

1 Flat scrapper

2. Special scrapper

Flat scrapper: The cross section of this scrapper is Flat. The cutting edge has Flat surface.

Use: It is used to scrap the high spots of a flat Surface

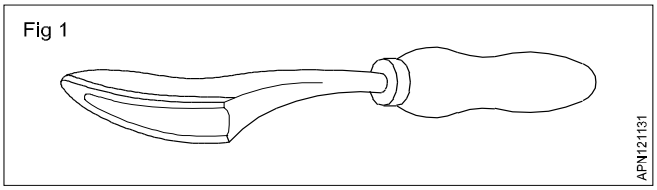
Special Scrapper: Special scraper is available for scraping and finishing curved surfaces.

They are:

- Half round scrapper
- Three-square scrapper
- Bull nose scrapper

Half round scraper: The cross-section of this scrapper is a segment and it tapers to a rounded point (Fig 1)

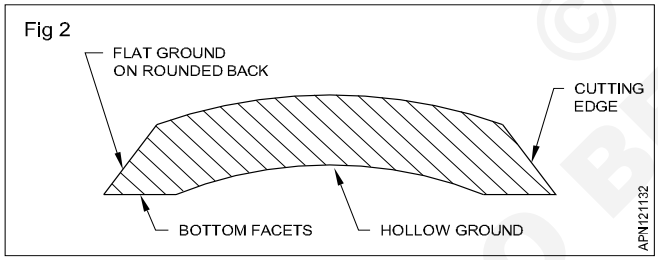
Fig 1



The round bottom face is curved and is hollow in the middle.

The bottom facet and the flat surfaces are ground along the edge to form the cutting edge. (Fig 2)

Fig 2



The cutting angle is between 45° and 65°.

The curvature at the cutting edge helps to make point contact while scraping, and also helps to remove small spots. (Fig 3)

Three-square scrapper (Fig 4): This scrapper is used for scraping small diameter holes and deburring the edges of holes.

Fig 3

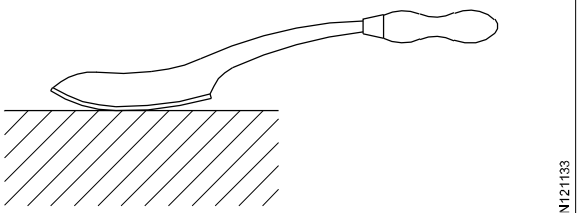
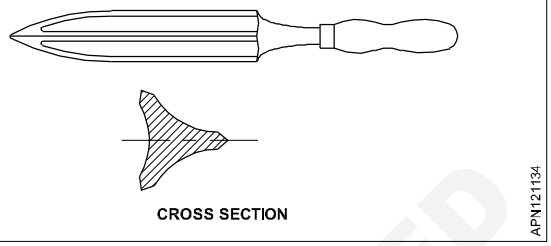


Fig 4



Bull nose scraper (Figs 5 & 6): This scrapper has the cutting edge shaped into a flat circular disc. The cutting edge forms about two thirds of the circle.It is useful for scraping large bearings.

Fig 5

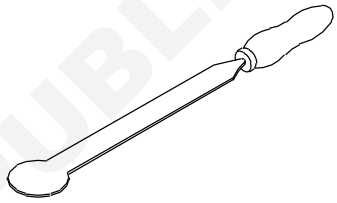
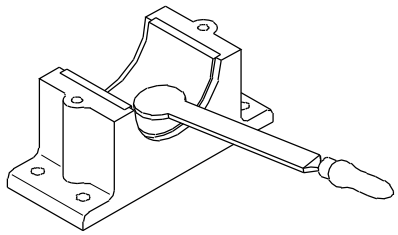


Fig 6



Always use scrappers with firmly fitted handles.

Protect the cutting edges with a rubber cover when it is not in use.

Apply oil or grease on the cutting edges when it is not use.

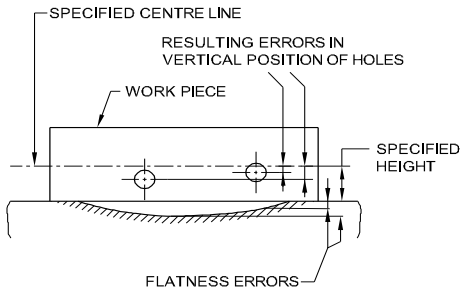
Surface plates

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

- **state the constructional features of surface plates**
- **state the application of different grades of surface plates**
- **specify surface plates and state the uses of marking tables.**

Surface plates - Their necessity: When accurate dimensional features are to be marked or to be checked it is essential to have a datum plane with a perfectly flat surface. Marking using datum surfaces which are not perfectly flat will result in dimensional inaccuracies. (Fig 1) The most widely used datum surfaces in machine shop work are the surface plates and marking tables.

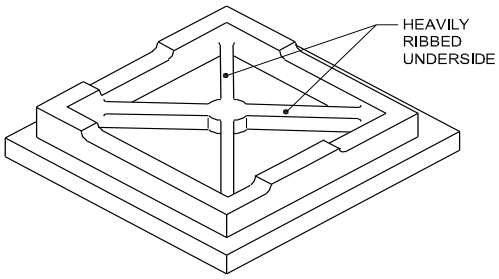
Fig 1



EFFECT OF MARKING-OUT FROM NON-FLAT SURFACE. NOTE THAT THE ERRORS IN THE HOLE POSITIONS ARE EQUAL TO THE FLATNESS ERRORS

Materials and construction: Surface plates are generally made of good quality cast iron which are stress-relieved to prevent distortion. The work-surface is machined and scraped. The underside is heavily ribbed to provide rigidity. (Fig 2)

Fig 2



CAST IRON SURFACE PLATE

Other materials used: Granite is also used for manufacturing surface plates. Granite is a dense and stable material. Surface plates made of granite retain their accuracy, even if the surface is scratched. Burrs are not formed on these surfaces.

Classification and uses: Surface plates are used in machine shop work and it is available in three grades - Grades 1, 2 and 3. The grade 1 surface plate is more acceptable than the other two grades.

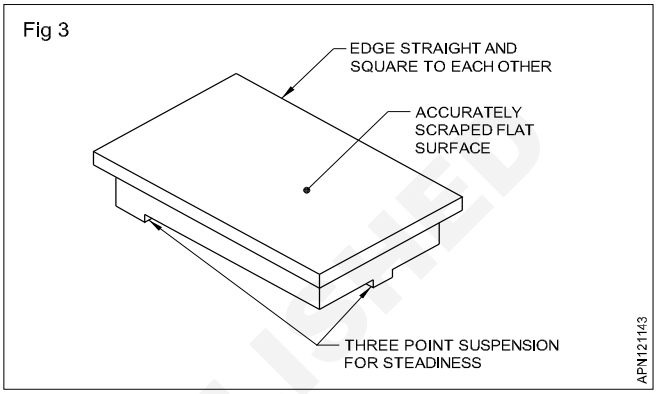
Specifications

Cast iron surface plates are designated by their length, breadth, grade and the Indian Standard number.

Example: Cast iron surface plate 2000 x 1000 Gr1. I.S.2285.

Marking-off tables (Fig 3)

Fig 3



These are heavily ribbed cast iron tables fitted with strong rigid legs. The top surface is accurately machined flat, and the sides square.

These are used for carrying out marking on heavy components. On certain types-parallel lines are engraved in both directions at a set distance.

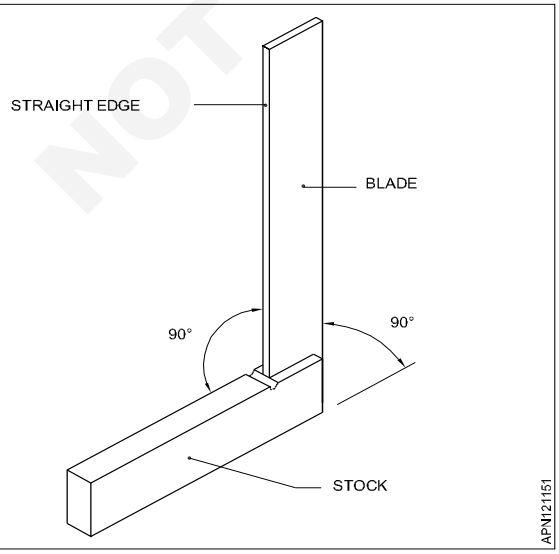
These lines serve as guides for positioning components while setting and marking.

Try square

Objectives: At the end of this lesson you shall be able to
- **name the parts of a try square**
- **state the uses of a try square.**

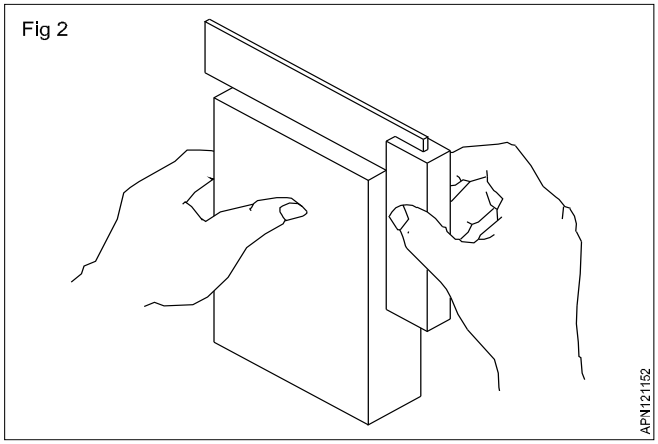
The try square (Fig 1) is a precision instrument which is used to check squareness (angles of 90^0) of a surface.

Fig 1



The accuracy of measurement by a try square is about 0.002 mm per 10 mm length, which is accurate enough for most workshop purposes. The try square has a blade with parallel surfaces. The blade is fixed to the stock at 90^0.

Fig 2



Uses: The try squareness is used (Figs 2 & 3)

- Check flatness of surfaces (Fig 3)
- Mark lines at 90^0 to the edges of work pieces. (Fig 4)

Fig 3

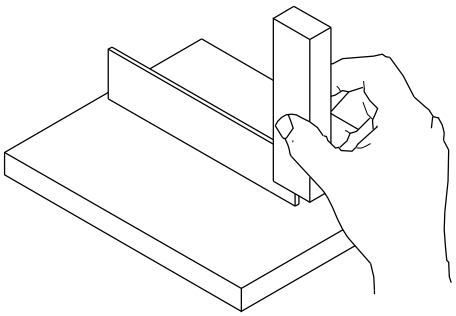
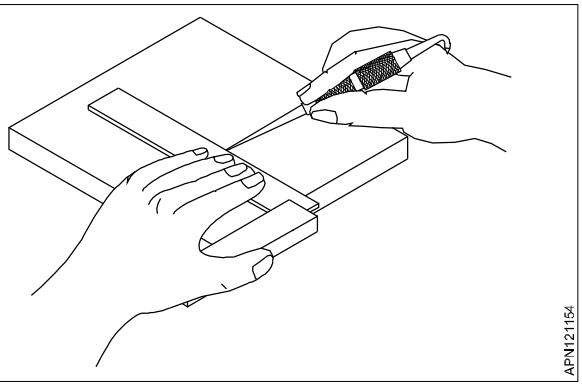


Fig 4



- Set workpieces at right angles on work. holding devices. (Fig 5)

Try squares are made of hardened steel.

Try squares are specified according to the lengths of the blade, i.e., 100 mm, 150 mm, 200 mm.

Use of a try square and steel rule.

Fig 6 shows the method of using a try square and a steel rule for accurate measurements.

Fig 5

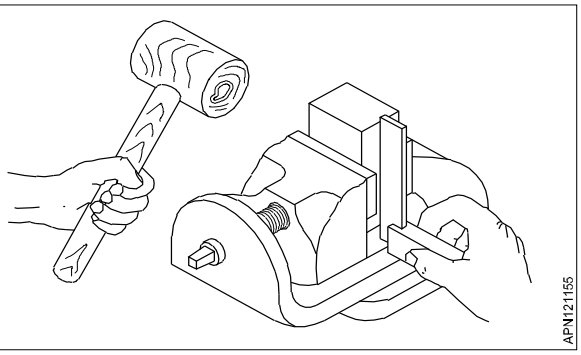
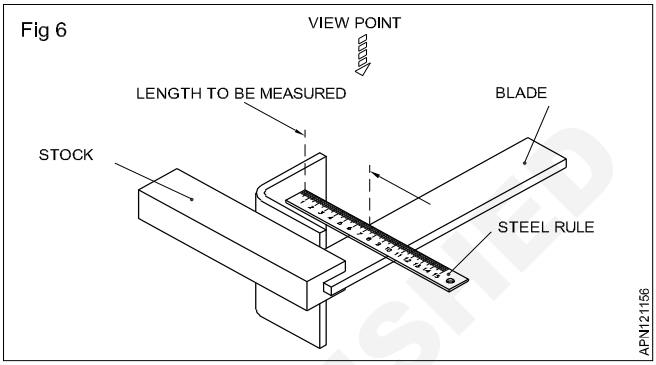


Fig 6



For maintaining accuracy it is important to see it, that the edges and surfaces of instruments are protected from damage and rust.

An experienced person can transfer measurements from a steel rule very accurately.

The steel rule graduations are accurately engraved, with the line thickness ranging from 0.12 to 0.18 mm.

Do not place a steel rule with any cutting tools. Apply a thin layer of oil when not in use.

For Accurate reading it is necessary to read vertically to avoid errors due to parallax

Types of calipers

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

- **name the commonly used calipers**
- **compare the features of firm joint and spring joint calipers**
- **state the advantage of spring joint calipers**
- **state the uses of inside and outside calipers.**

Calipers are simple measuring instruments used to transfer measurements from a steel rule to objects, and vice versa.

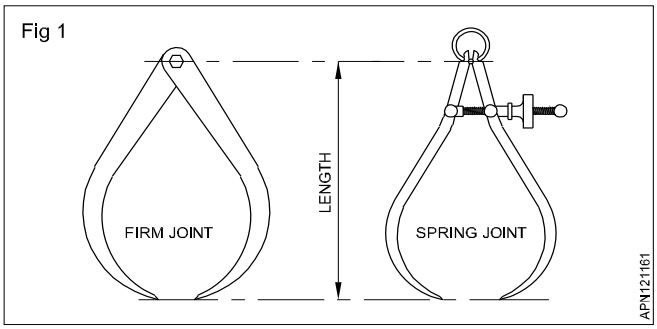
Calipers are of different types depending on the type of joint and the shape of leg.

Types of joint: The commonly used calipers are:

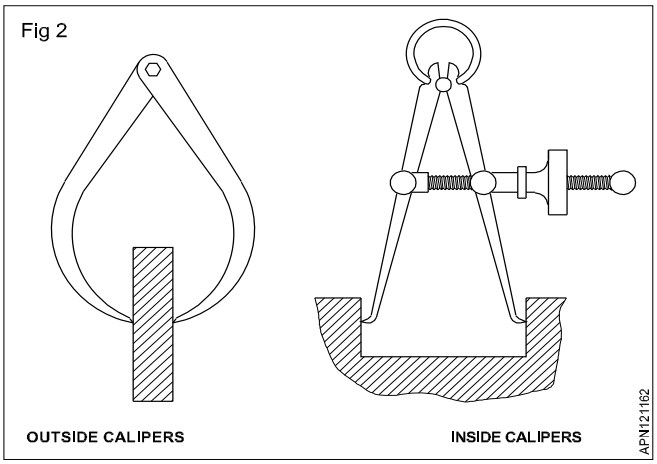
- Firm joint calipers
- Spring joint calipers.

Firm Joint calipers (Fig 1): In the case of firm joint calipers, both legs are pivoted at one end. To take measurements of a workpiece. It is opened roughly to the required size. Fine setting is done by tapping the caliper lightly on a wooden surface.

Fig 1



Spring joint calipers (Fig 2): For this type of calipers, the legs are assembled by means of a pivot loaded with a spring. For opening and closing the caliper legs, a screw and nut are provided.



Spring joint calipers have the advantage of quick setting. The setting made will not change unless the nut is turned. The size of a caliper is specified by its length - which is the distance between the pivot centre and the tip of the leg.

The accuracy of the measurement taken depends very much on the sense of feel an touch. While measuring the job, you should get the feel when the legs are just touching the surface.

Types of legs

Outside and inside calipers are differentiated by the shape of the legs.

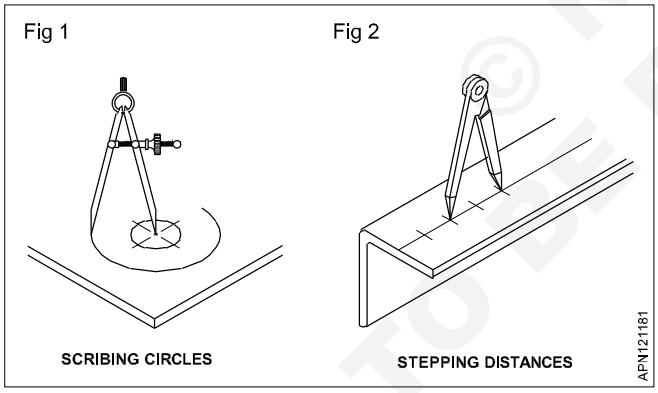
Calipers used for outside measurements are known as outside calipers. The calipers used be internal measurements are known as inside calipers.

Calipers are used along with steel rule, and the accuracy is limited to 0.5 mm; parallelism of jobs etc. can be checked with higher accuracy by using a caliper.

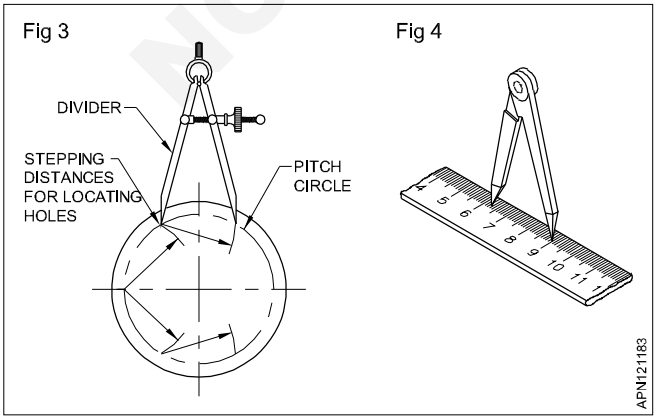
Dividers

Objectives: At the end of this lesson you shall be able to
- **name the parts of a divider**
- **state the uses of dividers**
- **state the specifications of dividers**
- **state the important aspects of be considered in respect of divider points.**

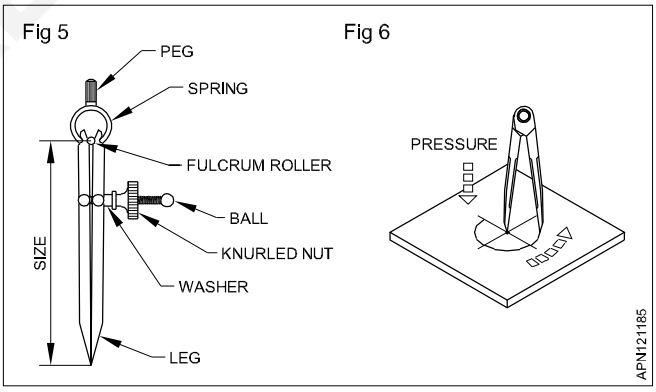
Dividers are used for scribing circles, arcs and transferring and stepping of distances. (Figs 1, 2 and 3)



Dividers are available with firm joints and spring joints. The measurements are set on the dividers with a steel rule. (Fig 4)



The sizes of dividers range between 50 mm to 200 mm. The distance from the point to the centre of the fulcrum roller (pivot) is the size of the divider. (Fig 5)



For the correct location and seating of the divider legs, prick punch marks of 30° are used. (Fig 6)

Both the legs of the divider should always be of equal length.

Dividers are specified by the type of their joints and length.

The divider point should be kept sharp in order to produce timelines. Frequent sharpening with an oil stone is better than sharpening by grinding. Sharpening by grinding will make the points soft.

Do not sharpen the divider points on grinding wheels.

Surface Gauges

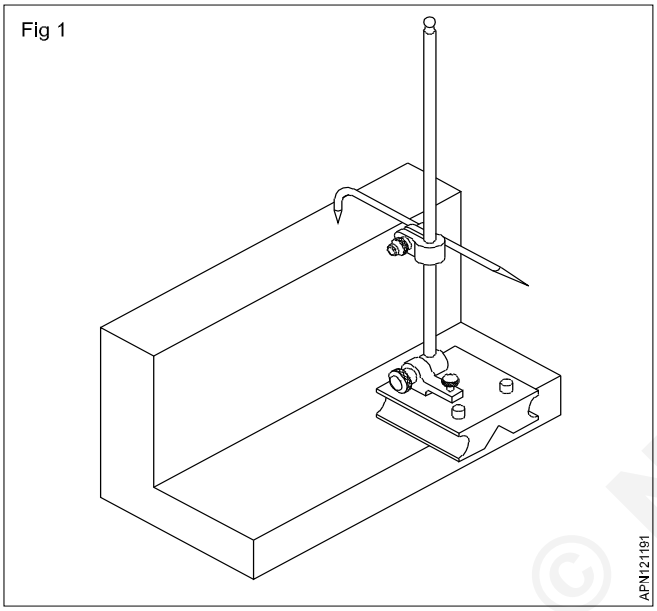
Objectives: At the end of this lesson you shall be able to
- **state the constructional features of surface gauges**
- **name the types of surface gauges**
- **state the uses of surface gauges**
- **state the advantages of universal surface gauges.**

The surface gauge is one of the most common marking tools used for. scribing lines parallel to a datum surface

Types of surface gauges

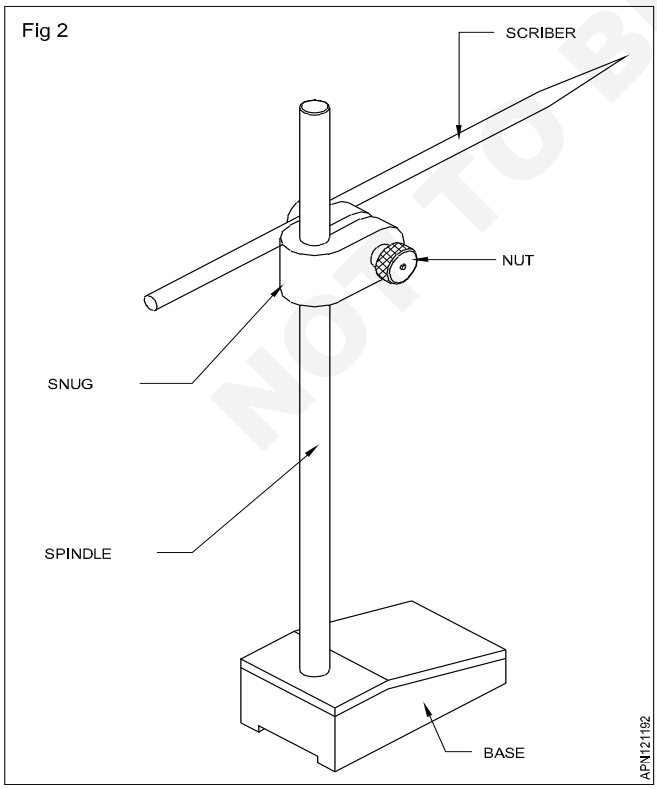
- Surface gauges/scribing blocks are of two types.
- Fixed
- Universal (Fig 1)

Fig 1



Surface gauge-fixed type (Fig 2)

Fig 2



- Setting jobs on machines parallel to a datum surface
- Checking the height and parallelism of jobs
- Setting jobs concentric to the machine spindle.

The fixed type of surface gauge consists of a heavy flat base and a spindle, fixed upright , to which a scriber is attached with a snug and a clamp-nut.

Universal surface gauge (Figs 3 & 4)

Fig 3

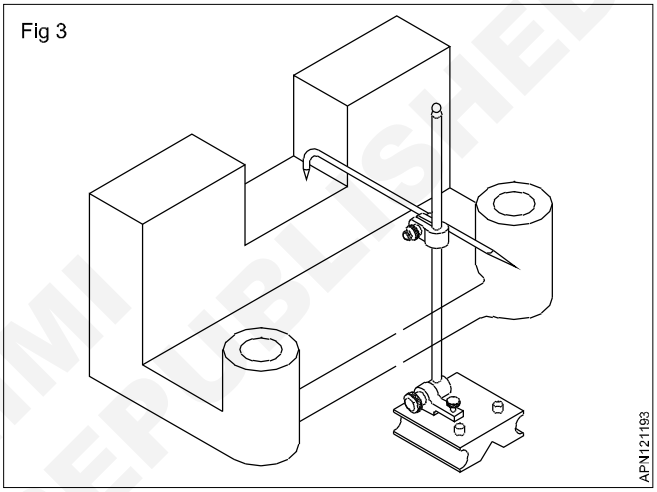
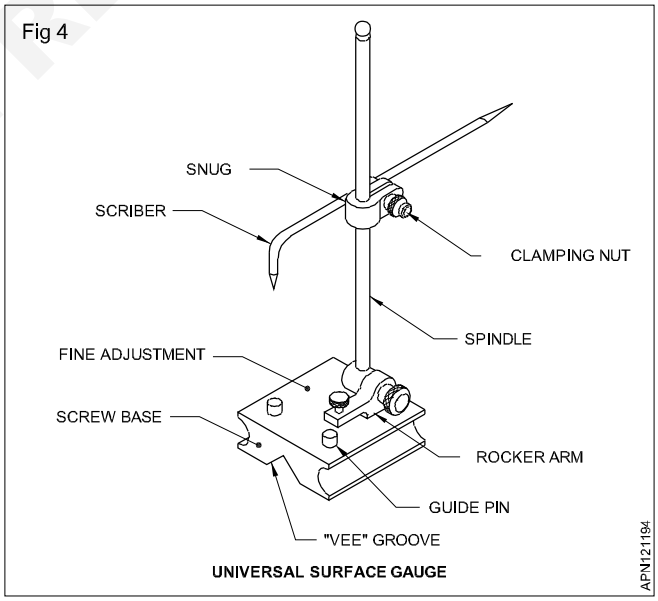


Fig 4



This has the following additional features.

- The spindle can be set to any position.
- Fine adjustments can be made quickly.
- Can also be used on cylindrical surfaces.

Scriber

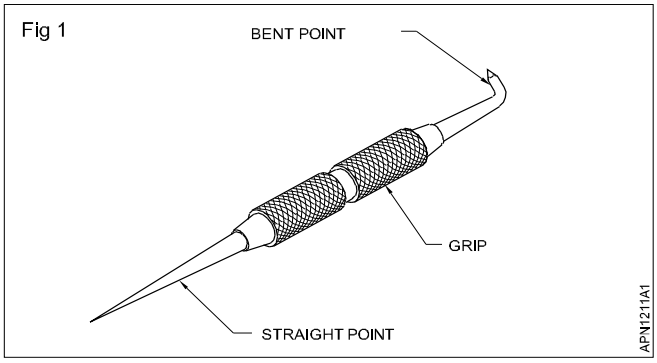
Objectives: At the end of this lesson you shall be able to
- **state the features of scribers**
- **state the uses of scribers.**

In layout work, it is necessary to scribe lines to indicate the dimensions of workpieces to be filed or machined .

The scriber is a tool used for this purpose. It is made of high carbon steel which is hardened. For drawing clear and sharp lines, a fine point is ground at one end.

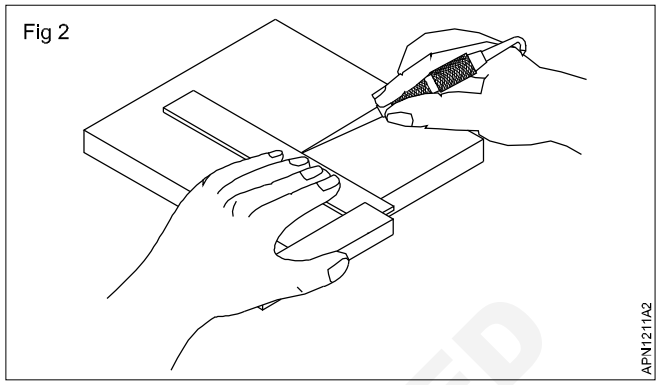
Scribes are available in different shapes and sizes. The one most commonly used is the plain scriber (Fig 1).

Fig 1



While scribing lines, the scriber is used like a pencil so that the lines drawn are close to the straight edge (Fig 2).

Fig 2



The point of the scriber should be ground and honed frequently for maintaining its sharpness.

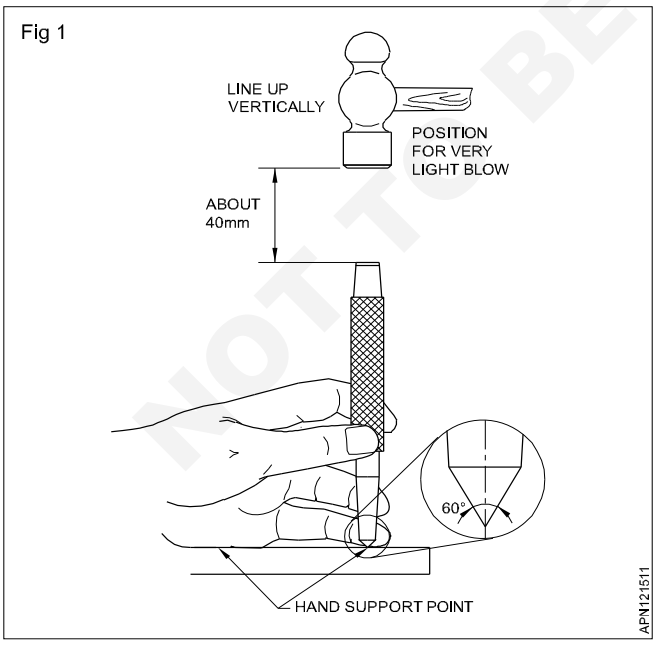
Scriber points are very sharp, and they are to be handled very carefully. Do not put the scriber in your pocket. Place a cork on the point when not in use to prevent accidents. (when it is not in use)

Hand tools

Objective: At the end of this lesson you shall be able to
- **state the application of punches.**

Punches are used in sheet metals and other work to mark position on work. (Fig 1)

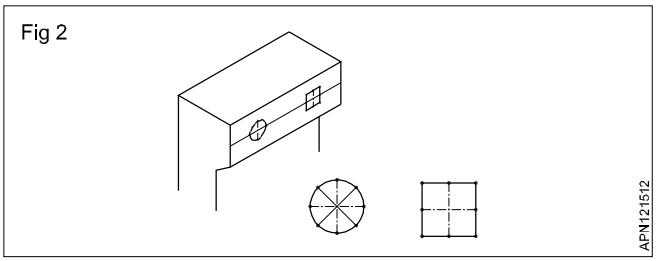
Fig 1



Prick punches

These punches are used to make witness marks on scribed lines. (Fig 2)

Fig 2



This makes it easier to see accurate marking out lines.

- To check the location of the centre positions before centre punching. (Fig 3)
- To locate the pivot points of compasses for scribing circles. (Fig 4)

A 100 mm prick punch with a 7 mm diameter body could have a 2.5 mm diameter point ground to an angle of 60° or 30°

Fig 3

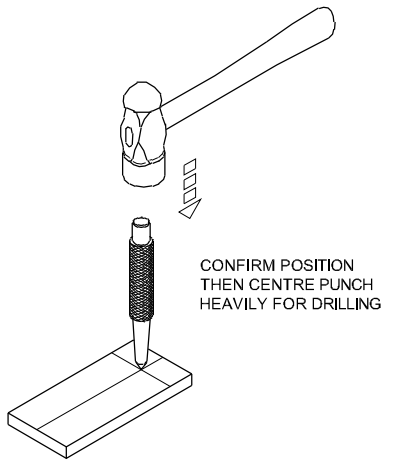
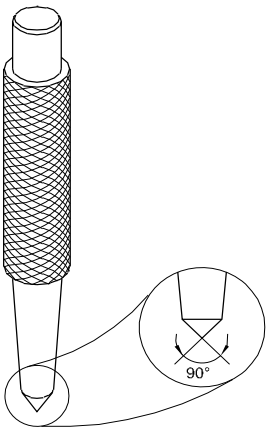


Fig 4



Centre punches

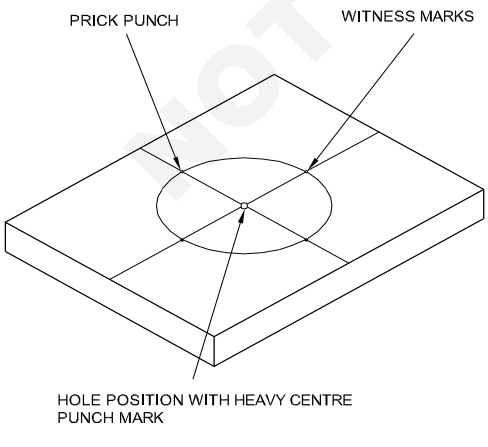
These punches are similar to prick punch, and it is generally larger then prick punch.

A 100 mm centre punch could have a 10 mm diameter body and a 6 mm diameter point ground to an angle of 90°

Centre punches are used:

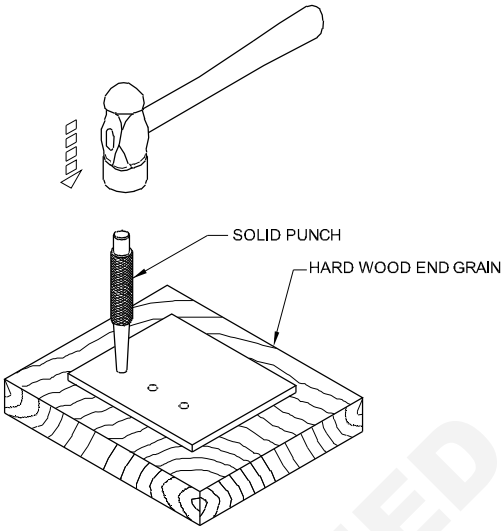
- To make deeper witness marks on scribed lines and to locate a centre position and make it easier for the drill to start correctly. (Fig 5)

Fig 5



Solid punch (Fig 6)

Fig 6



PUNCHING HOLES FOR RIVETS WITH A SOLID PUNCH

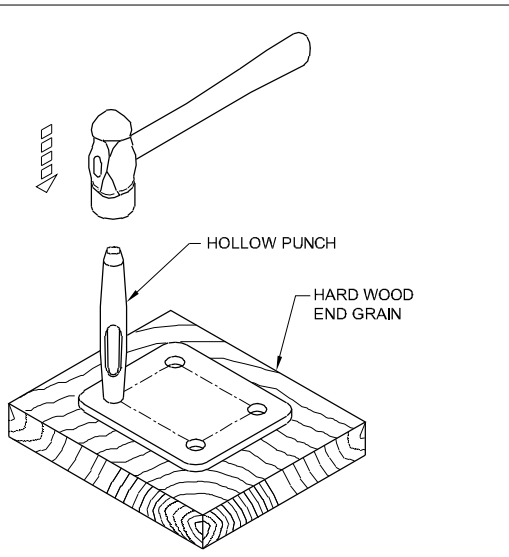
In riveting sheet metal, holes must be equally spaced and lined up. The holes in the metal are usually punched with solid punches.

Letter and number punches

These punches are known as letter stamps or number stamps, letter punches are used to emboss the impression of a letter or number into a workpiece. They are most common in the reverse image, this allows the end result to be immediately readable, however they may be made as a positive image. This is essential in the case of die or mold making and ensure that the finished product will be readable, as a die is a negative image.

Hollow punch (Fig 7)

Fig 7



USING A HOLLOW PUNCH

These punches are also used to punch holes in thin sheet metal, leather, plastic cork etc. Gaskets, seals and spacers are made using hollow punches.

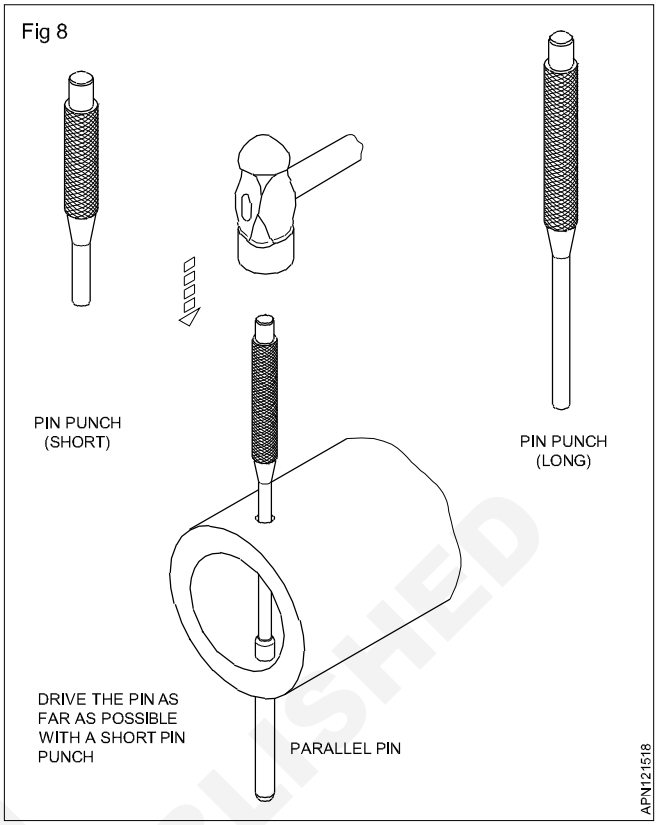
While using solid or hollow punches, the materials is rigidly supported with a block of wood (with the end of grain up) or lead. This will also avoid any damage to the tip of the punch while punching.

Pin punches (Fig 8)

Pin punches are used to drive locating or locking pins, dowels and rivets out of their holes.

Pin punches are available in a set of 5 pins of dia.3,4,5,6 and 8 mm with a knurled body to a length of approximately 150 mm.

Fig 8

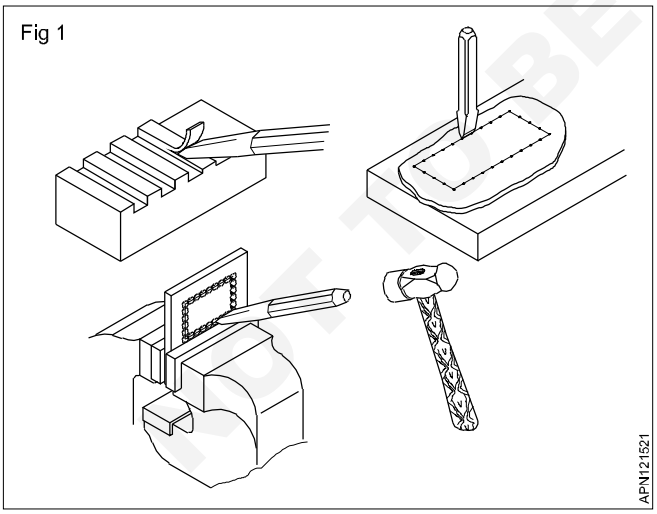


Chisel

Objectives: At the end of this lesson you shall be able to
- **list the uses of a cold chisel**
- **name the parts of a cold chisel**
- **state the different types of chisel.**

The cold chisel is a hand cutting tool used by fitters for chipping and cutting off operations. (Fig 1)

Fig 1



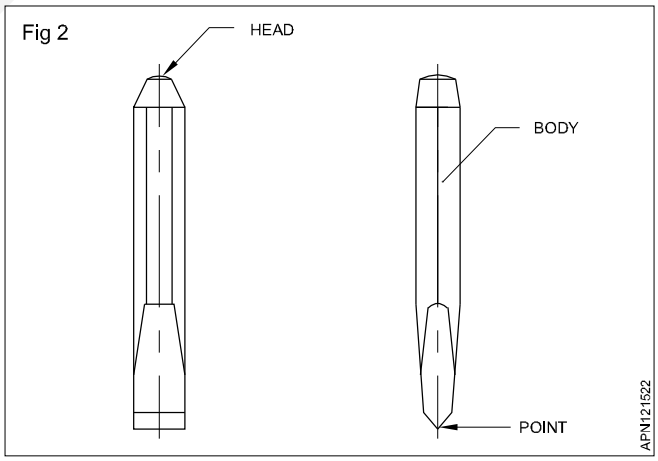
Chipping is an operation of removing excess metal with the help of a chisel and hammer. Chipped surfaces being rough, they should be finished by filing.

Parts of a chisel (Fig 2)

A chisel has the following parts.

Head

Fig 2



Body

Point or cutting edge

Chisels are made from high carbon steel or chrome vanadium steel. The cross-section of chisels is usually hexagonal or octagonal. The cutting edge is hardened and tempered.

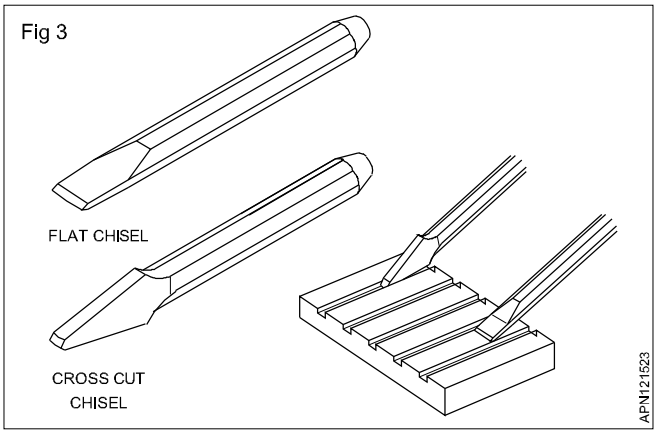
Common types of chisel

There are four common types of chisel

- Flat chisel (1)
- Cross-cut chisel (2)

- Half round nose chisel
- Diamond point chisel

Flat chisel (Fig 3)



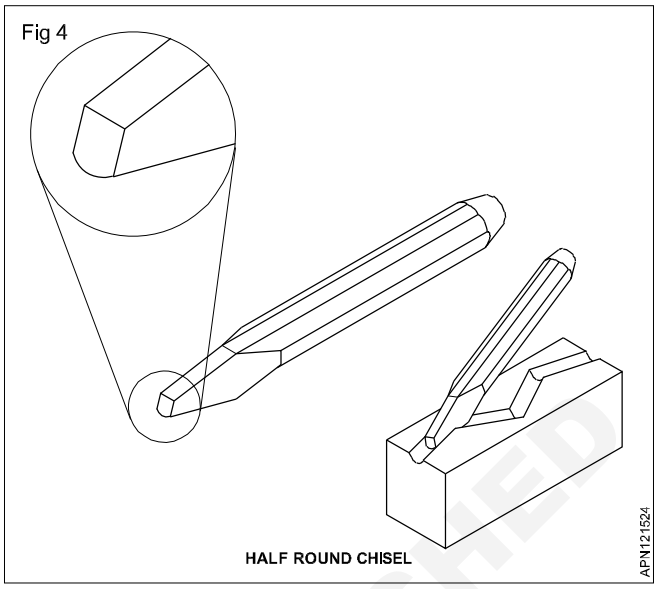
These are used to remove metal from large flat surfaces and chip excess metal of weld joints and castings.

Cross-cut or cape chisel (Fig 3)

These are used for cutting keyways, grooves and slots.

Half round nose chisel (Fig 4)

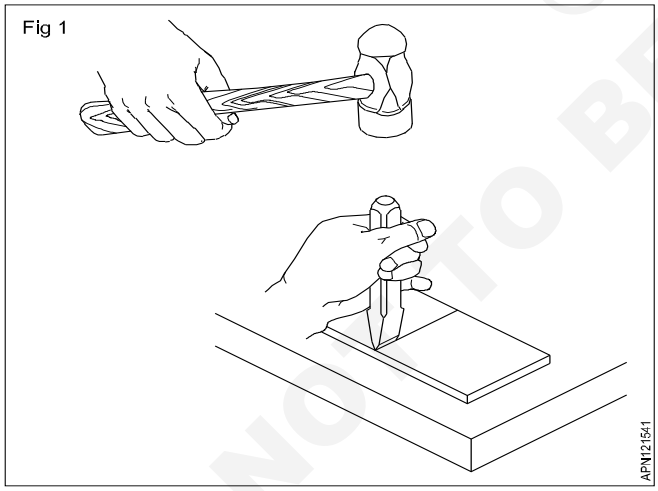
These are used for cutting curved grooves (oil grooves)



Hammers

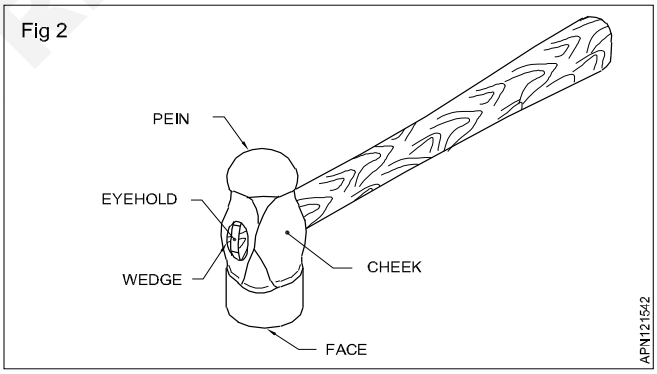
Objectives: At the end of this lesson you shall be able to
- **state the uses of an engineer's hammer**
- **list the parts of an engineer's hammer and state their functions**
- **name the types of engineer's hammers**
- **specify the engineer's hammer.**

An engineer's hammer (Fig 1) is a hand tool used for striking purposes while



- Punching
- Bending
- Straightening
- Chipping
- Forging
- Riveting

Major parts of a hammer (Fig 2)



The major parts of a hammer are a head and a handle.

The head is made of drop-forged carbon steel, while the wooden handle must be capable of absorbing shock.

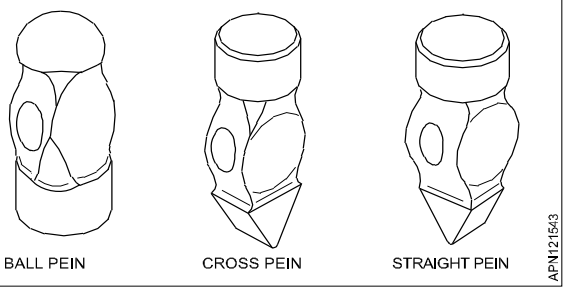
The parts of a hammer head are the

- Face (1)
- Pein (2)
- Cheek (3)
- Eyehole (4)
- Wedge (5)

The face is the striking portion. Slight convexity is given to it avoid digging of the edge.

The pein is the other end of the head. It is used for shaping and forming work like riveting and bending. The pein is a different shapes like the (Fig 3)

Fig 3



- Ball pein
- Cross pein
- Straight pein

The face and the pein are hardened.

The cheek is the middle portion of the hammer-head. The weight of the hammer is stamped here.

This portion of the hammer-head is left soft.

An eyehole is meant for fixing the handle. It is shaped to fit the handle rigidly. The wedges fix the handle in the eye hole. (Figs 4 & 5)

Fig 4

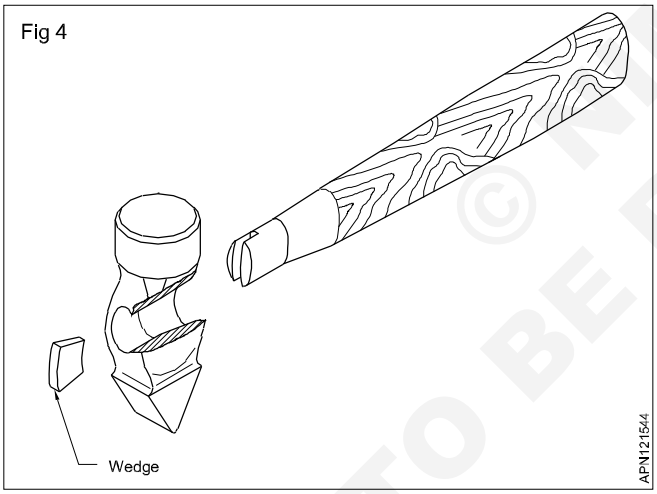
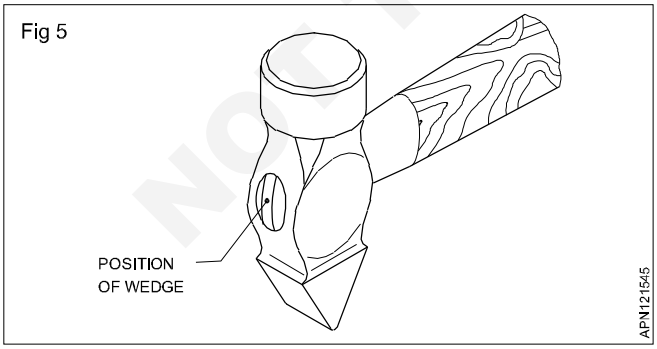


Fig 5



Specification

An engineer's hammers are specified by their weight and the shape of the pein. Their weight varies from 125 gms to 1.5 kg.

The ball pein hammers are used for general work in a machine/fitting shop.

Before using a hammer

Make sure the handle is properly fitted

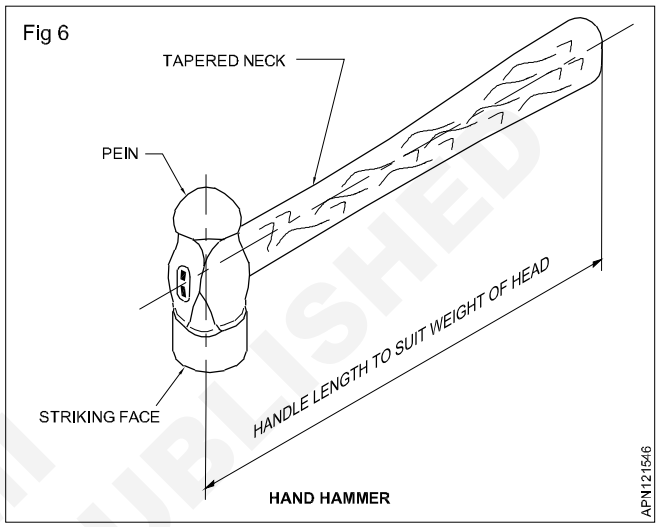
Select a hammer with the correct weight suitable for the job.

Check the head and handle for any cracks .

Ensure the face of the hammer is free from oil or grease.

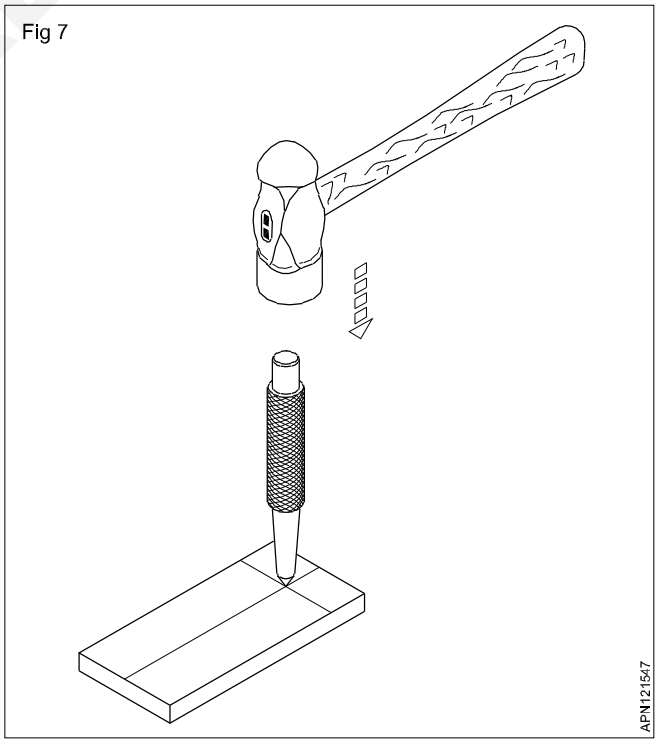
The figure 6 shows the different parts of a hammer. The handle is fitted in the eye-hole of the hammer.

Fig 6



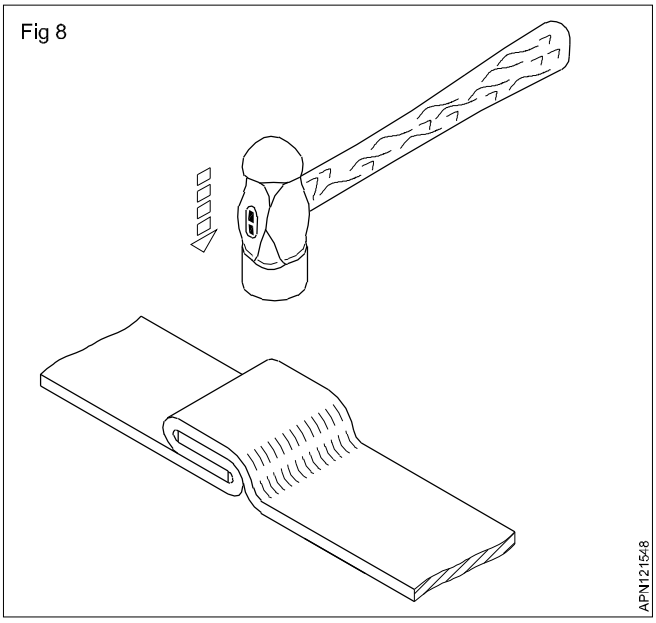
The face of the hammer is used for general work, such as striking chisels and punches and levelling and working over joints. (Fig 7)

Fig 7



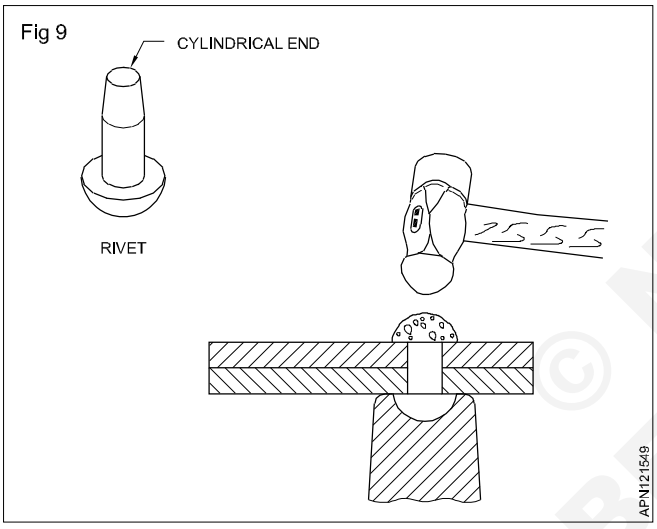
Ball pein hammer (Fig 8): A ball pein head is used to spread metal in all directions.

Fig 8



This hammer has a semi-spherical pein suitable for riveting. (Fig 9)

Fig 9

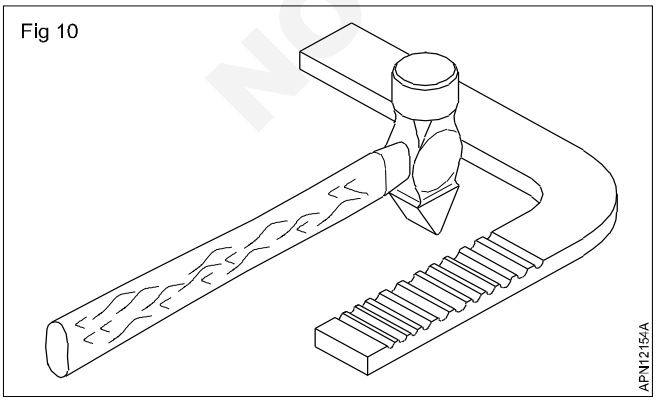


It is used for shaping the cylindrical end of a metal rivet to form a rivet head.

Cross pein hammer (Fig 10): A cross pein head is used to spread metal in one direction in the line of striking.

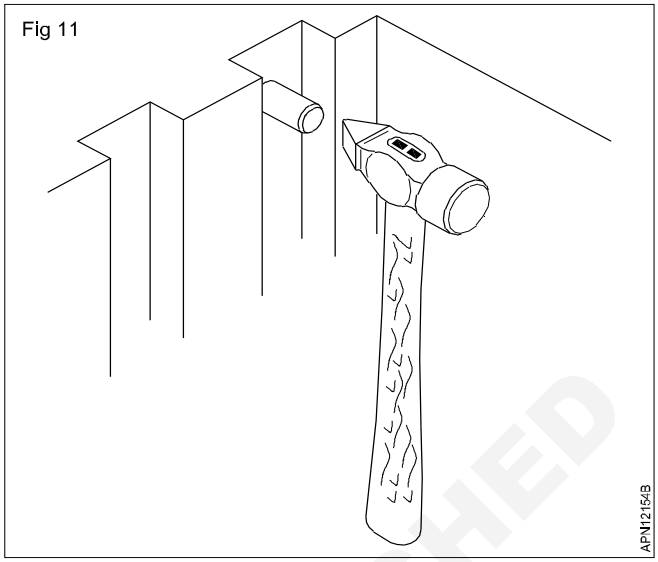
This has a blunt wedge-shaped pein at right angles to the axis of the handle.

Fig 10



Straight pein hammer: A straight pein hammer is used to spread metal in one direction at right angles to the line of striking (Fig 11)

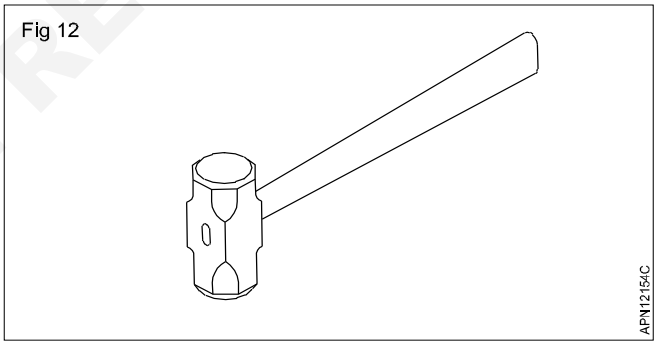
Fig 11



This hammer has a blunt wedge-shaped pein in line with the axis of the handle.

A lump hammer or club hammer is a small sledge hammer (Fig 12) whose relatively light weight and short handle allow single-handed use. It is useful for light demolition work, driving masonry nails, and for use with a steel chisel when cutting stone or metal. In this last application, its weight drives the chisel more deeply into the material being cut than lighter hammers.

Fig 12



Wooden mallet and metal body tools

Objectives: At the end of this lesson you shall be able to
- **state the metal body tools**
- **name the different types of mallets**
- **state the uses of each type of mallets.**

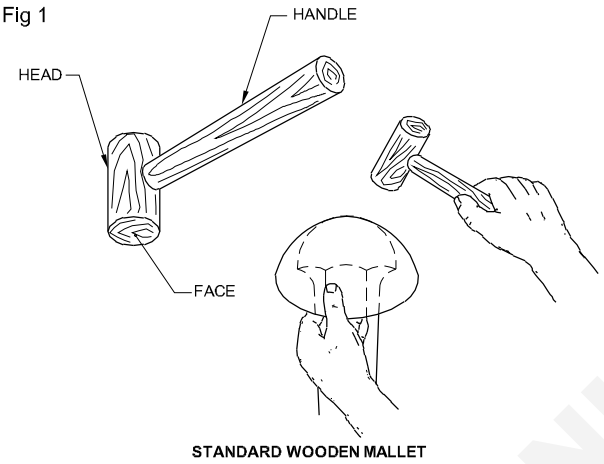
Mallets

Mallets are soft hammers and are made of raw hide, hard rubber copper, brase, lead or wood, and are used to strike a soft and light blow on the metal.

Types and uses

Standard wooden mallets (Fig 1) are used for general purpose work like flattening, bending etc.

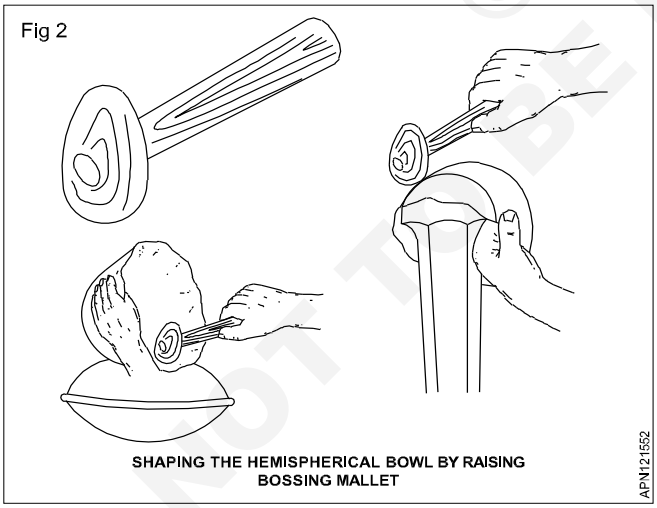
Fig 1



STANDARD WOODEN MALLET

Bossing mallets (Fig 2) are used for hollowing panel beatings etc.

Fig 2



SHAPING THE HEMISPHERICAL BOWL BY RAISING BOSSING MALLET

An end-faked mallet (Fig 3) is used for stretching, hammering etc.

Metal body tools

a Hammers

1 Dinging hammer (A) (Fig 4): It is a general purpose hammer for use on any body panel.

It has a 1/38 inch square face and 1 9/16 inch round face and is made from drop forged alloy steel which has been beat treated.

Fig 3

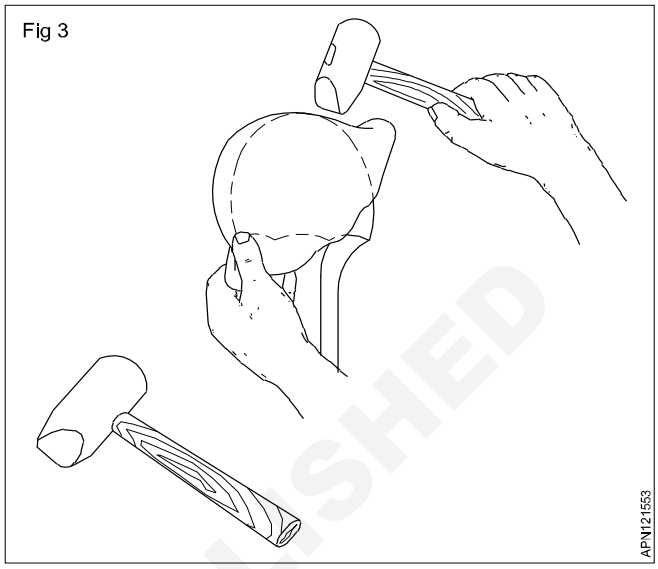
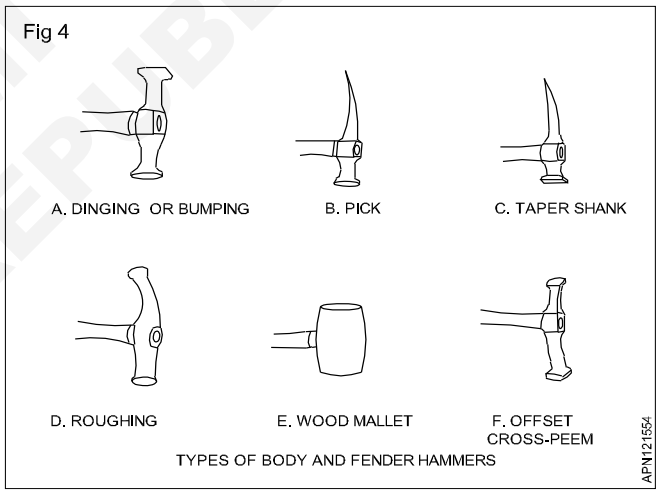


Fig 4



TYPES OF BODY AND FENDER HAMMERS

2 Pick hammer (B) (Fig 6)

The painted shank of this hammer is used to raise small, low spots when cross filling. It has a 1 9/16 inch round face and a curved shank tapering to a point. The bullet type pick hammer (not shown) is designed for use on all industrial metal finishing and general dinging work.

3 Taper shank hammer (C)

Designed for the latest metal bodies and fenders, it is used for reshaping all beads, moldings, head lamp insets, reveals and lowers. It has a wide chisel face for rapid pick surfacing in large areas.

4 Roughing hammer (D)

Its curved shank reaches places not accessible to hammers of ordinary design and its round face is ideal for working an extra heavy gage metal.

5 Wooden mallet (E)

It is for use in connection with hot-metal shrinking and for dinging soft metal such an aluminium, copper and brass. It will not chip under ordinary usage.

6 Offset cross-peen hammer (F).

Its offset square face affords ample clearance without danger of striking adjoining panels. Its high crown cross-pein is designed for deep and narrow panels and return contours. The high crown may also be used in conjunction with the shrinking dolly to cold-shrink panels or sink welds.

b Dollgs

1 Heel dolly (A) Fig 5

Fig 5

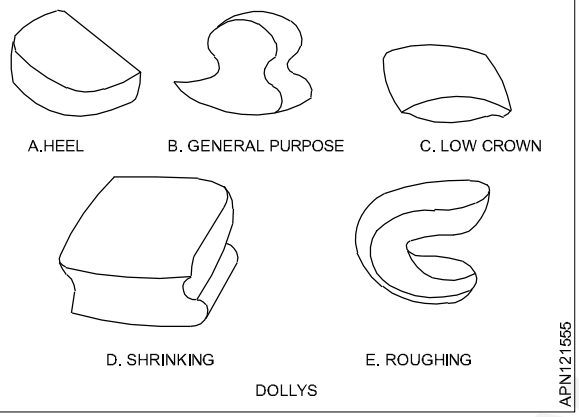
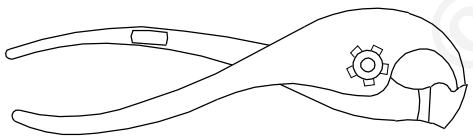


Fig 6



It is shaped like the heel of a shoe, round face on one side and flat on the other. It may be used as a general purpose dolly.

2 High crown (General purpose) Dolly (B)

It is precision ground for high-crown contours and is used in general body repair work. This tool is made from drop forged alloy steel.

3 Low crown dolly (C)

It is used on low crown panels. The hooks on the dolly are used on fender beads, drip moldings and sharp, concaved moldings.

4 Shrinking dolly (D)

It is a specially designed combination high and low crown dolly. It has nie distinct contour combinations for hot and cold shrinking. It has wide and narrow trenching grooves for sinking welds.

5 Heavy duty roughing dolly (E) (Fig 7A)

It has convenient grip and greater height to furnish extra backing for heavy duty hammering. It may be used in place of a roughing hammer for roughing out small dents. The lip at the end of its face is useful for reshaping turned under flanges.

c Drip molding pliers (fig 6)

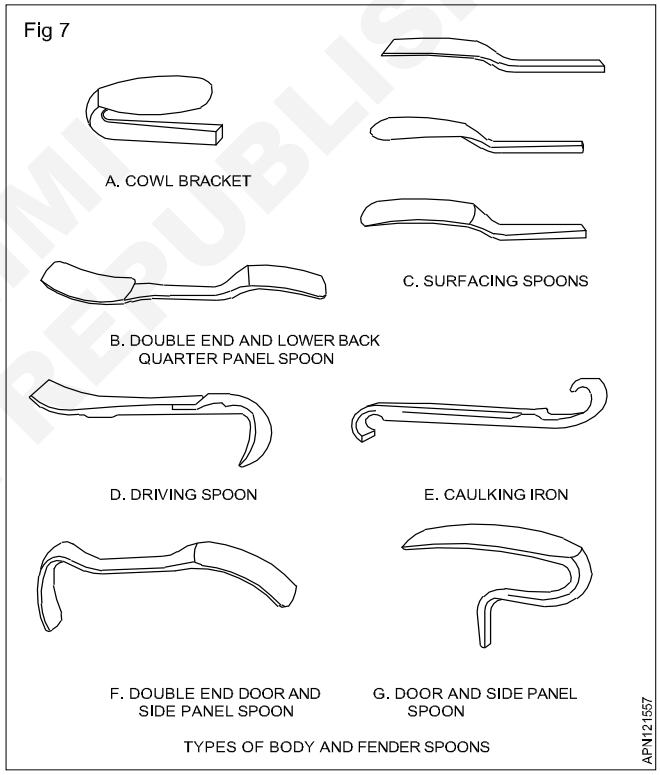
Their accurately formed working faces permit extremely rapid roughing out for finishing with a suitable spoon. Made from drop forged steel, they are indispensable for pulling out crushed drip moldings.

d Body spoons

Body spoons are generally used for driving high spots back to their normal position without disturbing the surrounding surface. The working surface of each spoon is designed for a specific purposes. The more common varieties of spoons are the following:

1 Cown bracket (A) (Fig 7)

Fig 7

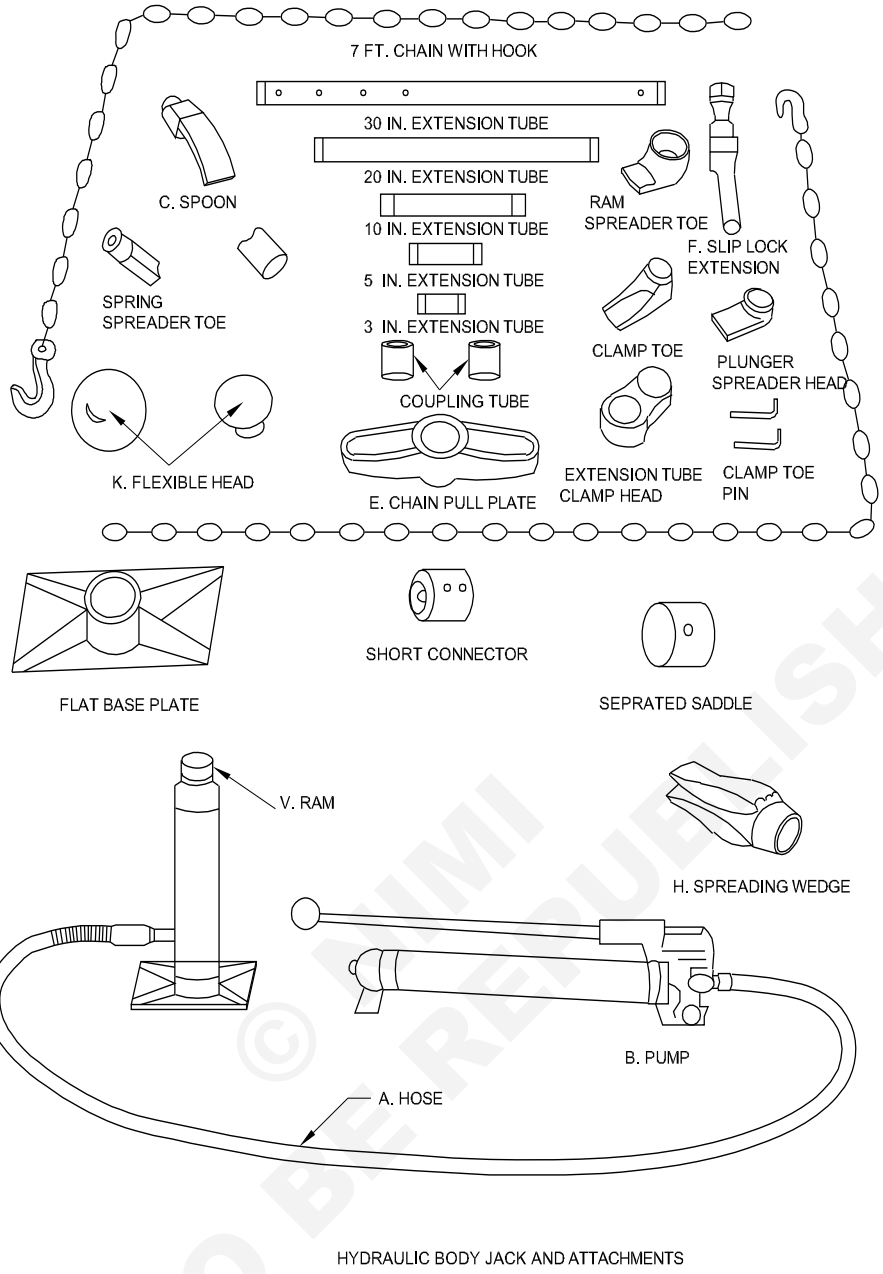


Designed especially to hook over the fender brackets, it is used to work over crown surface. It may be used as a dolly, so the wheel can be kept on when reaching a dent.

2 **Double end and lower beck quarter panel spoon (B):** It is used for removing dents on quarter panels around rear pillars, behind inner construction and behind back panel strainers. It may be used for removing dents from behind sills.

3 **Surfacing spoon (C) (Fig 8):** It is used for spring hammering operations with either the mallet or bumping hammer and surface finishing. It is useful on all fender repairs and on high crown areas finishing. It is useful on all fender and on cron areas. drip molding and back panels

Fig 8



4 Double end heavy duty driving spoon (D)

This is a general purpose utility spoon with a wide variety of uses. It is used to set inside seams of front fenders, bumping top rail panels, bead lamp housings, hood louvers, and straightening and finishing drip molding and back paners. It may be used for general biasing work, lighting hinge pins, railing low sports and for work around the ventilator in the down assembly.

5 Caulking iron (E)

A caulking iron is sometimes called a fender beading ool. It is a specially designed double and heavy duty bending tool used for straightening all reverse bead on fenders with no wire and turned under flanged edges. It may be used on return flanges or hoods and for aligning inner construction on body panels. Its hammer pad provide a base for hammering operations.

6 Double end door and side paner spoon (F)

Its precision ground face sakes it useful as a dolly block in direct hammering. It is designed to reach the hard-to-get places behind inner construction on doors and cowl panels.

7 Special door and side panel spoons (G)

The unusual length of this spoon, together with its shape, enables the workman to reach far behind construction and remove bumps from doors and trunk lid without cutting out the inner constructions.

e File bolder and blade

1 Adjustable file bolder

This tool quickly adjusts from an extreme concave to an extreme convex profile. It has maximum utility for filling a wide variety of contours: round oval corners, upper and

lower bracket panels, cowls, hoods and top rail panels. It is used for flat work, high and low crowns and on seep surfaces.

2 Vixen file blade

This blade is detachable from the holder and its different from any other type file. These blades are accurately machined with unbroken cutting edges about 1/8 of an inch apart. Each cutting edge is curved with the cutting edge on the convex side. This blade has the cutting edge on each side and the teeth run in opposite directions of each other to allow the blade to be turned over when one side becomes dull and unusable.

3 Maple solder paddle

This paddle is made from maple wood because it does not split as easily as other woods. It is used to shape hot solder to the desired shape. It is used with motor oil, beeswax or tallow to prevent the hot solder from sticking to the face of the paddle.

5 Metal body equipment

a Hydraulic body jack (Fig 8)

1 Types

a Direct acting jack. This type jack has the power unit or hydraulic pump integral with the ram. The action may be only one direction or it may work in either direction, push-pull.

b Remote controlled jack components

In this type jack, the hydraulic power supply is separated from the ram unit of the jack. The two units are connected by a reinforced rubber hose.

2 Remove controlled jack components

a Pump

b Hydraulic body jack

It is hand-operated, with all controls on the unit. The pump also serves as the reservoir for hydraulic oil. The oil level should be periodically checked.

b Ram (v)

Threads on the ram are for attaching other jack attachments. If the jack is used without attachments, a thread protector must be used on the top of the ram body.

c Flexible rubber heads (K)

Two sizes of rubber heads suit most body needs. Rubber heads are generally used on dry painted surfaces because they will not slip or mar the surface. These heads should not be used in or near oiled surfaces as they can slip and cause further damage. Internal threads are provided for to her jack attachments.

d Chain pull place (E) (Fig 8)

This plate is used in most pulling operations. The plate has internal threads with slots on both sides for securing chains. It attaches to the ram body.

e Slip lock extension (F) (Fig 8)

This tool gives six inches of prompt adjustment in pushing out large areas. A double friction lock holds securely at desired lengths and is adjusted by a convenient double trigger release.

f Rocker spoon (G) (Fig 8)

Specially designed for body work, it is held and locked in place by a hexagon pin. It may be set in may different positions. The selection of the spoon position is governed by the curvature of the body, the body bend or dent and amount of working space.

g Spreading wedge (H)

This tool is used for forcing out large or small concave areas and can be closed to ne inch and opened to three inches.

b Electric dist sander

The disk sander may be used to remove paint, revel low spots, shape the contours of areas built up with solder, sand down welds, remove excess solder, remove rust and remove deep scratches by using a fine abrasive sanding disk. It may be equipped with a flexible grinding wheel to serve as a grinder on thick sections of metal.

1 Backing plate

In most grinding, the disk is placed directly on the slightly flexible backing plate. Hard rubber and plastic can be used as backing plates. If a 9 inch sanding disk is used, it should have a 7 inch backing plate. The 7 inch backing plate will allow the 9 inch sanding disk outer edge to be cut down when it has become worn, increasing the disk life. Sanding disks are secured in place by a flat plate nut that is screwed onto the motor drive shaft and permits easy installation and removal of the plate nut when changing torn or worn-out disks.

2 Sanding disks

The coating abrasive disk does the cutting. Selection of the right grit and coating for each job is important.

Five different minerals are commonly used for manufacturing abrasives. Three of these, garnet, flint and emery are natural mineral abrasives. The other two are aluminum oxide and silicon carbide.

Screwdrivers

Objectives: At the end of this lesson you shall be able to
- **classify the hand-held screwdrivers**
- **state the features of standard screwdrivers**
- **list out the different types of special screwdrivers and their specific uses**
- **specify standard screwdrivers.**

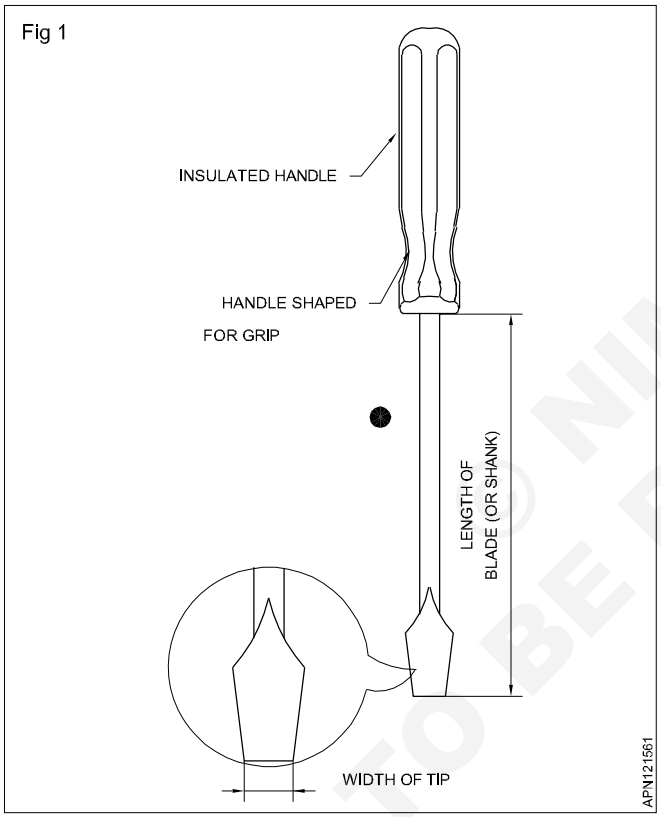
Screwdrivers are used to tighten or loosen screws which are fixed in the machine element.

Classification

- Standard type with tips to suit recessed head screw slots.
- Special type with tips to suit recessed head screws

Features of Standard screwdrivers (Fig 1)

Fig 1



Screwdrivers must have:

- Tips (1) of turn screws with slotted heads
- Handles of metals, wood or moulded insulating material (2), shaped to give a good grip for turning (3).
- Blades of hardened and tempered carbon steel or alloy steel
- Round or square blade with length (4) ranging from 40mm to more than 350mm.
- Flared tips which vary in length and thickness with the length of the blade.

Standard Screwdrivers

Standard screwdrivers are classified as:

- Heavy duty screwdrivers
- Light duty screwdrivers
- Stumpy screwdrivers

Heavy duty screwdrivers (Figs 2 & 3)

Fig 2

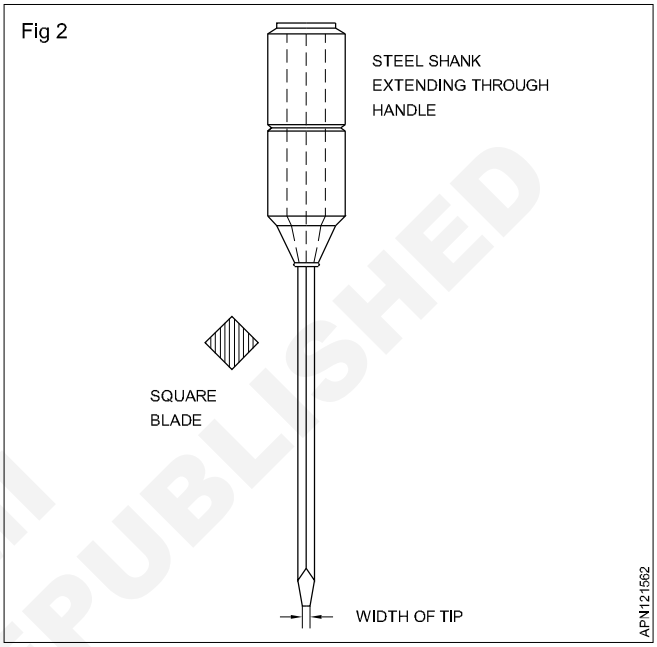
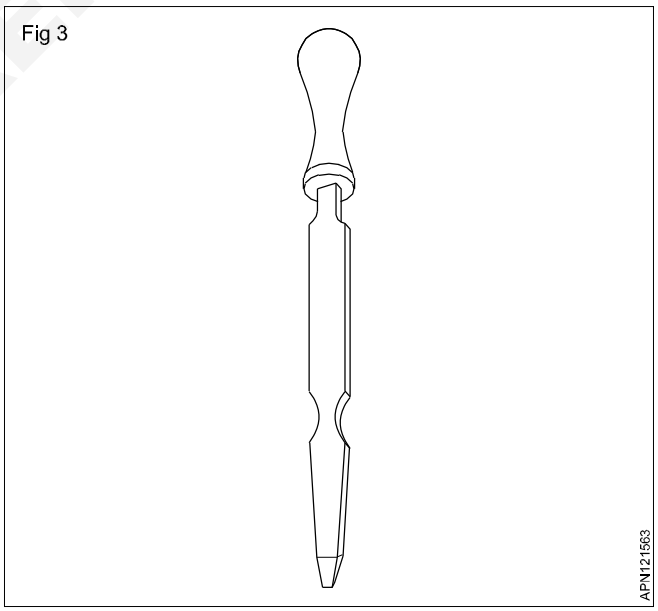


Fig 3

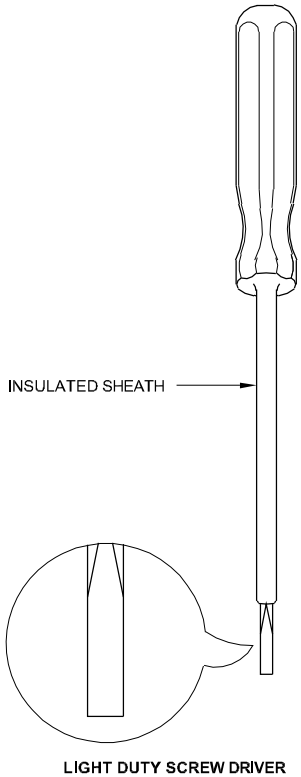


This screwdriver has a square blade for applying extra twisting force with the end of the spanner. Heavy duty screwdrivers of London pattern have a flat blade and are mostly used by carpenters.

Light duty screwdrivers (Fig 4)

This screwdriver has a round blade with parallel tips. This screwdriver is used by electricians. The blades are sheathed in insulation to avoid short circuiting live parts.

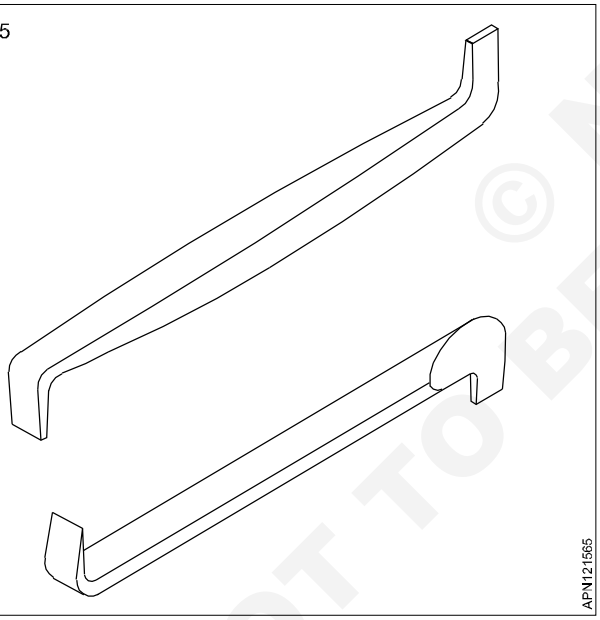
Fig 4



LIGHT DUTY SCREW DRIVER

Stumpy screwdrivers (Fig 5)

Fig 5



These are small stumpy screwdrivers. They are used when other types of screwdrivers cannot be used due to the space limitations.

Special screwdrivers and their uses

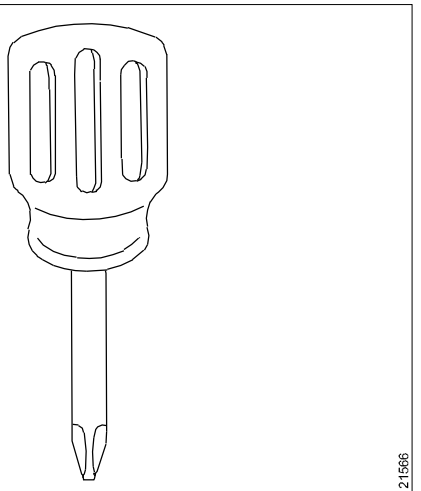
Offset screwdriver (Fig 6)

Offset screwdrivers are used on screws which are placed in blind spaces.

They are made with short blades and with the tips at right angle.

Greater turning force can be applied on screws by these screwdrivers because of their leverage.

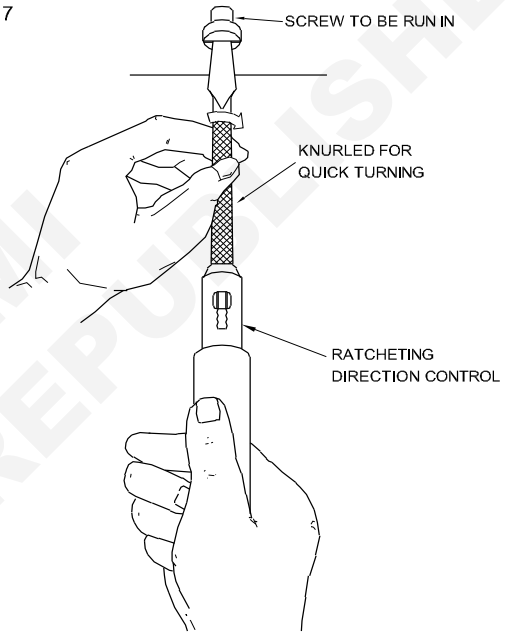
Fig 6



STUMPY SCREW DRIVER

Ratchet screwdriver (Fig 7)

Fig 7



RATCHET SCREWDRIVER

The following are the features of ratchet screwdrivers.

These screwdrivers are made with a three-position ratchet control for screwing, unscrewing of a screw and also providing a neutral position.

They are used for turning screws in confined spaces.

They can be operated without changing the hand grip.

They are used for slackening or tightening with a medium force.

They are used in mass production.

Phillips (cross-recess) screwdrivers (Fig 8)

Phillips screwdrivers have cruciform or cross-shaped tips that are unlikely to slip from the cruciform slots in Phillips recessed head screws.

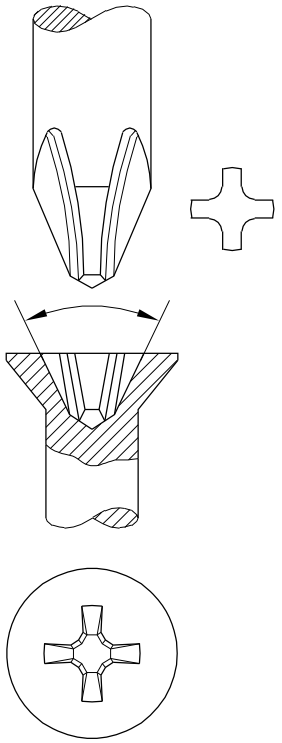
The end of the four flats is tapered to an angle of 53°

The extreme end is ground to 110°.

Four different sizes to cover the full range of screws are available. These are specified by point sizes 1,2,3 & 4 which correspond to the size of the Phillips screw heads.

For quicker application ratchet offset screwdrivers are also available with renewable tips. (Fig 9)

Fig 8



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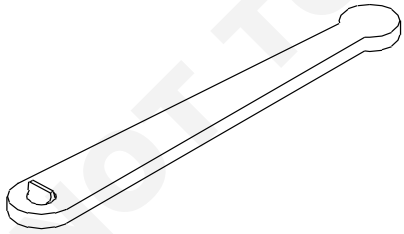
Specification of Screwdriver: Screwdrivers are specified (Fig 10) according to the

- Length of the blade (a)
- Width of the tip (b).

Normal blade length : 45 to 300mm. Width of blade : 3 to 10mm.

The blades of screwdrivers are made of carbon steel or alloy steel, hardened and tempered.

Fig 9



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Screwdrivers for special uses: Small sturdy screwdrivers (Fig 11) are available for use where there is limited space.

Screwdrivers with blades sheathed in insulation are available for the use of electricians (Fig 12)

Precautions: Use screwdrivers with tips correctly fitting into the screw slot. (Fig 13)

Make sure your hand and the handle are dry.

Hold the screwdrivers axis in line with the axis of the screw.

Fig 10

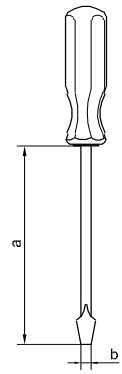

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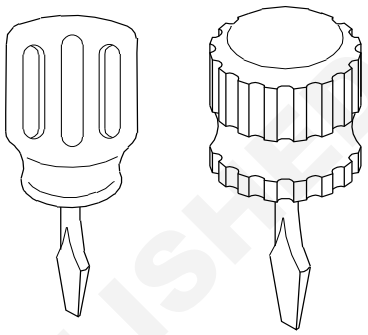
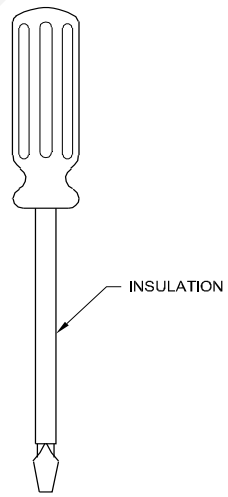
Fig 11



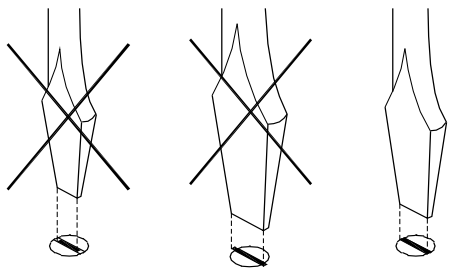
APN12156B

Fig 12



APN12156C

Fig 13



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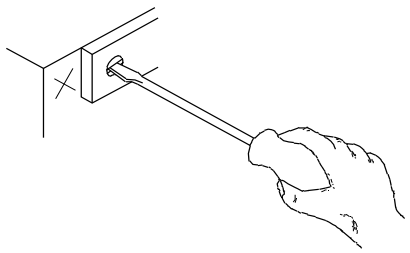
While using a Phillips screwdriver apply more downward pressure.

Keep your hand away to avoid injury due to slipping of the screwdriver. (Fig 14)

Do not use screwdrivers with split or defective handles. (Fig 15)

Fig 14



APN12156E

In the case of damaged screwdrivers, the blades can be ground (the faces will be parallel with the sides of the screw slot) and used. While grinding ensure the end of the tips is as thick as the slot of the screw.

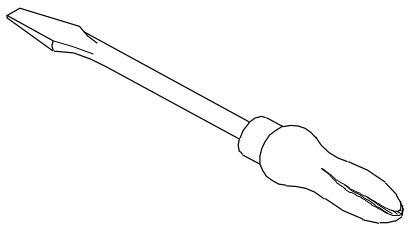
While using screwdrivers on small jobs, brace the job on the bench or hold them in a vice.

Specification of a screwdriver: Screwdrivers are specified according to the

- Length of the blade
- Width of the tip

The normal blade length varies from 45mm to 300mm and the width of the blade varies from 3mm to 10mm.

Fig 15



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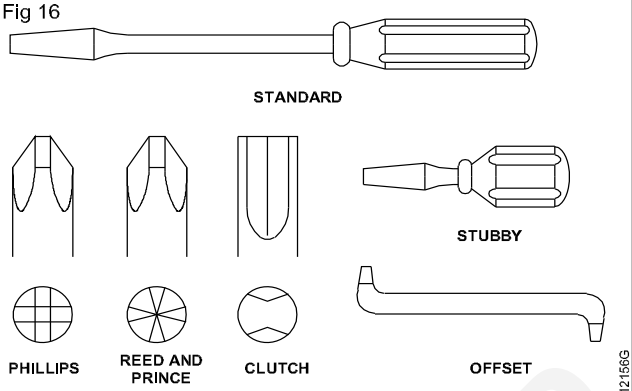
Screw driver (Fig 16): There are several different size of screw drivers of the standard, reed & prince & phillips types.

Fig 16



TYPES OF SCREW DRIVERS

APN12156G

The offset screw driver is useful in tight quarters where even a “Stubby” cannot be used.

Safety

1 Always use correct type and size screw drivers.

2 Don’t do repair work by holding the job on the hand with the help of screw driver, if may slips it pierce the hand.

Allen keys

Objectives: At the end of this lesson you shall be able to
- **state the features and uses of hexagon socket screw keys**
- **specify hexagon socket screw keys**.

Hexagon socket screw keys/Allen keys are made from hexagonal section bars of chrome vanadium steel.

These are hardened and tempered. These are bent to `L’ shape. The size of an Allen key is identified by the size across the flat of the hexagon.

Uses

They are used to tighten or loosen screws having internal hexagon sockets. (Fig 1)

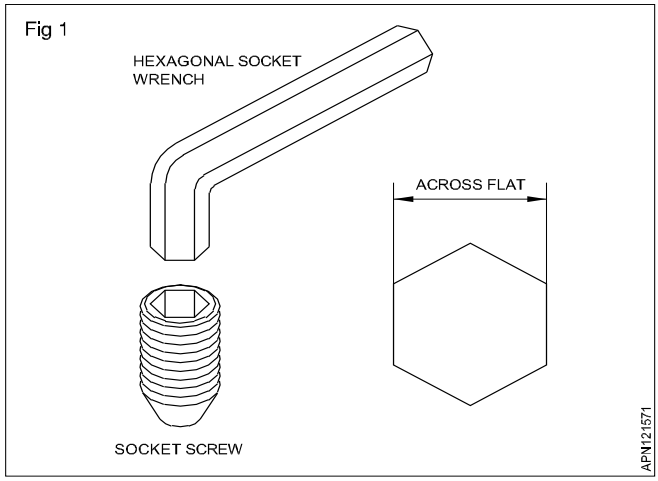
Allen keys, available in different sets in plastic wallets, surprise of a set of 8 (2 to 10mm)

2,3,4,5,6,7,8 and 10mm

Sizes of Allen keys (Fig 1)

Individual pieces are available as follows.1, 1.5, 2, 2.5,3, 4, 5, 6, 8, 10, 12, 14, 17, 19, 22, 24, 27, 32 and 36.

Fig 1



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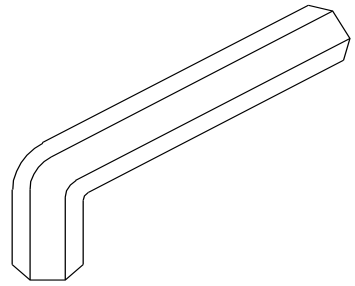
Designation of Allen keys (Fig 2)

A hexagonal socket screw key of width across flat 8 mm shall be designated as Key 8 IS:3082.

Fig 2



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Bench vice

Objectives: At the end of this lesson you shall be able to
- **name the parts and uses of a bench vice**
- **specify the size of a bench vice**
- **state the uses of vice clamps.**

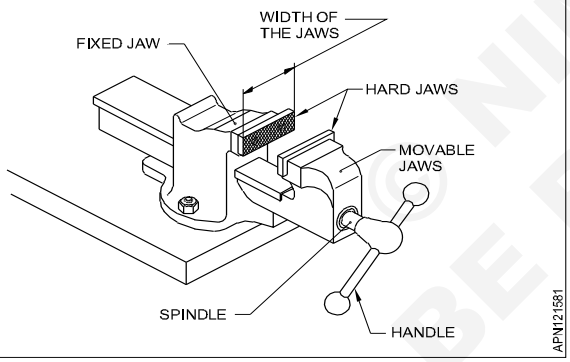
Vices are used for holding workpieces. They are available in different types. The vice used for bench work is called as bench vice or (Engineer's vice)

A bench vice is made of cast iron or cast steel and it is used to hold work for filing, sawing, threading and other hand operations.

The size of the vice is stated by the width of the jaws.

Parts of a bench vice (Fig 1)

Fig 1



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The following are the parts of the vice

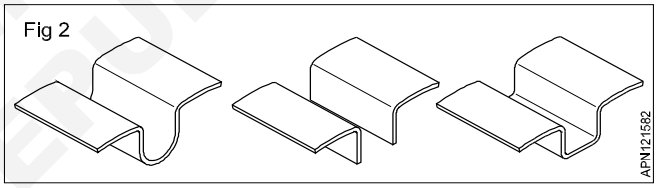
The Vice is generally bolted and secured in a wooden work table, and is useful for operations like filing, chipping, hacksawing, bending sheet metal etc.

Fixed jaw, movable jaw, hard jaws, spindle, handle, box-nut and spring are the parts of vice.

The box-nut and the spring are the internal parts.

Vice clamps or soft jaws (Fig 2)

Fig 2



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The hold a finished work use soft jaws (vice clamps) made of aluminium over the regular jaws. This will protect the work surface from damage.

Do not over-tighten the vice as, the spindle may get damaged.

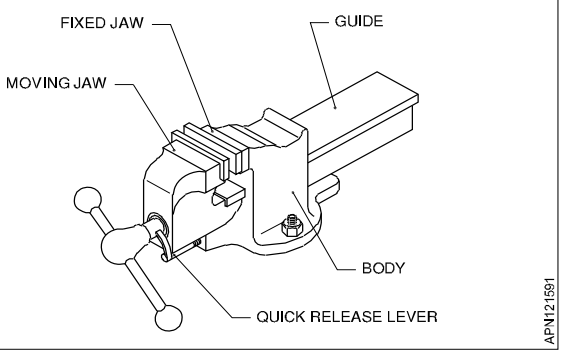
Types of vice

Objectives: At the end of this lesson you shall be able to
- **state the construction and advantages of a quick releasing vice**
- **state the uses of pipe vice, toolmakers vice, hand vice and pin vice.**

There are different types of vice used for holding workpieces. They are quick releasing vice, pipe vice, hand vice pin vice and toolmaker's vice.

Quick releasing vice (Fig 1)

Fig 1



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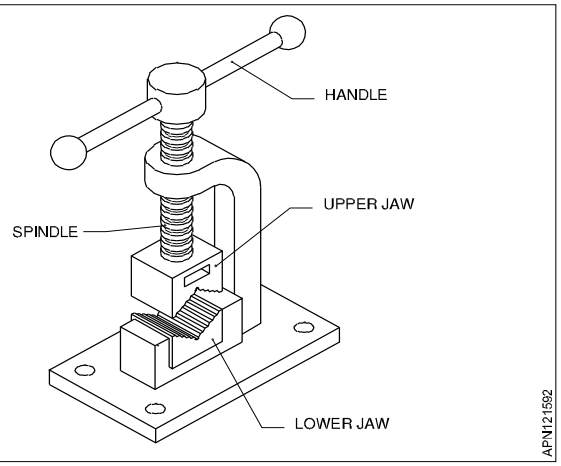
A quick releasing vice is similar to an ordinary bench vice but the opening of the movable jaw is done by using a trigger (lever). If the trigger at the front of the movable jaw is pressed, the nut disengages the screw and the movable jaw can be set in any desired place quickly.

Pipe vice (Fig 2)

A Pipe vice is used for holding round sections of metal, and pipes. In this vice, the screw is vertical and movable. The jaw works vertically.

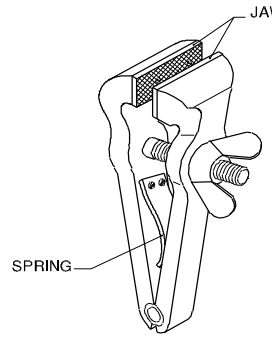
The pipe vice grips the work at four points on its surface. The parts of a pipe vice are shown in Fig 2.

Fig 2



Hand vice (Fig 3)

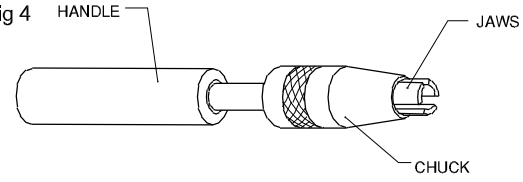
Fig 3



Hand vice is used for gripping screws, rivets, keys, small drills and other similar objects which are too small to be conveniently held in the bench vice. A hand vice is made in various shapes and sizes. The length varies from 125 to 150 mm and the jaw width from 40 to 44 mm. The jaws can be opened and closed using the wing nut on the screw that is fastened to one leg, and passes through the other.

Pin vice (Fig 4)

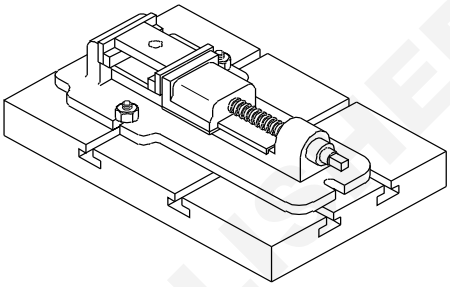
Fig 4



The pin vice is used for holding small diameter jobs. It consists of a handle and a small collect chuck at one end. The chuck carries a set of jaws which are operated by turning the handle.

Toolmaker's vice (Fig 5)

Fig 5



The toolmaker's vice is used for holding small work which required filing or drilling and for marking of small jobs on the surface plate. This vice is made of mild steel.

Toolmaker's vice is accurately machined.

'C' Clamps and toolmaker's clamps

Objectives: At the end of this lesson you shall be able to
- **state the purpose of using clamps**
- **specify the requirements of the clamping devices**
- **state the features and uses of 'C' clamps**
- **state the features of Toolmaker's clamps.**

Purpose of using clamps

Clamps are used for preventing the movement of work, and for holding the job tight.

Requirements of clamping devices

Should be able to manipulate for easy loading.

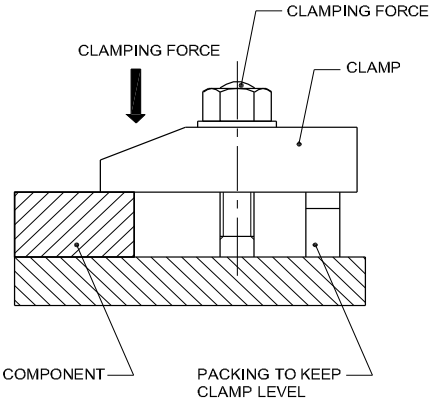
Should provide the required clamping force.

Should be capable of locking with minimum movement.

Should accommodate a range of sizes of jobs.

Fig 1 shows a typical clamping device, employing a screw and nut to provide the clamping force.

Fig 1



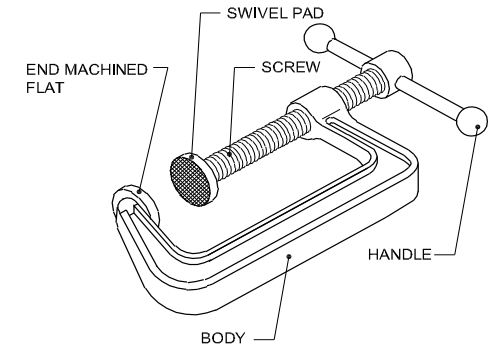
'C' Clamps

These clamps are in the shape of a 'C'. The 'C' clamp has its body forged or cast. One end of the clamp is machined flat. The other end is drilled and threaded to accommodate a screw-rod which is operated by a handle. The screw-rod carries a swivel pad which is free to revolve. The clamp is hardened and the face is serrated. (Fig 2)

These clamps are used to hold work, on an angle plate or a drill press table, and also, for holding two or more workpieces together.

The swivel pad on the end of the clamping screw helps in clamping surfaces which are not parallel. 'C' clamps are available for light and heavy duty work.

Fig 2



Spanners and their uses

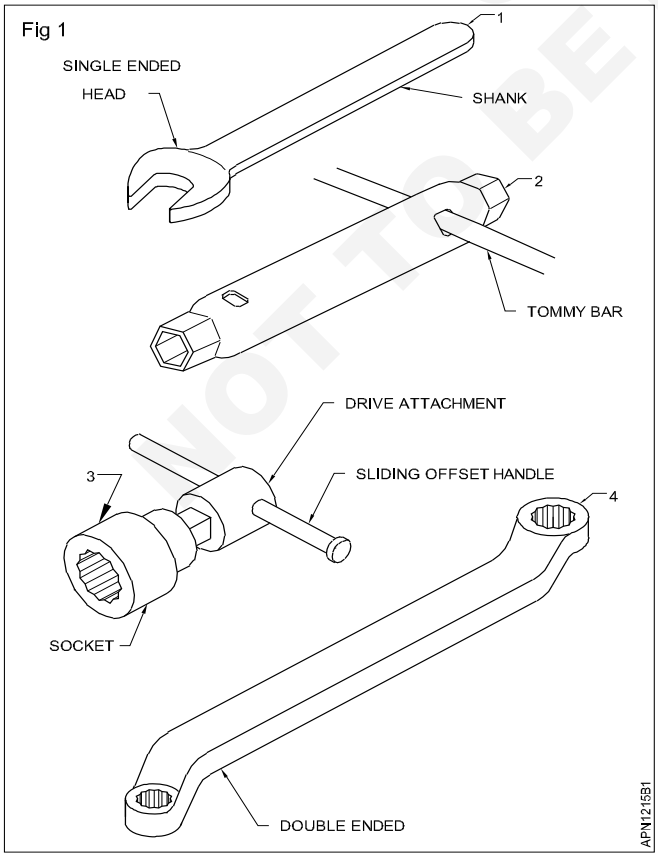
Objectives: At the end of this lesson you shall be able to
- **state the necessity of spanners**
- **identify the different types of spanners**
- **specify the spanners**
- **list out the parts of adjustable spanners**
- **state the features of 'C' spanners and their uses.**

Spanners are used for operating threaded fasteners, bolts and nuts. They are made with jaws or opening that fit square on hexagonal nuts and bolts and screw heads. They are made of high tensile or alloy steel. They are drop-forged and heat-treated for strength. Finally they are given a smooth surface finish for ease of gripping.

Spanners are considerably in shape to provide ease of operation under different conditions.

The basic types of spanners are: (Fig 1)

Fig 1

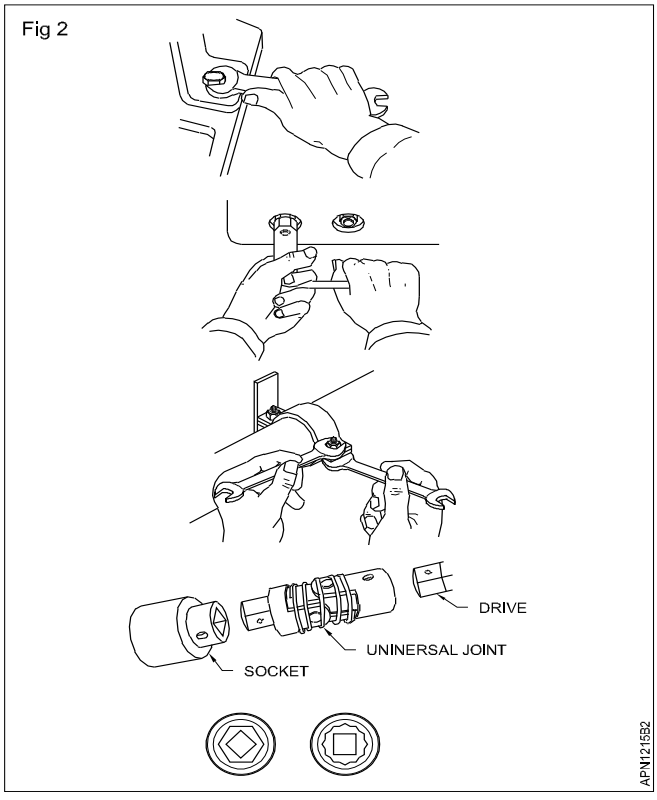


- Open end spanners (1)
- tube or tubular box spanners (2)
- Socket spanners (3)
- Ring spanners (4)

The correct spanner fits exactly and allows room for use. They should also permit the job to be done in a shorter time.

The following are the points to be noted for using spaners in a safe way. (Fig 2)

Fig 2



Use open end and ring spanners by pulling on the shank. It is safest to pull as there is less chance of hitting your knuckles if the spanner or nut slips suddenly. If you are forced to push the spanner, use the base of your hand and keep your hand open.

Use both hands for large spanners.

Keep yourself balanced and firm to avoid slipping yourself, if the spanner slips suddenly, Hold on to some support, if there is any chance of falling.

Use both hands as shown in the figure, when using tubular box spanners. (Fig 2)

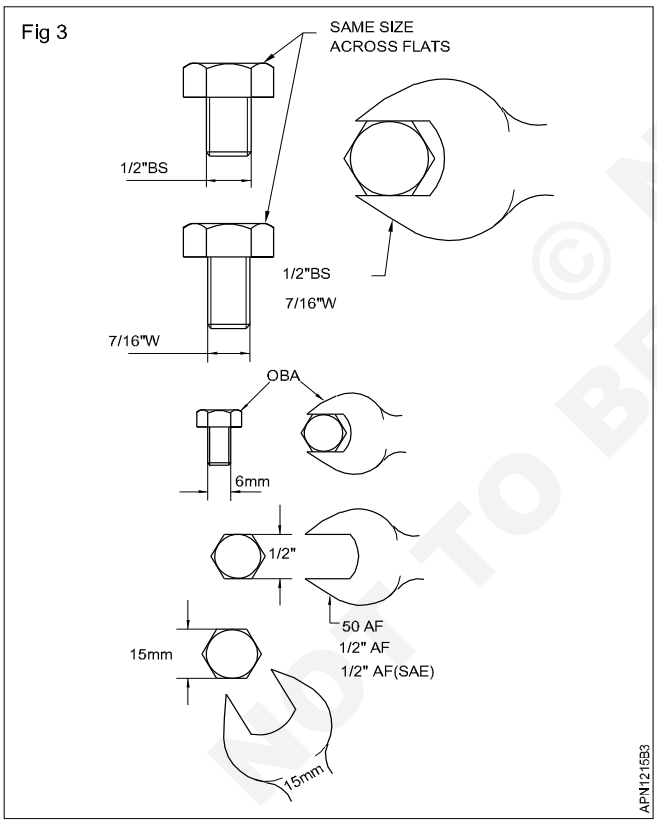
Use two spanners as shown in the figure to stop the head of the bolt rotating as the nut is operated. (Fig 2)

Socket spanners may be turned by accessories which have square driving ends. (Fig 2)

Size and identification of spanners

The size of a spanner is determined by the nut or bolt it fits. The distance across the flats of a nut or bolt varies both with the size and the thread system. (Fig 4)

In the British system the nominal size of the bolt is used to identify the spanner. (Fig 3)

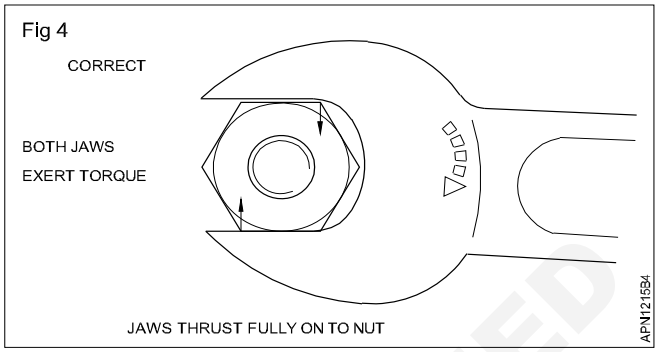


In the unified standard system (Fig 3), the spanners are marked with a number based on the gas requirement decimal equivalent of the nominal fractional size across the flats of the hexagon, following the sign A/F or with the fractional size across the flats following the sign A/F. In the metric system, spanners are marked with the size across the jaw opening followed by the abbreviation 'mm'.

To fit exactly, a spanner must be:

- Of the correct size
- Placed correctly on the nut
- In good condition.

Spanners have their jaws slightly wider than the width of the nut so that they can be placed into position easily. Any excess more than a few hundredths of a millimeter clearance could cause the spanner to slip under pressure. (Fig 4)



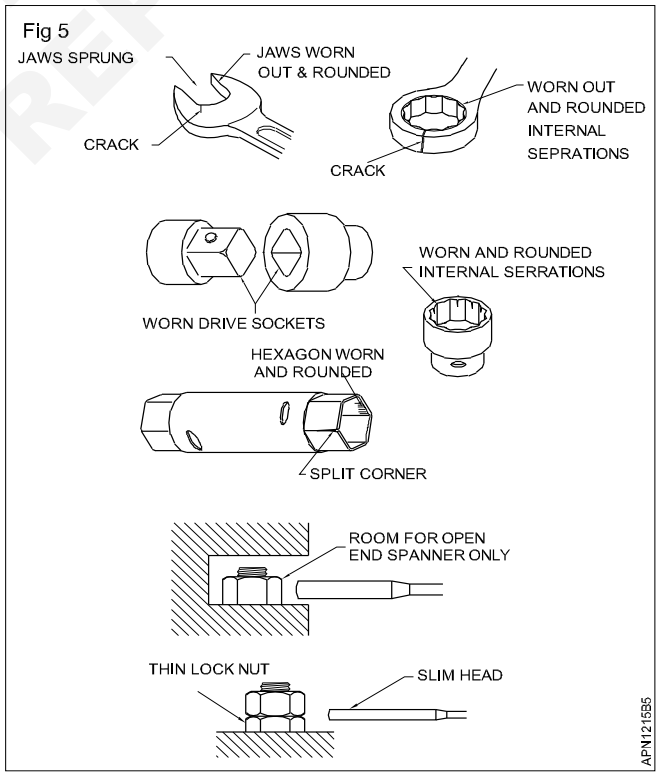
Place the spanner so that its jaws bearfully on the flats of the nut.

Incorrect use damages the spanners & the nuts too.

Discard any defective spanners. The spanners illustrated here are dangerous for use.

Choose spanners that allow room for use.

Nuts in inaccessible positions may be reached with socket spanners, with special drawing accessories. (Flg 5)

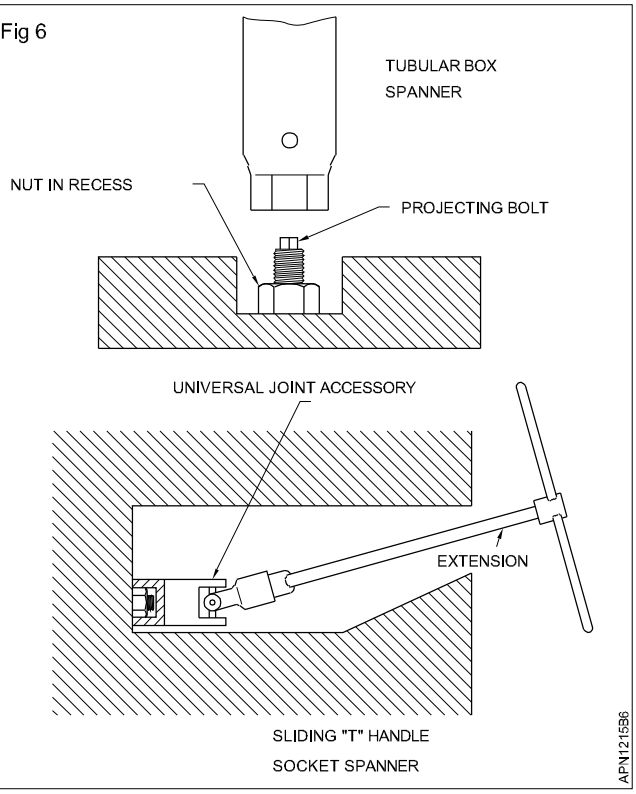


Length of spanners (Fig 6): Normally spanners have a length that is about ten times the width of the jaw opening.

Never exert excessive pull on a spanner, particularly by using a pipe to extend the length of a spanner.

Excess turning effect of the spanner could result in:

Fig 6



- Striping the thread
- Shearing the bolt
- Straining the jaws of the spanner
- Making the spanner slip and cause an accident.

Adjustable spanners (Figs 7 & 8)

Fig 7

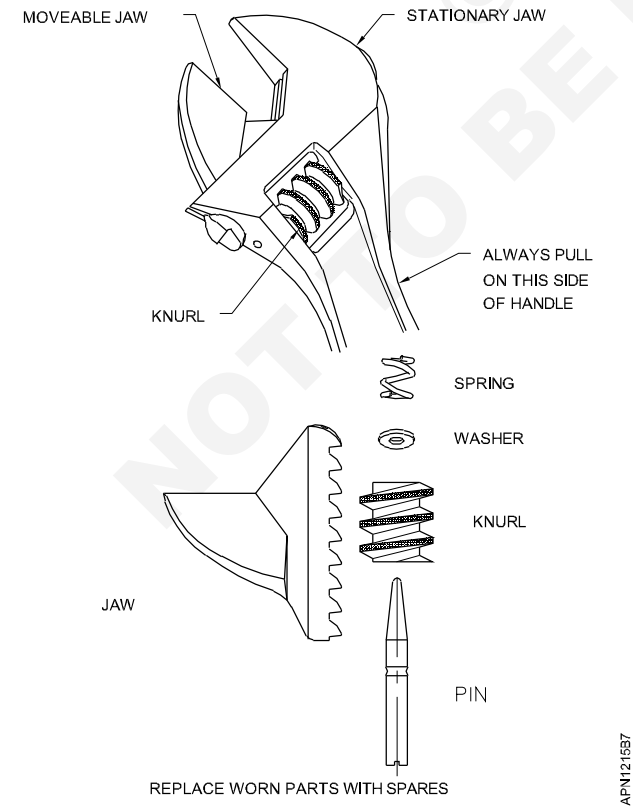
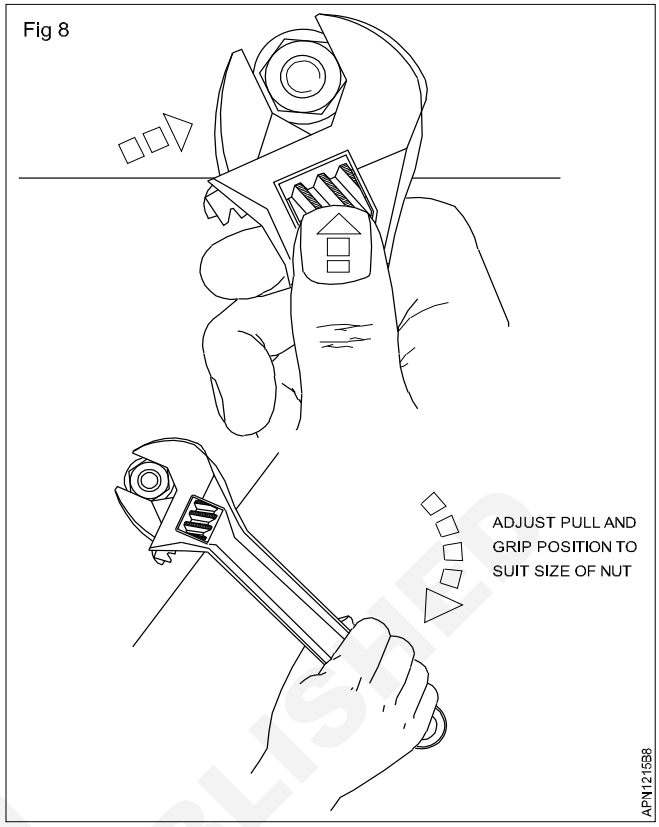


Fig 8



Most common types of adjustable spanners are similar to open and spanners, but they have one movable jaw. The opening between the jaws of a typical 250 mm spanner can be adjusted from zero to 28.5 mm. Adjustable spanners may range in length from 100 mm to 760 mm. the type illustrated has its jaws set an angle of 22 $1/2^0$ to the handle. Adjustable spanners are convenient for use where a full kit of spanners cannot be carried about. They are not intended to replace fixed spanners which are more suitable for heavy service. If the movable jaw or knurled screw is cracked or worn out, replace them with spare ones.

When using the adjustable spanner follow the steps given below.

Place it on the nut so that the jaw opening points in the same general direction the handle is to be pulled. In this position the spanners are less liable to slip and the required turning force can be exerted without damage to the moving jaw and knurl.

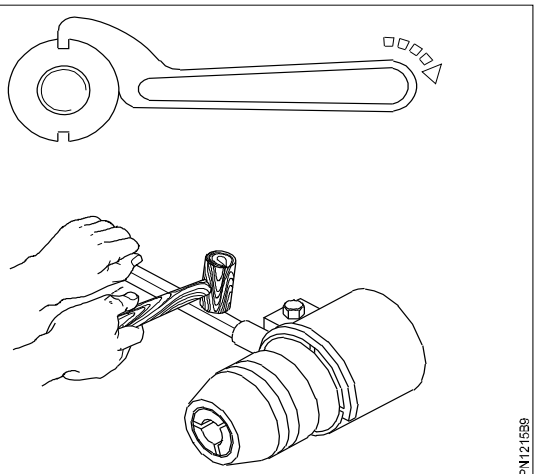
Push the jaws into full contact with the nut.

Use the thumb to tighten the adjusting knurl so that the jaws fit the nut strongly.

Pull continuously. The length of the handle is designed to suit the maximum opening of the jaws. With small nuts, a very small pull on the handle will produce the required torque.

'C' spanners (Hook spanners) (Fig 9): It has a lug that fits in a notch, cut in the outer edge of a round nut. The 'C' section is placed around the nut in the direction in which it is to be turned. In adjustable hook wrenches, part of the 'C' section pivots to fit nuts with a range of diameters. A set of three spanners is needed to cover diameters from 19 mm to 120 mm.

Fig 9



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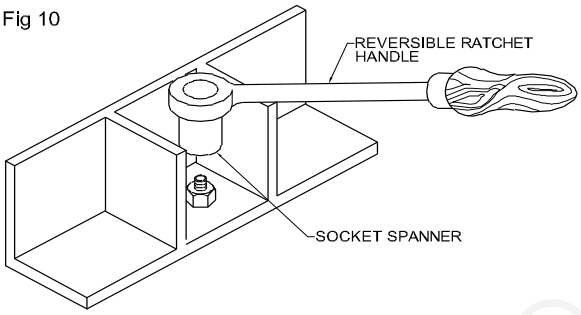
The applications of 'C' spanners are shown in the figure.

C' Spanners are also used for zero - selfing of micrometer.

With socket spanners (Fig 10), use the reversible ratchet handle for doing fast work, where turning space is restricted.

Fig 10



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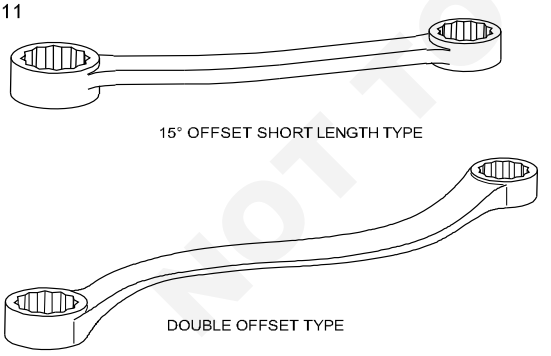
Ring or box spanner (Fig 11): For critical tighting and loosening of nuts. For multi contact on bolts and nuts.

Pliers (Fig 12): Pliers are commonly used for cutting wires, holding parts, crimping electrical connections and bending cotter pins.

Fig 11



RING SPANNER

APN1215BB

Safety

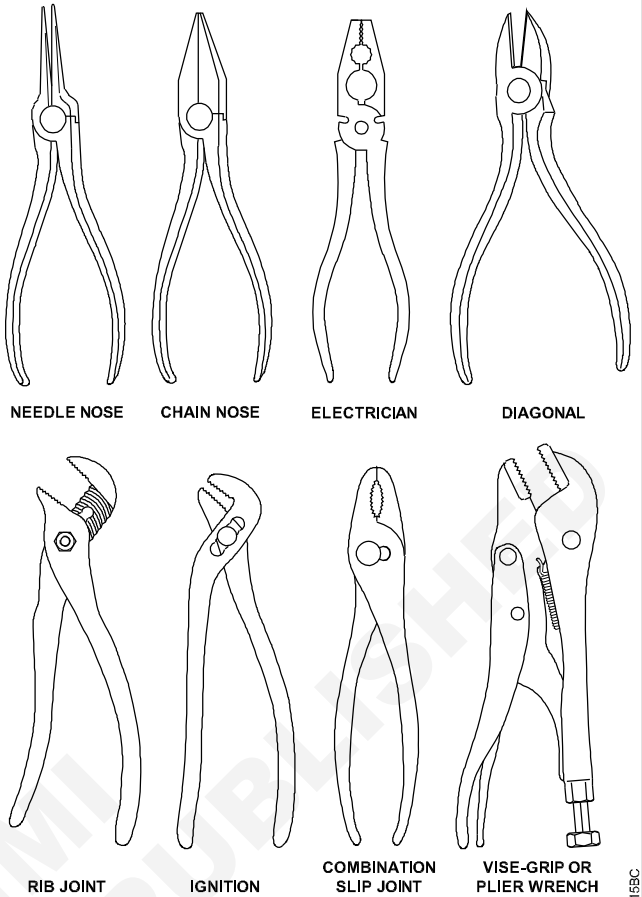
1 Avoid cutting hardened objects.

2 Never use pliers to turn nuts, bolts or tubing fitting.

Combination of ring and open end spanner (Fig 13)

This tool has a box end on one end and an open end on the other. Both ends are of the same size.

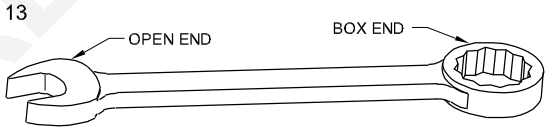
Fig 12



PLIERS

APN1215BC

Fig 13



COMBINATION OF RING AND OPEN END SPANNER

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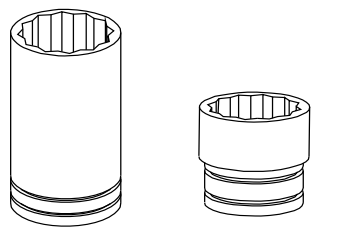
Socket spanners (Fig 14)

Fig 14



SOCKET SPANNER

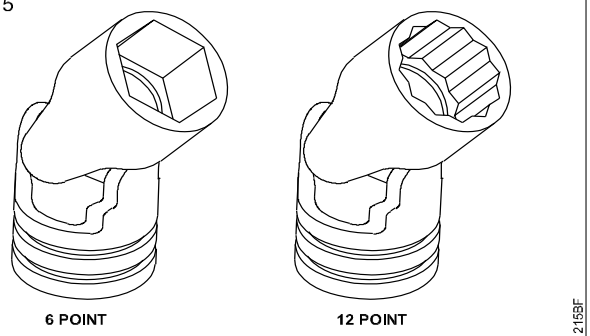
APN1215BE

The socket is one of the fastest and most convenient of all the spanners. Sockets come in two sizes; standard and deep.

Standard sockets will handle the most of the works, while the extra reach of the deep socket is occasionally needed.

Swivel socket (Fig 15)

Fig 15

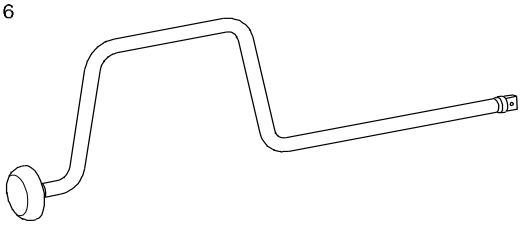


SWIVEL SOCKETS

The swivel socket allows the user to turn fasteners at an angle.

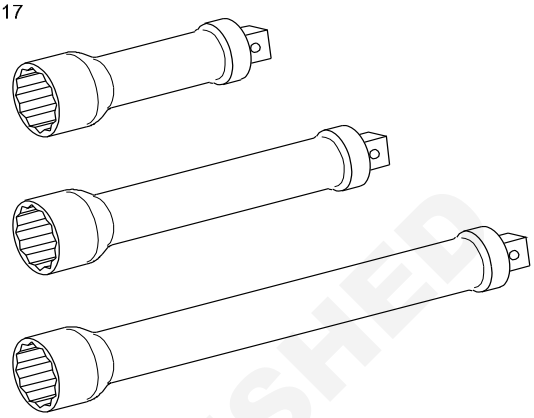
Socket handles: Several different drive handles are used. The speed handle (Figs 16 & 17) is used whenever possible as it can be turned rapidly.

Fig 16



SOCKET SPEED HANDLE

Fig 17



SOCKET EXTENSION BARS

Pliers

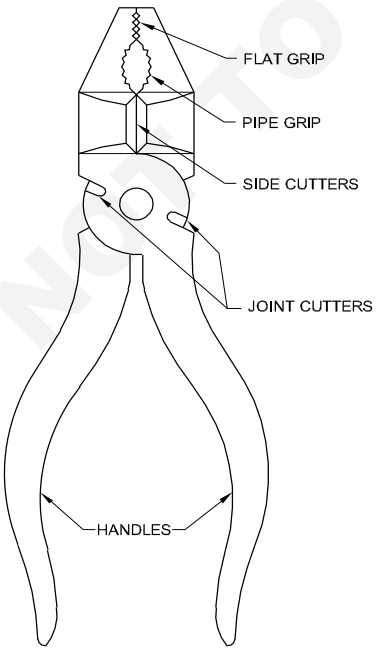
Objectives: At the end of this lesson you shall be able to
- **state the features of pliers**
- **state the uses of pliers.**

Features

Pliers have a pair of legs joined by a pivot, hinge or fulcrum pin. Each leg consists of a long handle and a short jaw.

Elements of pliers with two joint cutters (Fig 1) (Combination pliers)

Fig 1



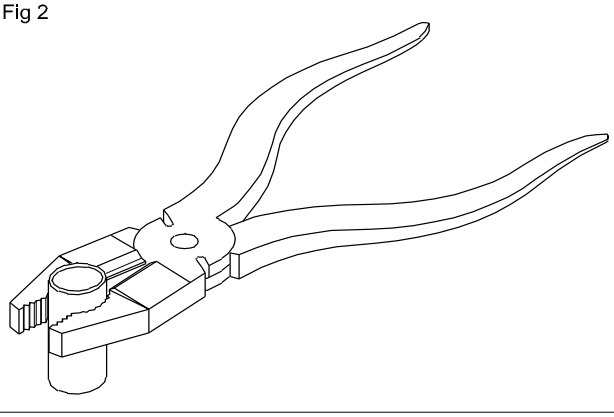
- Flat jaw
- Pipe grip
- Side Cutters
- Joint cutters
- Handles

Features

Flat jaw tips are serrated for general gripping.

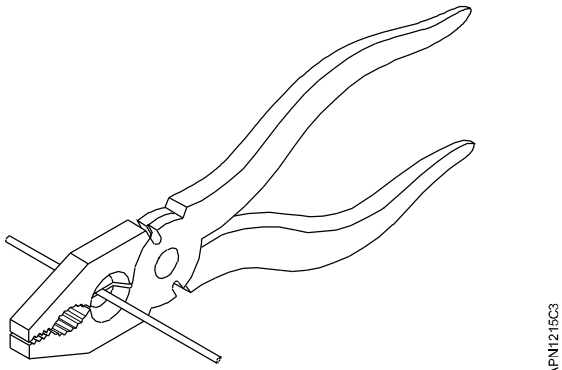
Pipe grip is serrated for gripping cylindrical objects. (Fig 2)

Fig 2



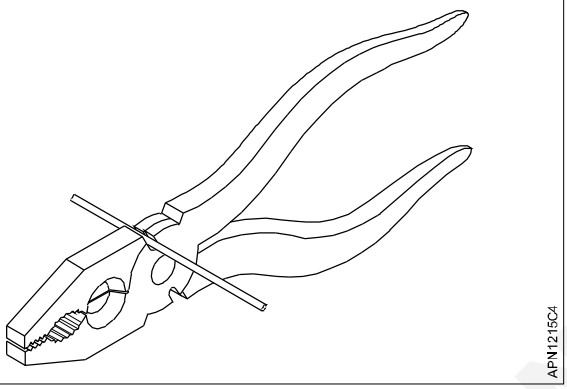
Cutters are provided for cutting off soft wires. (Fig 3)

Fig 3



Two joint cutters are provided for cutting or shearing off steel wires. (Fig 4)

Fig 4



Handles are used for applying pressure by hand.

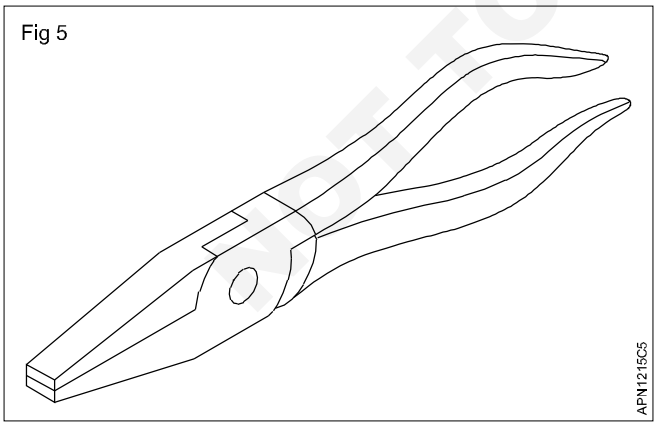
Pliers are available in sizes from 150 mm to 230 mm. (Size = Overall length)

Other types of pliers

Flat nose pliers

It has tapered wedge jaws with flat gripping surfaces which may be either smooth or serrated. (Fig 5)

Fig 5



It is used for bending and folding narrow strips of thin (Fig 6)

Round nose Pliers

This type of pliers is made with tapered round shaped (Fig 7) They are used to shape loops in wires and the form curves in light metal strips. (Fig 8)

Fig 6

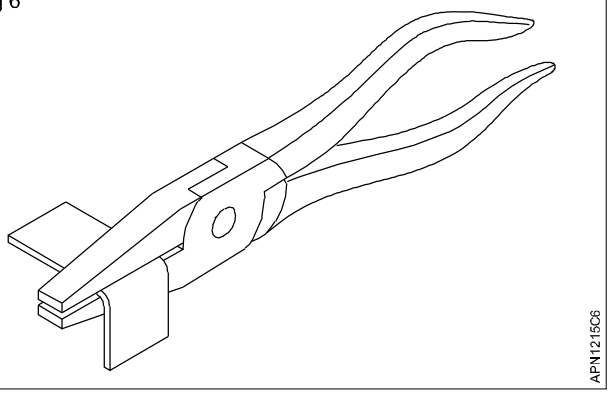


Fig 7

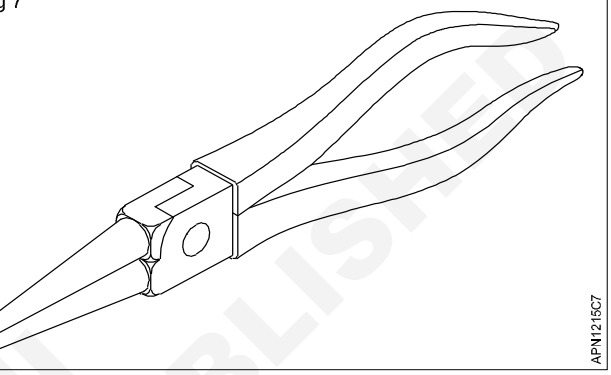
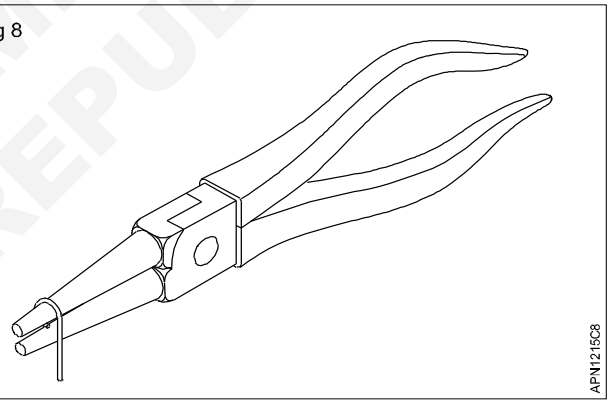


Fig 8

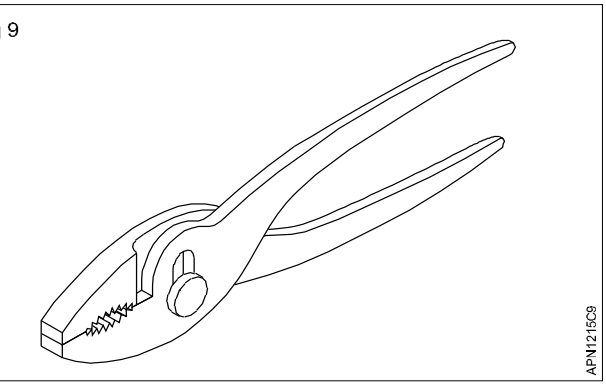


Slip-joint pliers

These pliers are available in various ranges of positions with different shapes of pivot pins so that they have various ranges of jaw opening.

Mainly used for gripping. (Fig 9)

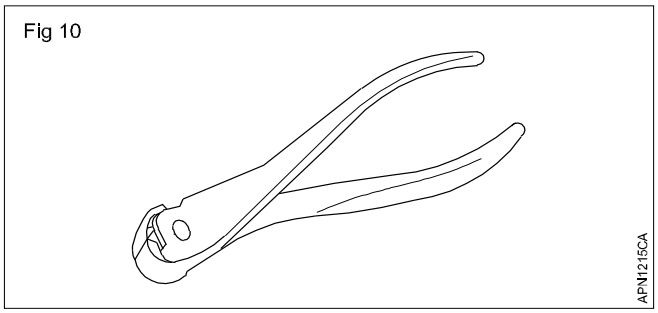
Fig 9



End cutting pliers

These pliers have the same uses as the side cutting pliers. (Fig 10)

Fig 10

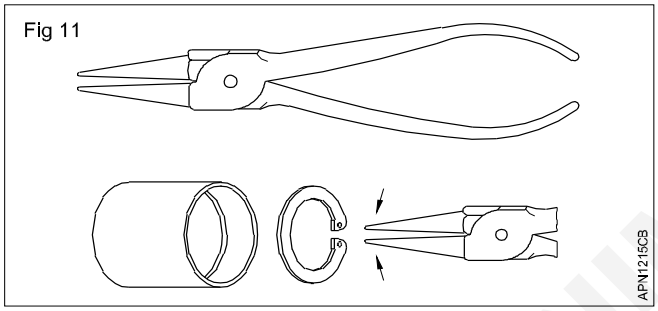


Circlip pliers

Circlip pliers are used for fitting and removing circlips in assembly works.

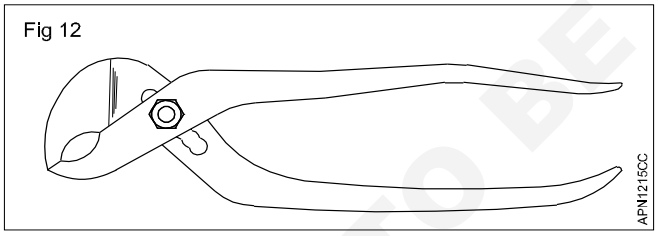
Internal circlip plier: It is used to fit and remove the internal circlip in the groove of the bore. (Fig 11)

Fig 11



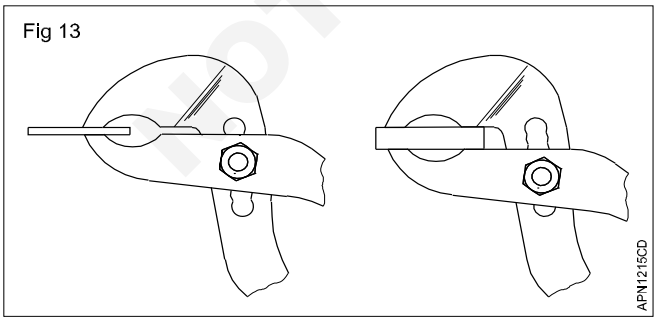
Slip-joint, multi-grip pliers: It is similar to the grip pliers but has more openings in the legs. It gives a range of jaw openings. It allows parallel gripping by the jaws in a number of positions. (Fig 12)

Fig 12



The shape and length of the leg are different from those of the slip-joint pliers. (Fig 13)

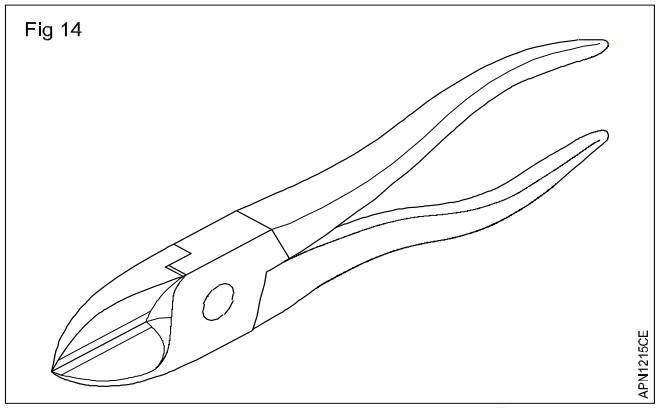
Fig 13



Side cutting pliers

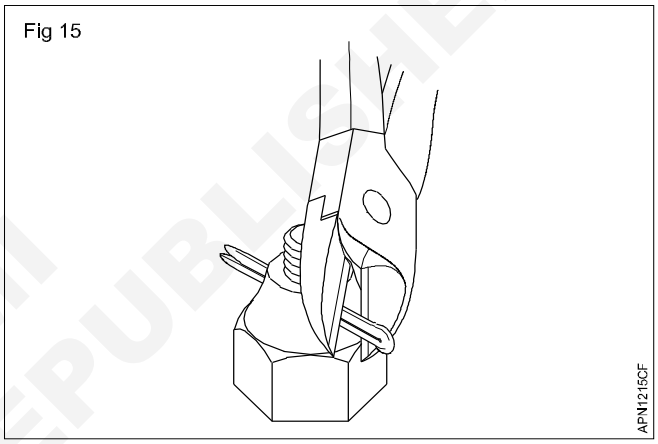
It is made with jaws set at an angle. (Fig 14)

Fig 14



They are used for shearing off wires in confined spaces and cutting off wires close to the surface level. (Fig 15)

Fig 15



They are also used for spreading the cotter pin.

External circlip pliers.

External circlip pliers are used to fit and remove the external circlip in the grooves of the shafts.

Locking pliers

The locking lever of the locking pliers is attached with a movable handle which clamps the jaws on to an object of any shape.

It has high gripping power.

The screw in the handle enables adjustment of the lever action to the work size.

SNIPS (Straight & Bent)

Objectives: At the end of this lesson you shall be able to
- **state the uses of straight and bent snips**
- **state the features and use of lever shears**
- **state the uses of circle cutting machines.**

A snip, also called a hand shear and it is used like a pair of scissors to cut thin, soft metal sheets. Snips are used to cut sheet metal upto 1.2mm thickness.

Types of snips (shears)

There are several types of snips available for making straight or circular cuts, the most common being straight snips and curved snips.

The choice of shears (snips) depends on the shape and type of the cut required.

Straight snips (Figs 1 & 2)

Fig 1

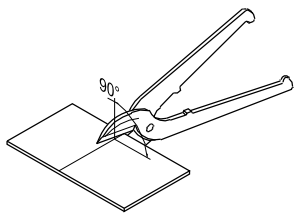
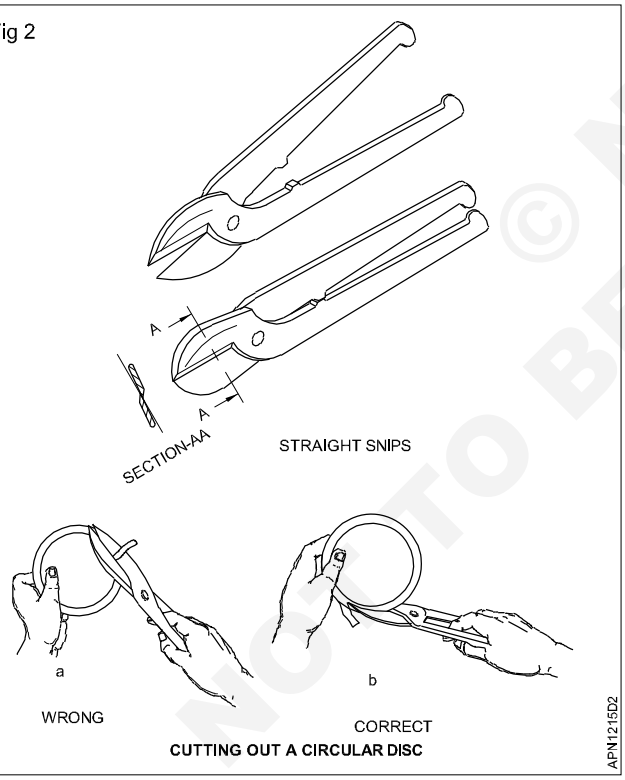


Fig 2



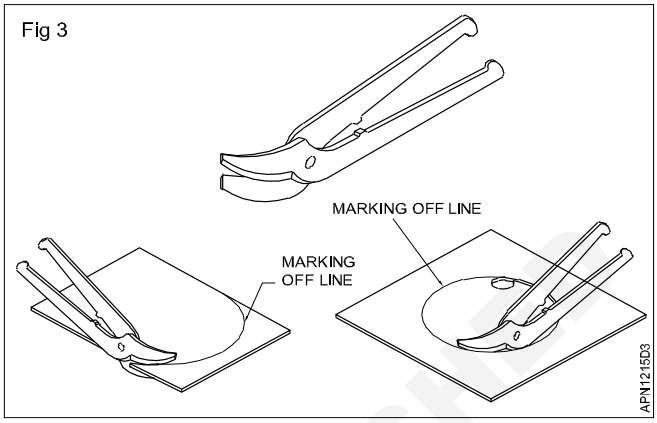
These are used for making straight cuts and large external curves.

Straight snips have thin blades which are only strong on a vertical planes. They are, therefore, only suitable for straight cuts and external curves when surplus waste has to be removed.

While cutting, the blade of the snips should not cover the marking.

Bent snips (Fig 3)

Fig 3



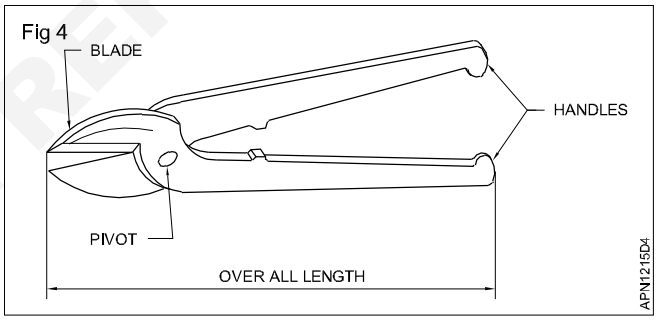
These snips have curved blades for making circular cuts. They are also used for trimming cylindrical or conical work in sheet metal.

Snips are specified by the overall length and the shape of the blade.

Example

200mm straight snip. (Fig 4)

Fig 4



Lever shears (Fig 5)

Lever shears are used to cut sheets which cannot be cut with hand shears.

Fig 5

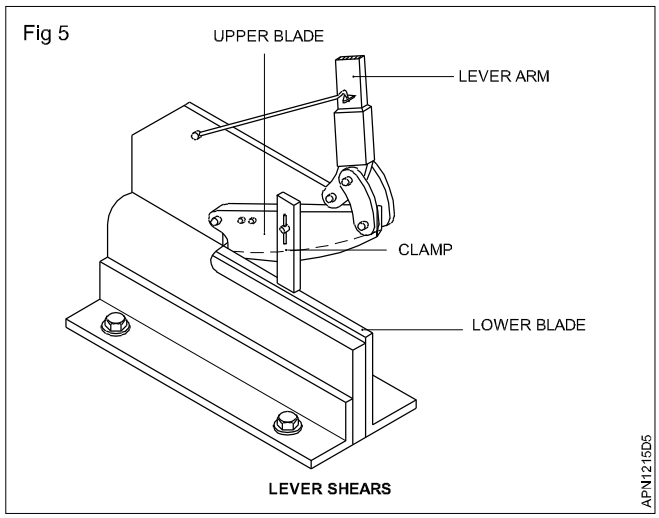
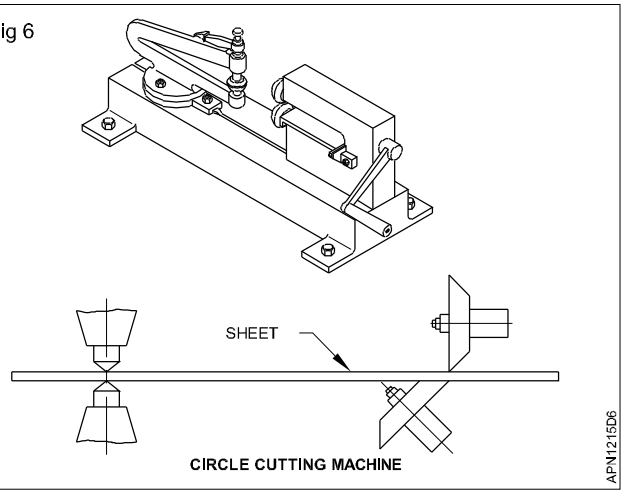


Fig 6



CIRCLE CUTTING MACHINE

The lever shear possesses a fixed lower blade and a moving upper blade. The sheet being cut is prevented from tilting by a clamping device which can be adjusted to the thickness of the sheet. The knife-edge cutter of the upper blade is curved so that the opening angle at the point of cut remains constant.

Circle cutting and curve cutting machines (Fig 6)

These machines are used to cut circles and curves of the desired shapes. When cutting curves, the sheet must be guided by the hand.

Puller

Objectives: At the end of this lesson you shall be able to
- **state the function of puller**
- **state the types of puller.**

Puller

The puller is a General Workshop tool which is used to remove Gears, bearings pulleys, flanges, bushes.

The puller is made out of steel material, generally with two or three legs and they are adjusted to hold the outside of the gears or bearing sleeves while the central threaded shaft is screwed forward exerting force on the gear/bearing. This enables to remove the bearing without damaging the shaft.

Pullers are classified according to the application and the number of legs.

Another classification is based on the power utilised i.e. Mechanical puller and Hydraulic puller.

Two legs puller is generally used for removing the gears. Where as puller with three legs are for removing pulleys. flanges and bearings. It is also called gear puller. Special pullers: These are mainly used for specialised application such as crank shaft bearing removal brake drum, removal pilot bearing removal.

Hydraulic puller: These pullers eliminate time consuming and unsafe hammering, heating or prying. Damage to past is minimised through the use of Hydraulic. pullers.

Safety

To avoid personal injury during system operation,

Always wear proper PPE gear

Never use a tool to strike a puller

Make sure that items are pulled is well and adequately supported

Do not apply heat to a puller

Before every use lubricate the centre bolt threads, with graphite - based lubricant

Use puller only with recommended attachment

Do not over load a pulley which may cause to break

Note: Always keep the guide parts of the lifting plate greased.

Hydraulic pullers are designed to help you extend bearing life in your applications through proper installation, removal and service.

Hydraulic pulling systems are available with capacity ranging from 4 tons to 30 tons, and are ideal for removing all kinds of shaft filled parts.

Hydraulic pulling system comprises of integrated pump. cylinder, hose, puller with safety-release valve. The pullers have self-contained hydraulic pump and are compact, handy. There are ideal for pulling variety of press-fit parts including bearing, wheels bushings, gears, pulleys.

In Automobiles Hydraulic Puller especially used for removing Engine Liner from the cylinder block during engine Reconditioning Work.

Mechanical Puller Operation (Figs 1 & 2)

1 Ensure that the spindle is clean and applied grease before use.

2 The Shaft (A) must have a center hole (B) as shown in the figure. If it does not, use a shaft protector (C) as shown in (fig 1)

3 Tighten strap bolts to hold jaws lightly in place

4 Position the puller that the spindle as shown in fig 2.

5 Tighten the spindle slightly by turning the spindle nut with proper wrench

6 Check that the jaws are fully contacting the part to be pulled.

7 Tighten the strap bolts.

8 Apply pulling force by turning the spindle.

Fig 1

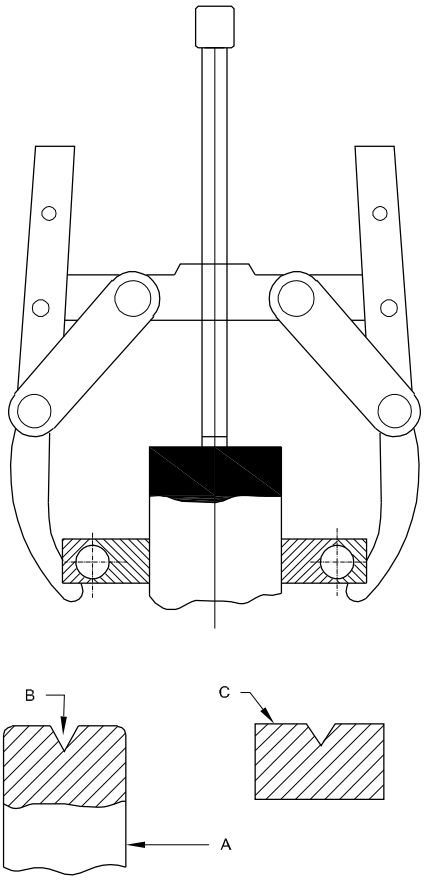
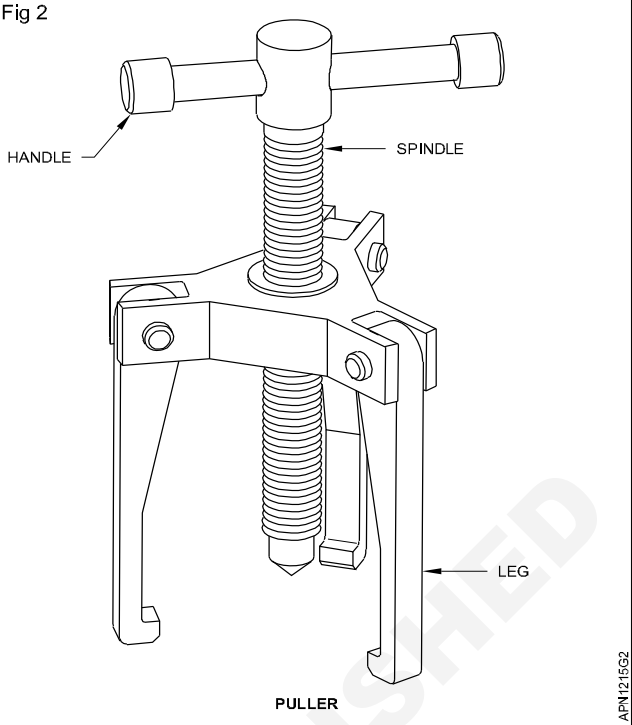


Fig 2



Post lock puller operation (Manual pullers)

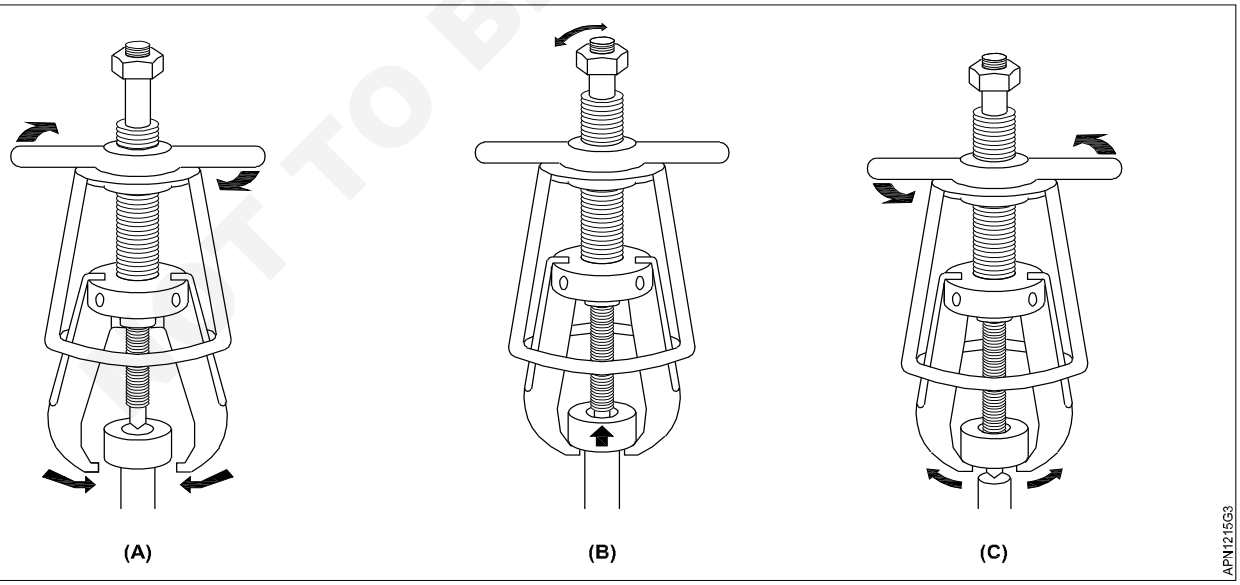
1 Make sure that all items being pulled are supported by means other than the puller. (NO LOOSE PIECES)

2 Before each use, lubricate the center bolt of the puller with a graphite-based lubricant.

3 To operated the puller, grasp the puller with one hand and and turn the T-handle counter-clockwise with the other hand until the jaw opening is big enough to fit over the component to be pulled

4 Turn the T-Handle clockwise with the other hand until the jaw firmly onto the component. (Fig 3A)

Fig 3



5 Make sure that the center of the puller is aligned with the center of the component to be pulled. Using hand tools only, tighten the center bolt to pull the component off of its shaft. Never exceed the maximum torque ratings of the puller's drive bolt. (Fig 3B)

6 Turn the T-handle counter-clockwise to remove the puller from the component. (Fig 3C)

Hydraulic Puller Operation (Fig 4)

1 Make sure that all items being pulled are supported by a means other than the puller. (NO LOOSE PIECES)

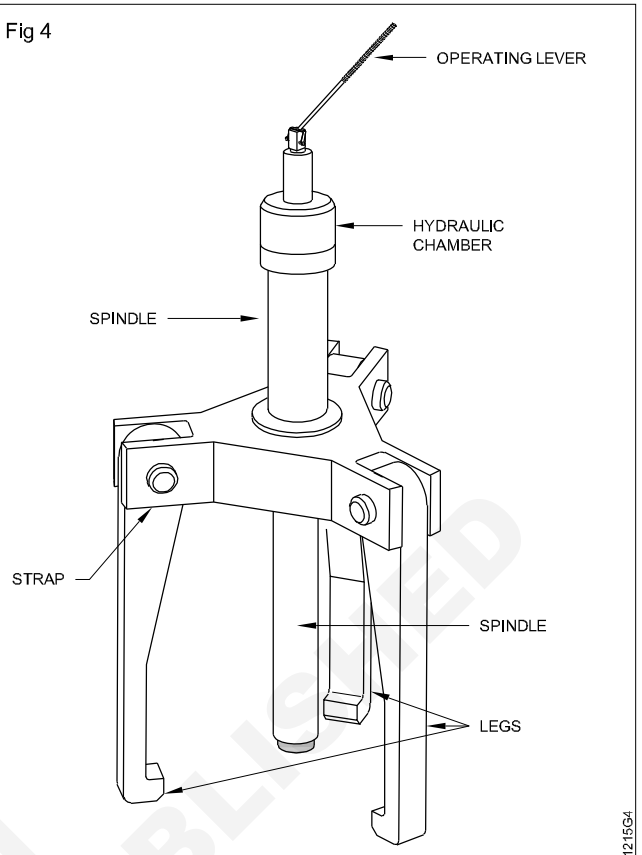
2 Install the cylinder into the puller by threading collar threads clock-wise into the jaw head assembly. Make sure that the puller collar threads are fully engaged in the puller. Attach lift plate to the coupler end of the cylinder. Remove the saddle from the cylinder and insert the ram point into the plunger. Select the ram point that will provide the maximum contact with the shaft.

3 To operate the puller, grasp the puller with one hand and turn the T-handle counter-clockwise with the other hand until the jaw opening is big enough to fit over the component to be pulled.

4 Turn the T-Handle clockwise to tighten the jaw firmly onto the component.

5 Make sure that the puller is square with the component to be pulled. Advance the plunger until the ram point contacts the shaft to insure correct alignment. The center point of the puller must be aligned with the center point of the shaft. Continue to advance the plunger slowly to pull the component off of the shaft. Never try to retighten the T-handle during the pulling operation.

Fig 4



Add: Sheet metal cutting plier (Aviagen) snips) panel cutter, trim and upholstery tool. Door handling tools. (clip puller) metal file, rival file, surform file, sanding board, Sanding block, speeden squeezes.

Care and use of micrometer

Objectives: At the end of this lesson you shall be able to
- **name the principal parts of an outside micrometer**
- **derive the least count of metric micrometer**
- **determine the reading by using a metric micrometer**
- **solve the reading and give the measurement**
- **state the features of a large micrometers.**

The purpose of a metric micrometer is to read an accuracy of 0.01 mm of an object. It is available in various sizes. However, the measuring range is limited to the length of the threaded spindle. (Fig 1)

The principal parts of a micrometer are the frame, anvil, spindle and the thread, sleeve or barrel and the thimble, there is a knurled collar or small lever on the frame to lock the spindle in the barrel.(Fig 2) In addition to this, a ratchet stop is provided to the spindle in order to prevent a possible excess pressure on the screw treads.

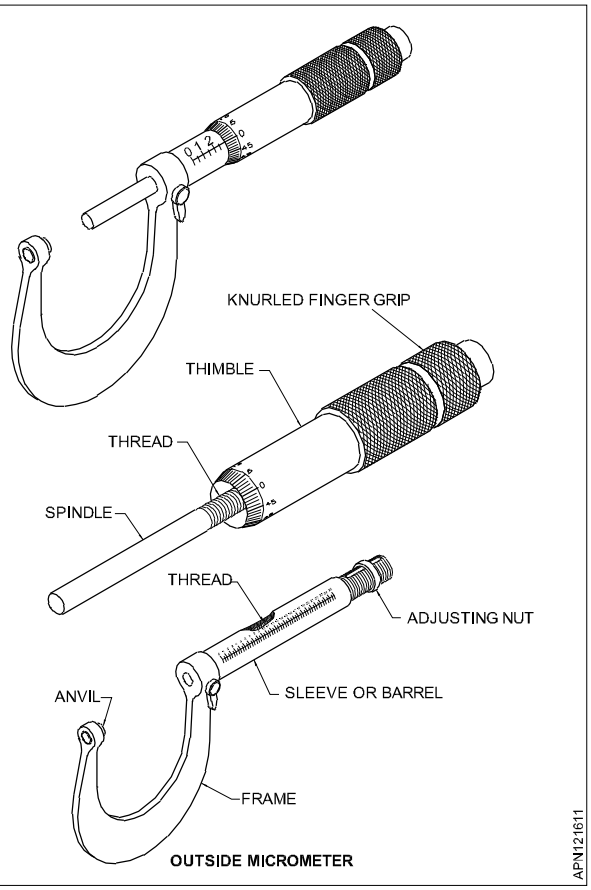
The sleeve or barrel is marked (Fig 3) with the main scale in full mm and half mm. The thimble bevel end is graduated with the thimble scale. Fifty equal divisions are made on the circumference of the thimble bevel end. Every 5th division of the graduation is indicated with the number. Normally, the spindle face is fitted with a carbide tip to resist the wear. The spindle with the screw is attached to the thimble of the micrometer. The corresponding threaded nut is fitted to the barrel or sleeve of the micrometer. The other measuring face of the micrometer is the anvil, which is normally fitted with a carbide tip to resist the wear.

The range of micrometers are 0-5 mm, 25-50 mm, 50-75, 75-100 mm etc. The spindle can be easily screwed down in the barrel. In order to have the reference point for reading the micrometer, the datum or index line is marked on the sleeve.

When the face of the anvil and the face of the spindle are in contact, the O graduations of the index line and O graduation of the thimble coincide with each other.

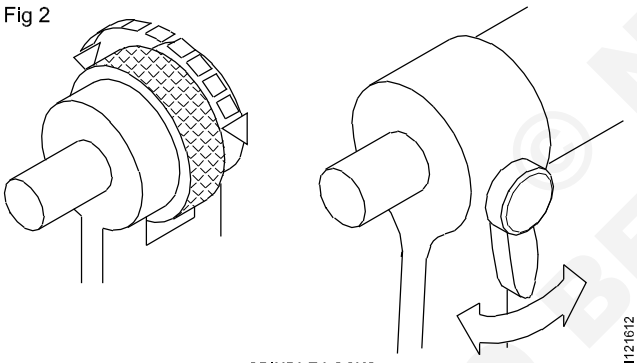
The spindle may be withdrawn by rotating the thimble in an anticlockwise direction. The thimble portion is knurled to provide a good grip for holding as well as for rotating the spindle.

Fig 1



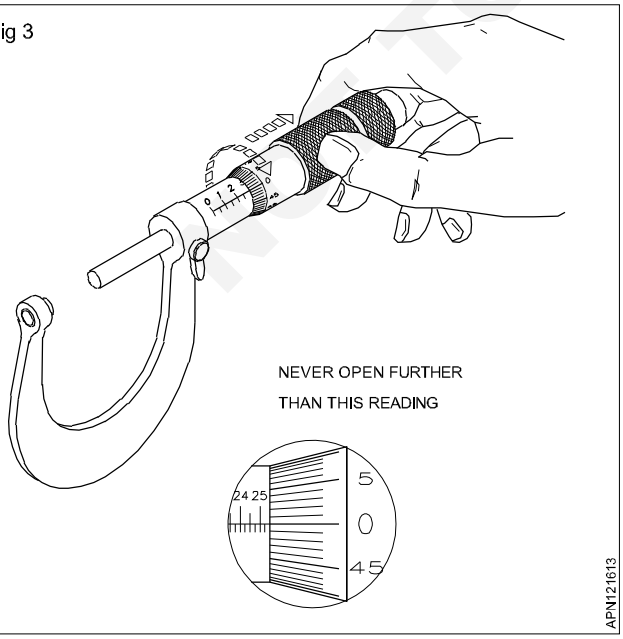
OUTSIDE MICROMETER

Fig 2



SPINDLE LOCKS

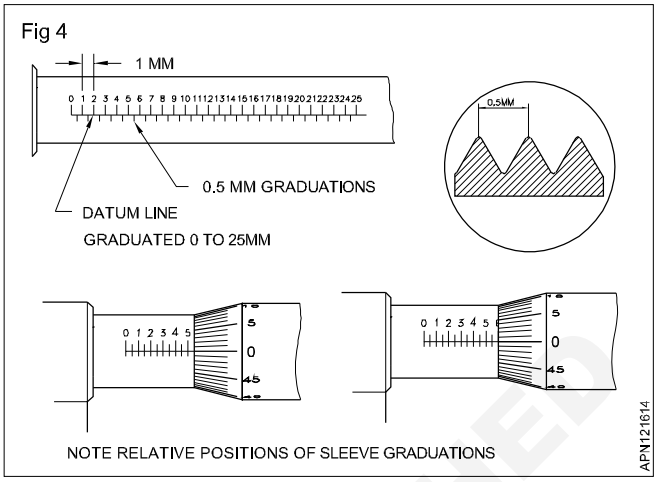
Fig 3



Deriving the least count of a metric micrometer

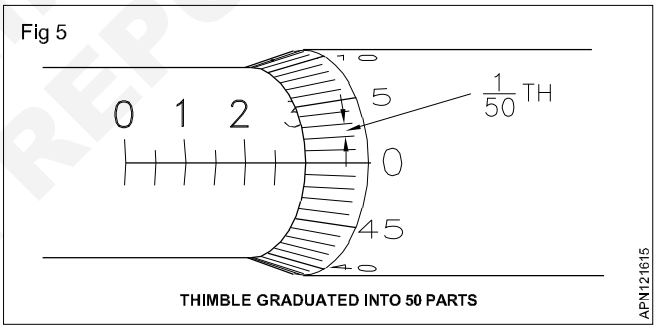
The main scale is graduated in ½ mm. Every 5th mm is shown with the reading. The pitch of the screw thread is accurately maintained to ½ mm. (Fig 4)

Fig 4



By turning one complete revolution of the thimble in a clockwise or an anticlockwise direction, the spindle moves exactly ½ mm in the forward direction or the reverse direction. As the circumference of the thimble graduated into 50 equal divisions, the advancement of the spindle for each division of the thimble scale is ½ mm - 50 i.e. 1/100 mm or 0.01 mm. Therefore, the least count of a metric micrometer is 1/100 mm or 0.01 mm.(Fig 5)

Fig 5



THIMBLE GRADUATED INTO 50 PARTS

Determining the reading of a metric micrometer

Before using the micrometer for measurement, it is necessary to ascertain that there is no error in the micrometer.

The faces of the anvil spindle must be free from dust.

While reading the micrometer, the spindle must be locked with the reading.

Method of reading

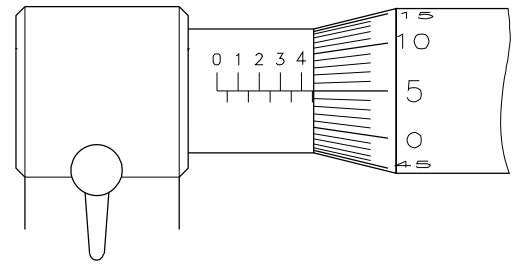
Read on the barrel scale the number of whole millimeters that are completely visible from the bevel edge of the thimble. It reads 4 mm. (Fig 6)

Add to this any half millimeters that are completely visible from the bevel edge of the thimble.

The figure reads ½ = 0.5 mm

Add the thimble reading to the two earlier readings. (Fig 7)

Fig 6



EACH MAJOR DIVISION ON BARREL =1 MM READING IS 4 = 4 MM

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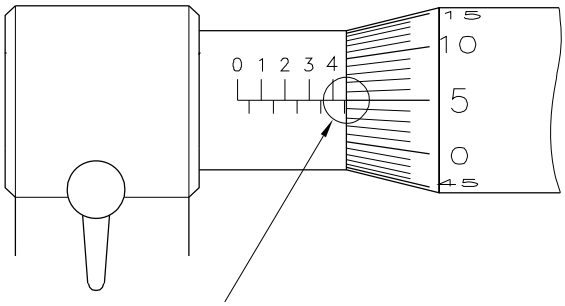
Fig 7



PLUS ADDITIONAL MINOR DIVISIONS. READING IS 1=0.5 MM

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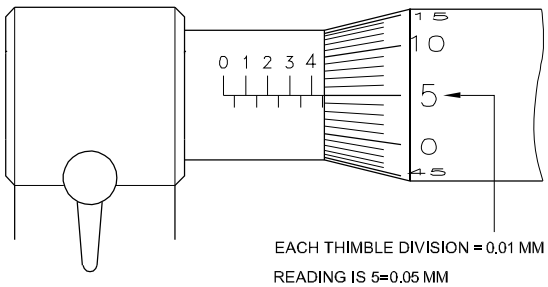
The figure shows the 5th division of the thimble is coinciding with the index line of the sleeve. Therefore the reading of the thimble is 5 8 0.01 mm = 0.05 mm. The total reading of the micrometer.(Fig 8)

Fig 8



EACH THIMBLE DIVISION = 0.01 MM
READING IS 5=0.05 MM
TOTAL READING = 4.55 MM

APN121618

a 4.00 mm

b 0.50 mm

c 0.05 mm

Total reading 4.55 mm

Outside micrometers have limited reading capacity as they are dependent upon the length of the spindle which itself is limited and fixed.

A 0-25 mm capacity outside micrometer can read a maximum dimension of 25 mm. For measuring sizes over and above this, we have to change to the next capacity micrometer 25-50 mm, then 50-75 mm and so on depending on the size of the job. As such, a good number of micrometers will have to be used for finishing jobs of various dimensions. In order to eliminate this problem, a large micrometer is used for measurements.

Precision Measuring Instruments - Outside Metric Micrometer

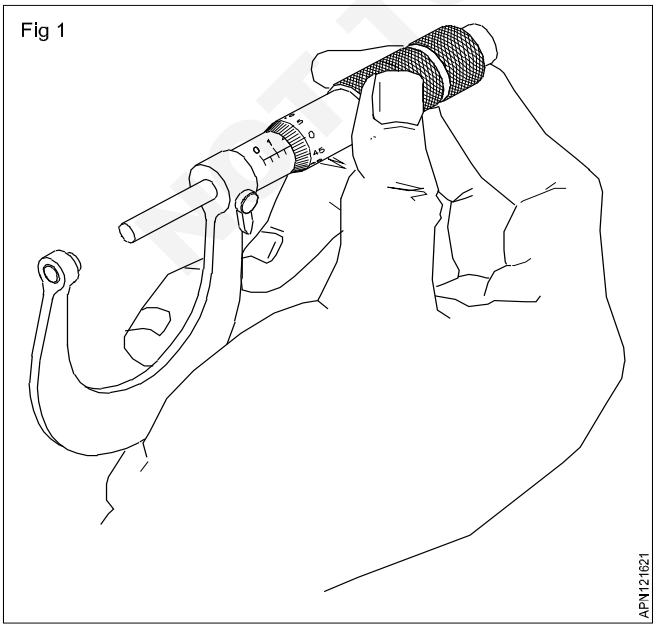
Objectives: At the end of this lesson you shall be able to
- **hold the micrometer for measurement**
- **set the micrometer on work for measurement**
- **read the measurement.**

Holding the micrometer for measurement

The micrometer may be held either in one hand or both the hands.

Holding In one hand (Fig 1)

Fig 1



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Hold the outside micrometer in your right hand, keeping the graduations on the main scale towards you.

Support the frame on the lower centre of your palm. Use your little or third finger to hold the frame in the palm.

Place the middle finger behind the frame to support it.

Keep the first finger and thumb free to adjust the knurled thimble.

Holding by both the hands (Fig 2)

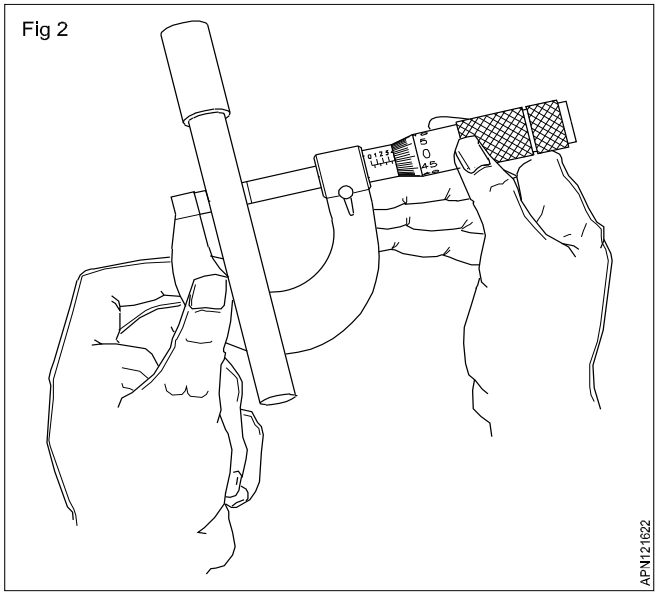
Sometimes, it may be more convenient to hold the micrometer with both the hands.

Support the frame between the fingers and the thumb of your left hand.

Use the thumb and finger of your right hand to adjust the thimble.

Setting the micrometer on the workplace for measurements (Fig 3): High skills needed for obtaining accurate measurements with the outside micrometer. A wrong setting of the micrometer over the workplace may cause:

Fig 2

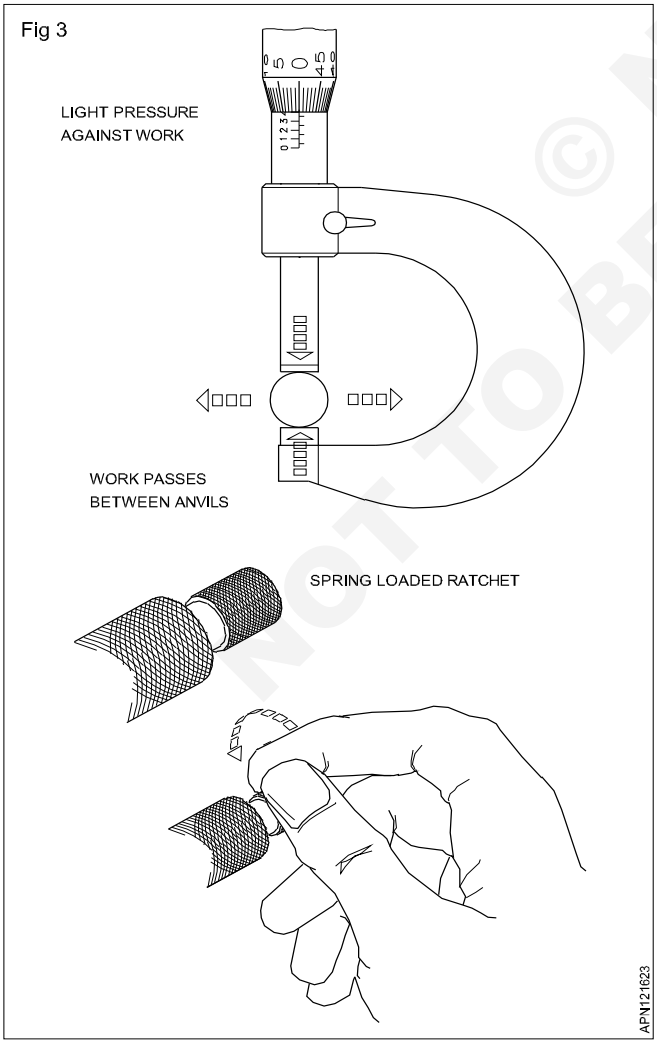


APN121622

- In accurate reading
- Excessive strain on the screw thread
- Distortion in the frame.

Figures 3 shows the adjustment of the spindle and anvil over workplace. As you adjust the workplace between the spindle and the anvil, you should feel a light pressure or resistance against the workplace surface. Use the spring loaded ratchet stop to ascertain the feel.

Fig 3



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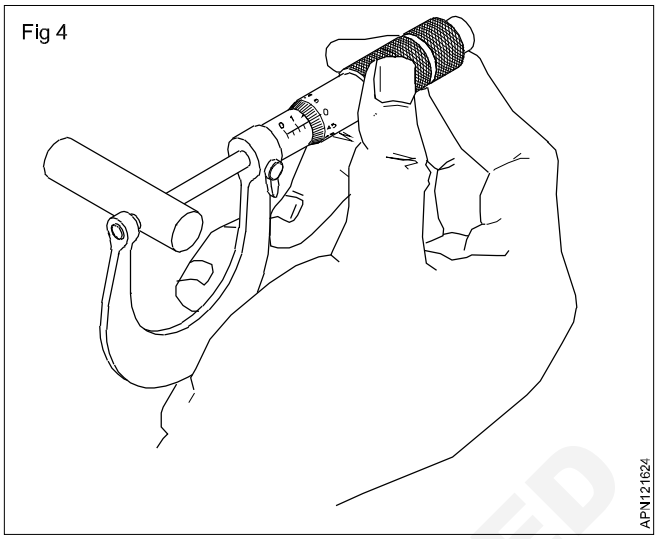
While using only one hand (Fig 4)

Fig 4

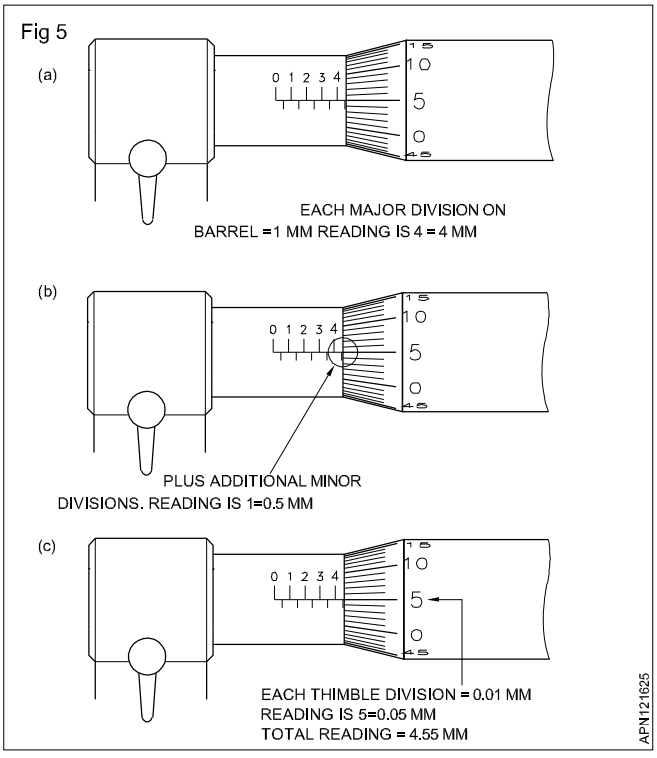


APN121624

- Close the anvil and spindle until you feel them just touching the work
- Move the work slightly between the spindle and the anvil or pass the micrometer over the workplace by moving your wrist
- Make further adjustments of the thimble as required until you obtain the right 'feel'
- When satisfied with the feel, remove the fingers from the thimble
- Turn the micrometer towards you
- Read the measurement

Method of reading the micrometer 0-25 range (Fig 5): Look at the reading which has been taken from the workplace.

Fig 5



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Read on the barrel scale the number of whole millimeters that are completely visible from the bevel edge of the thimble. Figure 'a' shows 4 divisions = 4 mm.

Add any half millimeters that are completely visible from the bevel edge of the thimble.

Figure 'b' shows 1 division = 0.5 mm.

Add the thimble reading to the main scale reading which has already been taken. Figure 'c' shows the 5th division of the thimble scale is coinciding with the index line. So thimble reading = 5 * 0.01 = 0.05 mm.

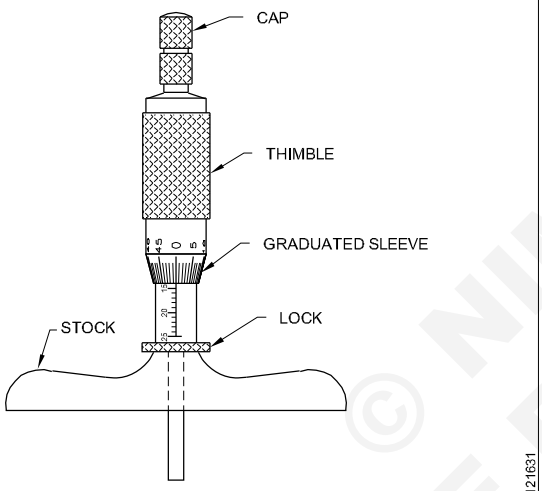
	4. 00 mm
	0.50 mm
	0.05 mm
Total reading	4.55 mm

Depth micrometer

Objectives: At the end of this lesson you shall be able to
- **name the parts of a depth micrometer**
- **state the constructional features of a depth micrometer**
- **read the depth micrometer measurement.**

Constructional features (Fig 1)

Fig 1



DEPTH MICROMETER

A depth micrometer consists of a stock on which a graduated sleeve is fitted.

The other end of the sleeve is threaded with 0.5 mm pitch 'V' thread.

A thimble, which is internally threaded to the same pitch and form, mates with the threaded sleeve and slides over it.

The other end of the thimble has an external step machined and threaded to accommodate a thimble cap.

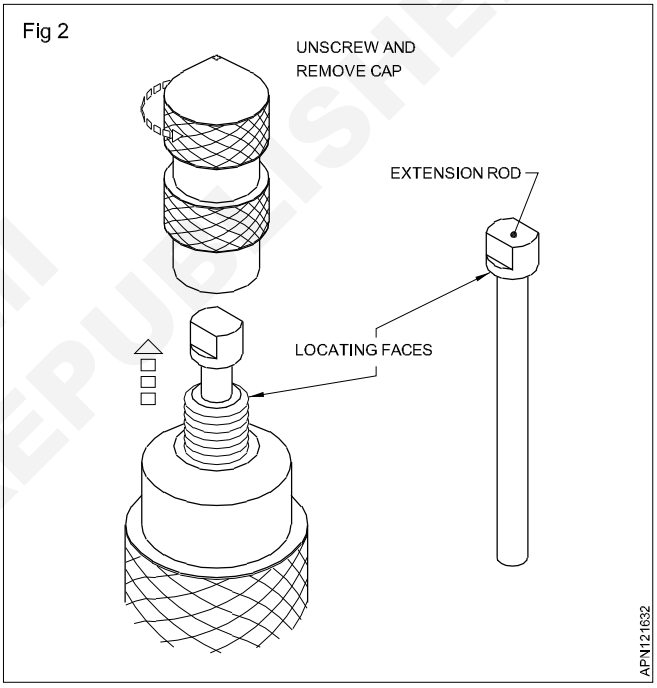
A set of extension rods are generally supplied. On each of them, the range of sizes that can be measured with that rod is engraved as 0-25 mm, 25-50 mm, 50-75 mm, 75-100 mm, 100-125 mm and 125-150 mm.

These extension rods can be inserted inside the thimble and the sleeve.

The extension rod has a collar head which helps the rod to be held firmly. (Fig 2)

The measuring faces of the stock and the rods are hardened, tempered and ground. The measuring face of the stock is machined perfectly flat.

Fig 2



The extension rods may be removed and replaced according to the size to be measured.

Graduation and least count

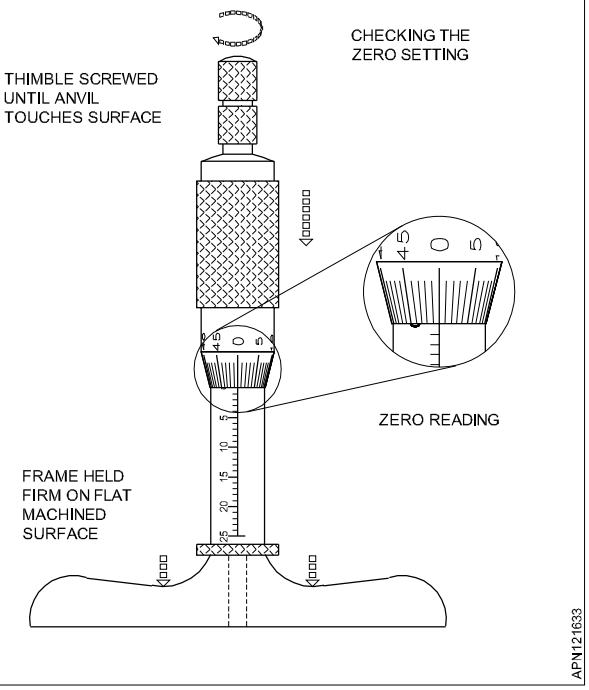
On the sleeve a datum line is marked for a length of 25 mm. This is divided into 25 equal parts graduated. Each line represents one millimeter. Each fifth line is drawn little longer and numbered. Each line representing 1mm is further subdivided into two equal parts. Hence each subdivision represents 0.5 mm. (Fig 3)

The graduations numbered are in the reverse direction to that marked on an outside micrometer.

The zero graduation of the sleeve is one the top and the 25 mm graduation is near the stock.

The bevel edge of the thimble is also graduated. The circumference is divided into 50 equal parts and every 5th division line is drawn longer and numbered. The numbering is in the reverse direction and increases from 0 to 5, 10, 15, 25, 30, 35, 40, 45 and 50 (0). (Fig 4)

Fig 3



The advancement of the extension rod for one full turn of the thimble is one pitch which is 0.5 mm.

Therefore the advancement of the extension rod for one division movement of the thimble will be equal to 0.5 / 50 = 0.01 mm.

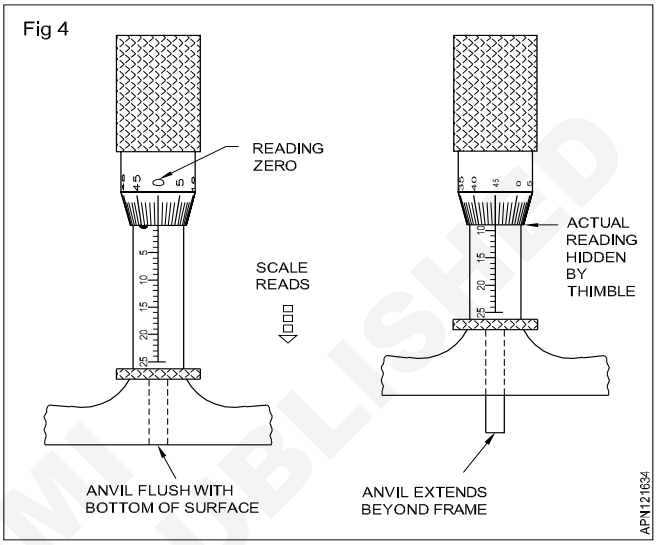
This will be the smallest measurement that can be taken with this instrument, and so this is the accuracy of measurement of this instrument.

Uses of a depth micrometer

Depth micrometers are special micrometers used to measure:

- Depth of holes
- Depth of grooves and recesses
- Heights of shoulders and projections.

Fig 4



The universal vernier caliper and its application

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

- **list out the parts of a universal caliper**
- **state the constructional features of the universal vernier caliper**
- **state the functional features**
- **list out the points for taking the measurements.**

One of the precision instruments having the principle of vernier applied to it is the universal vernier caliper. It is known as a universal vernier caliper because of its application to take outside, inside and depth measurements. Its accuracy is 0.02 mm.

A universal vernier caliper consists of a:

- Beam
- Fixed jaw for external measurements
- Movable jaw for external measurements
- Movable jaw for internal measurements
- Blade for depth measurement
- Main scale
- Vernier scale
- Fine adjustment screw
- Set of locking screws.

All parts are made out nickel-chromium steel, heat-treated and ground. They are machined to a high accuracy. They are stabilized to avoid distortion due to temperature variations.

Constructional features (Fig 1)

The beam is the main part and the main scale graduations are marked on it. The markings are in millimeters and every tenth line is drawn a little longer and brighter than the other graduations and numbered as 1,2,3 ….

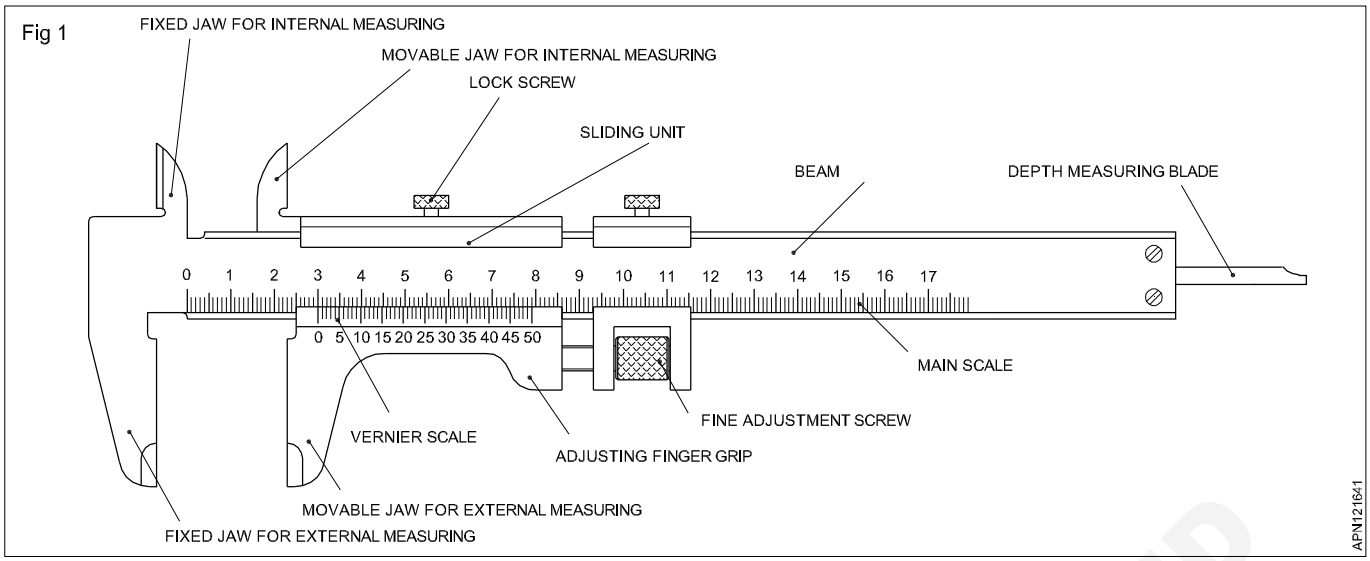
To the left of the beam the fixed jaws for external and internal measurements are fixed as integral parts., The vernier unit slides over the beam.

At the bottom face of the beam a keyway-like groove is machined for its full length, permitting the blade to slide in the groove.

At the bottom right hand end, a unit is fixed serving as a support for the blade when it slides in the groove.

The vernier unit has got the vernier graduations marked on it. The movable jaws for both external and internal measurements are integral with this.

The fixed and movable jaws are knife-edged to have better accuracy during measurement. When the fixed and movable jaws are made to contact each other, the zero of the vernier scale coincides with the zero of the main scale.



At this position in the blade will be in line with the right hand edge of the beam.

When the vernier scale unit slides over the beam, the movable jaws of both the measurements as well as the blade advance to make the reading.

To slide the vernier unit, the thumb lever is pressed and pulled or pushed according to the direction of movement of the vernier unit.

Least count

In the vernier scale illustrated here, 19 mm are divided into 10 equal parts on the vernier scale. The value of 1 vernier scale division will then be

$$\frac{19}{10} = 1.9 mm$$

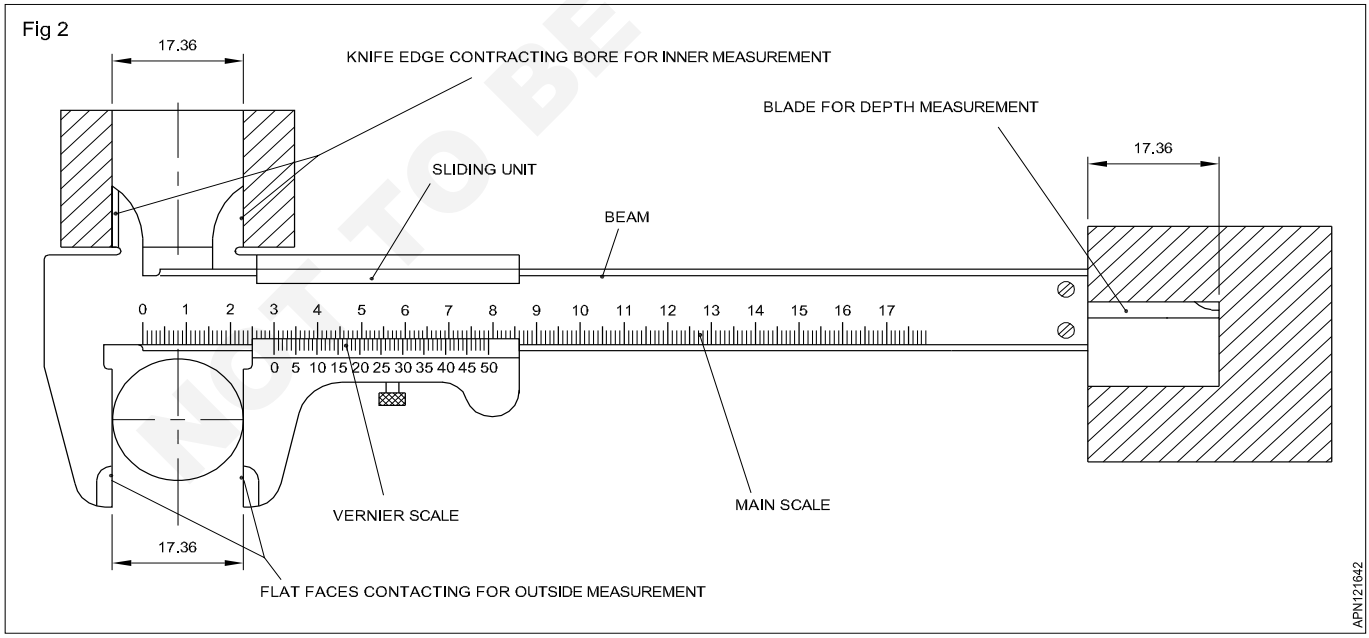
The difference of the two main scale divisions and 1 vernier scale division gives the least count and it is equal to 2*1m -1.9 mm = 0.1 mm.

For better accuracy, a 49 mm space is divided into 50 equal parts on the vernier scale so that one vernier scale division value will be

$$\frac{49}{50} = 0.98 mm$$

Here the least count will be 1 main scale division - 1 vernier scale divisions = 1 mm-0.98 mm= 0.02 mm.

The application of the universal vernier caliper is taking external, internal and depth measurements is shown in (Fig 2)



Advantages

No need to have separate precision instruments for taking external, internal and depth measurements.

Disadvantages

Accuracy of reading depends on the skill of the operator.

Loses its accuracy by constant usage as slackness in the sliding unit develops.

Cannot be used to measure components having deviations less than +/-0.02 mm.

Possibility of parallax error during noting down the coinciding line may cause the reading of the measurement to be wrong.

To read a measurement: Note the number of graduations on the main scale passed by the zero of the vernier. This gives the full mm.

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

Multiply this number with the least count.

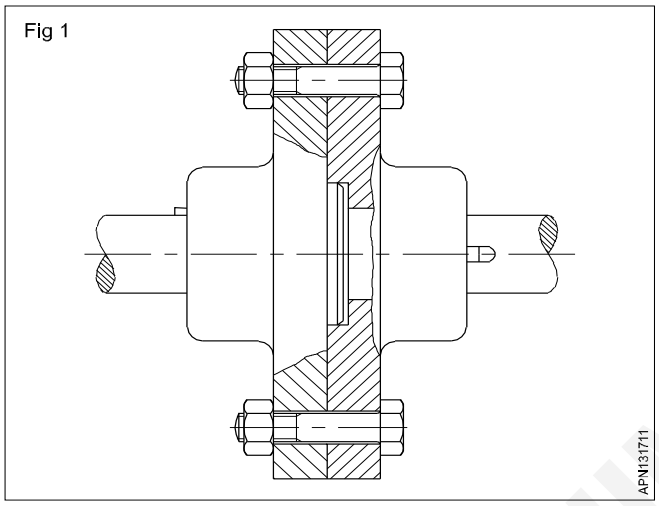
Add the multiplied value to the main scale reading.

Bolts, studs and nuts

Objectives: At the end of this lesson you shall be able to
- **state the situations in which bolts and nuts are used**
- **state the advantages of using bolts and nuts**
- **name the different types of bolts**
- **state the applications of the different types of bolts**
- **state the situations in which studs are used.**

Bolts and nuts (Fig 1)

Fig 1



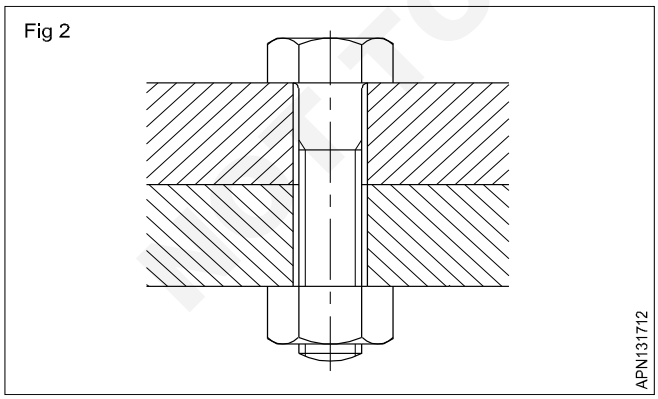
These are generally used to clamp two parts together.

When bolts and nuts are used, if the thread is stripped, a new bolt and nut can be used. But in the case of a screw directly fitted in the component. When threads are damaged, the component may need extensive repair or replacement.

Depending on the type of application, different types of bolts are used.

Bolts with clearance hole (Fig 2)

Fig 2

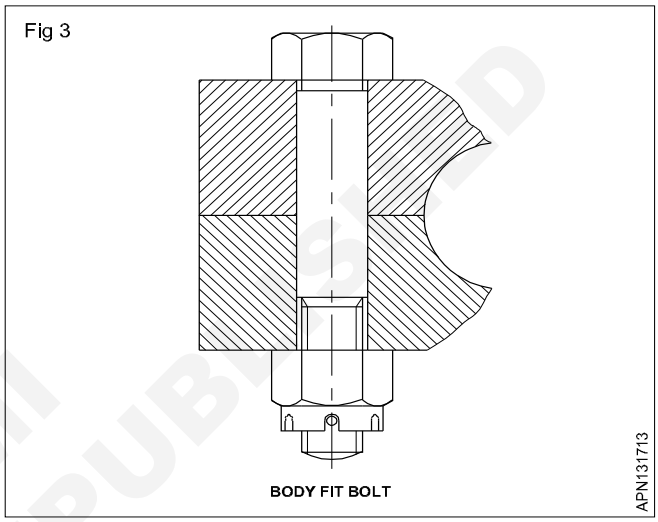


This is the most common type of fastening arrangement using bolts. The size of the hole is slightly larger than the bolt (clearance hole)

Slight misalignment in the matching hole will not affect the assembly.

Body fit bolt (Fig 3)

Fig 3

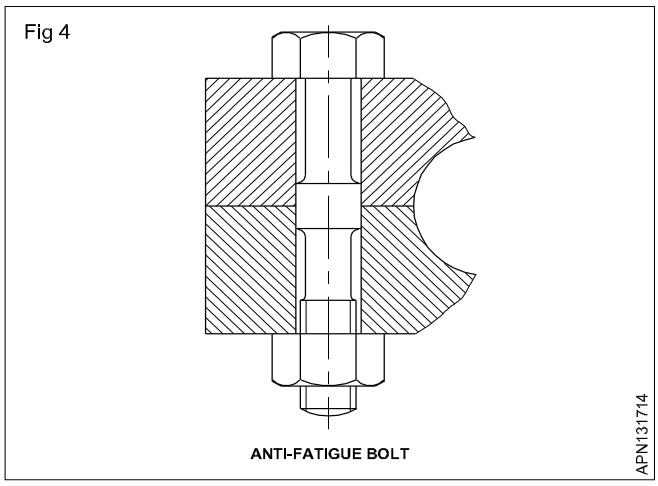


This type of bolt assembly is used when the relative movement between the workpieces has to be prevented. The diameter of the threaded portion is slightly smaller than the shank diameter of the bolt.

The bolt shank and the hole are accurately machined for achieving perfect mating.

Anti-fatigue bolt (Fig 4)

Fig 4

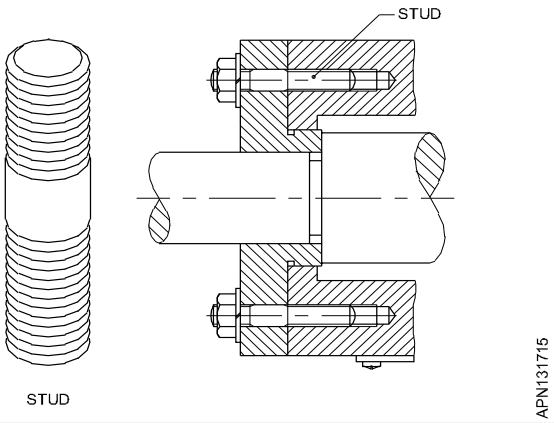


This type of bolt is used when the assembly is subjected to alternating load conditions continuously. Connection rod big ends in engine assembly are examples of this application.

The shank diameter is in contact with the hole in a few places and other portions are relieved to give clearances.

Studs (Fig 5)

Fig 5



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

When excessively tightened, the variation in the thread pitch allows the fine thread or nut end to slip. This prevents damage to the casting.

Designation of bolts as per B.I.S. specifications

Hexagon head bolts shall be designated by name, thread size, nominal length, property class and number of the Indian Standard.

Example

A hexagon head bolt of size M10, nominal length 60mm and property class 4.8 shall be designated as:

Hexagon head bolt M10x60 - 4.8-IS: 1363 (Part 1)

Explanation about property class

The Part of the specification 4.8 indicates the property class (mechanical properties). In this case it is made of steel with minimum tensile strength = 40kgf/mm2 and having a ratio of minimum yield stress to minimum tensile strength = 0.8.

NOTE

Indian standard bolts and screws are made of three product grades - A,B, & C, `A' being precision and the others of lesser grades of accuracy and finish.

While there are many parameters given in the B.I.S. specification, the designation need not cover all the aspects and it actually depends on the functional requirement of the bolt or other threaded fasteners.

For more details on the designation system, refer to IS: 1367, Part XVI 1979.

Locking Devices

Objectives: At the end of this lesson you shall be able to
- **state what is a locking device**
- **name the effect, if proper locking devices are not employed**
- **name the various types of locking devices**
- **state the uses of the commonly used locking devices.**

Locking devices

A locking device is a device used to lock the threaded fasteners to prevent them from loosening. Due to vibration in the moving part, there is a tendency for the threaded fastener to get slack and to slip off. Then the assembled part will get loose and cause damages. Some examples are given below to illustrate the importance of the locking device.

In the case of a micrometer, the lock-nut avoids the Movement of the spindle after taking the reading. In the case of boilers and gas cylinders, locking of the nut avoids the leakage of steam or gas.

In automobiles the lock-nut avoids the loosening of the assembled part.

Classification of lock-nuts

Lock-nuts are classified into two categories.

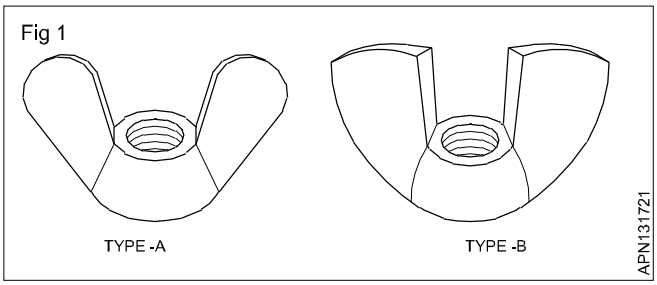
- Positive locking device
- Frictional locking device

These nuts have special provision in the form of slots for fixing split pins for locking the nuts.

Slotted nuts are hexagonal shaped throughout. In the case of castle nuts, the top part of the nut is cylindrical in shape.

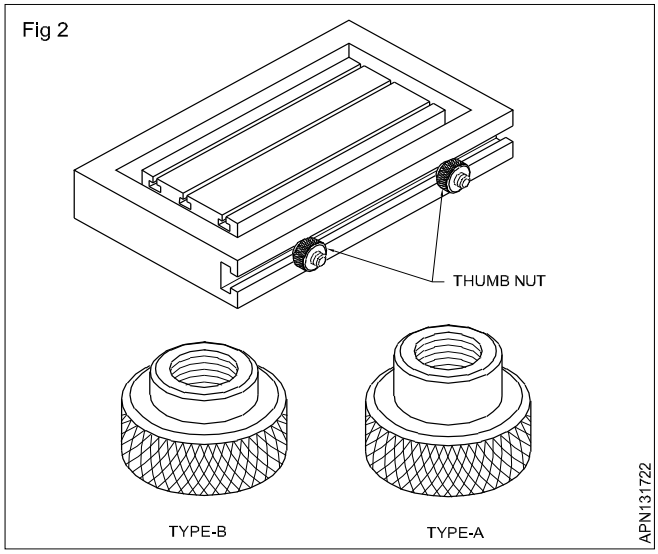
Wing-nuts (Fig 1)

Fig 1



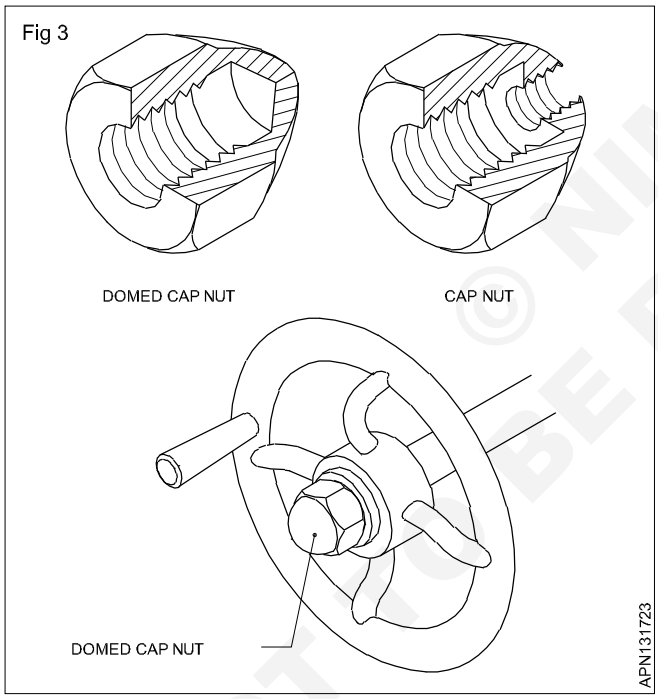
Wing-nuts are used in light duty assembly which require frequent removal and fixing. These are available as hot forged/cast (Type A) and cold forged (Type B).

Thumb-nut (Fig 2)



These are used in places where frequent adjustments are required and mere finger tightening enough. They are available in two types - Types A & Type B.

Cap nut (Fig 3)



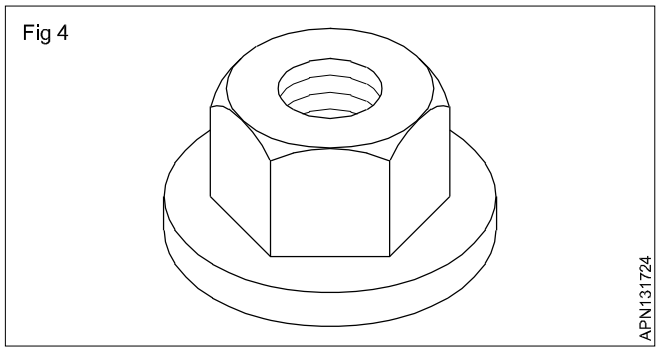
These are used to protect the bolt end threads from damages and also as a protector for safe working. They serve to provide a decorative appearance.

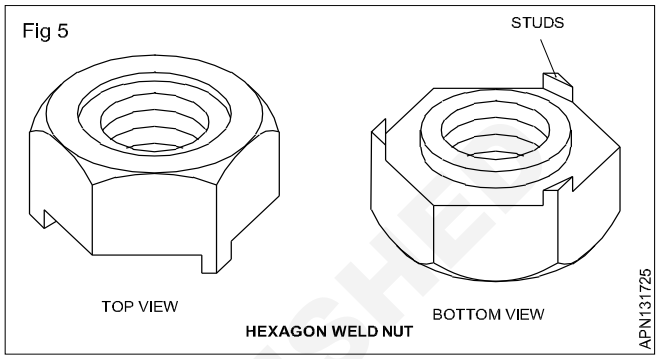
Hexagonal nuts with collar (Fig 4)

These nuts have a machined collar on one end. This provides additional bearing surface in assembly. The collar acts like a washer and is useful where frequent tightening and loosening is necessary.

Hexagonal weld nuts (Fig 5)

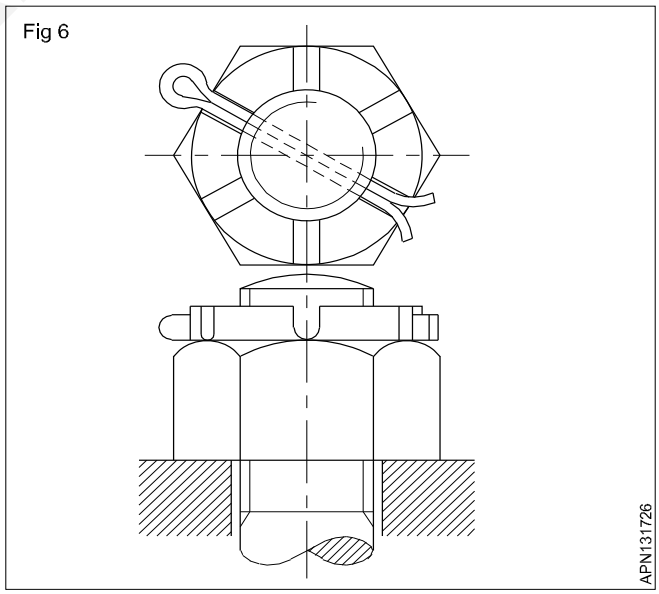
These are nuts used for welding on the plate work. These nuts have:





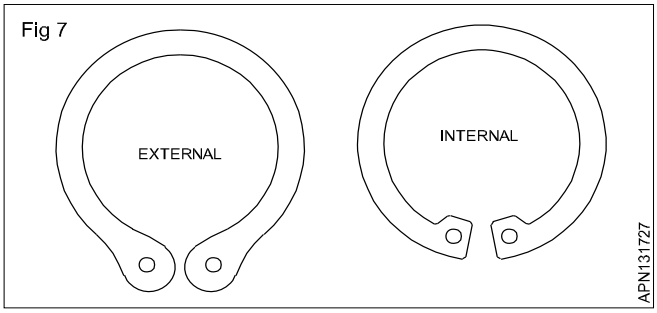
- A spigot ring which fits in the hole of the plate
- Three projections to provide a uniform contact on the surface, that is to be welded
- A countersunk hole on one end to protect the thread during welding.

Out. Castle nuts (Fig 6) are widely used in automobiles and locomotive engines to avoid sudden shock and vibration.

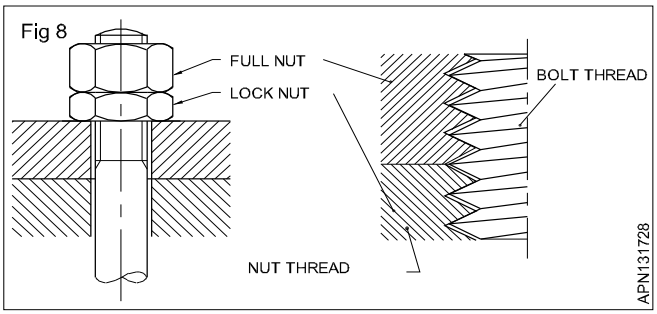


Circlip (Fig 7)

These are widely used to retain the component on a shaft or in a bore. Seating of these circlips in a slot by using a special type of pliers facilitates rapid assembly and disassembly.



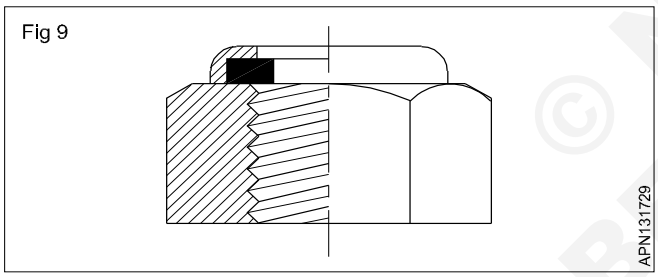
Chuck nut (Fig 8)



This nut is used along with one ordinary nut as shown in the figure.

A chuck nut is also called a lock-nut. The two nuts are thus locked or wedged tightly against each other and against the bolt. This will prevent slackening.

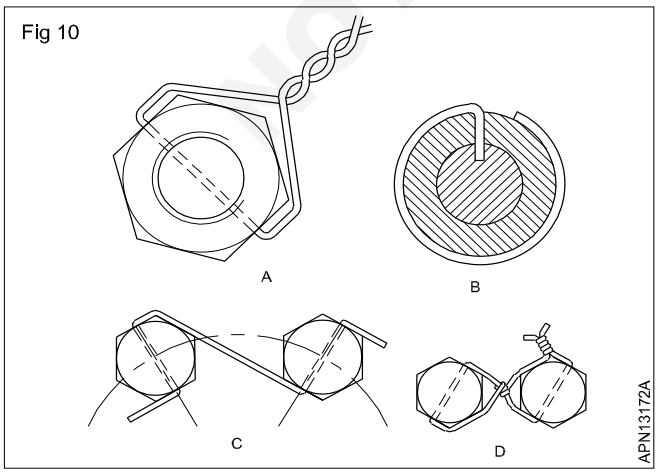
Self-locking nut (Fig 9)



Self-locking nut will have a nylon insert to prevent the loosening of the nut from shock, vibration and temperature.

Wire lock (Fig 10)

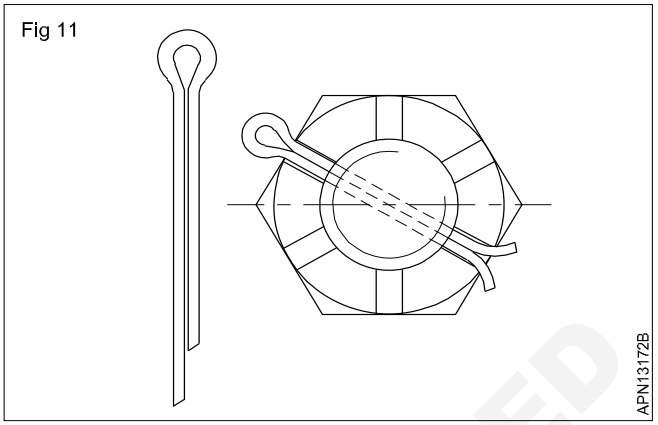
Wire locks are used for light engineering works. The wire is passed through the groove.



Nut applied with a sealant

These locking devices are for permanent locking in light works.

Split pin (Fig 11)



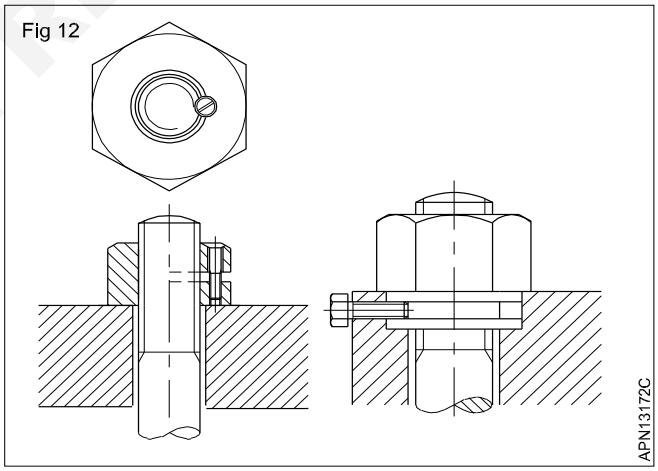
A split pin is made from a steel wire of semicircular cross section, bent as shown in the figure. It is inserted in a hole drilled in the bolt so that it exerts pressure on the top face of the nut to prevent it from turning.

awn nut (Wiles nut)

In this locking device, a slot is cut half way across the nut. A screw is fitted with a clearance hole on the top part and a matching thread on the lower part of the nut. Tightening of the nut provides positive locking for the nut.

Positive locking device (Fig 12)

Frictional locking device



Positive locking device(Fig 13)

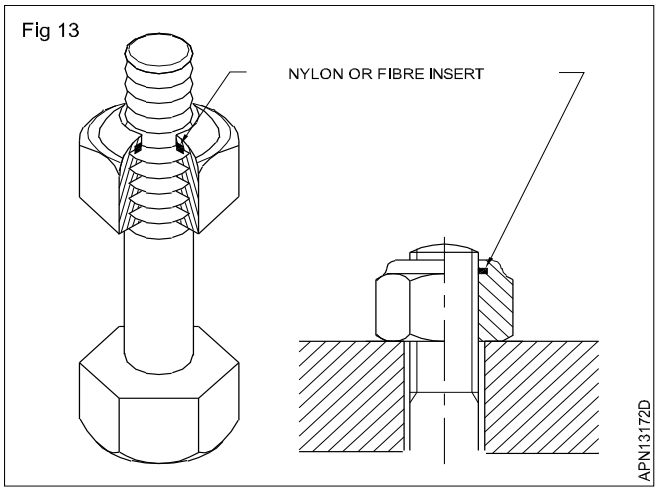
In the positive locking device, the locking action is positive. This locking device is difficult to fit and may take more time. But it is very essential to use this type of locking device in critical joints where failure could cause serious accidents.

Eg. Clutches, brakes, controls etc.

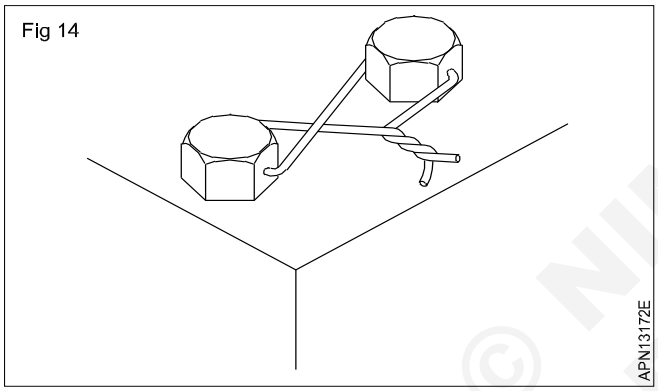
The positive locking devices are:

- Standard hexagonal nut, cross-drilled and pinned
- Standard slotted nut

- Standard castle nut
- Hexagonal nut and locking plate
- Wiring bolt heads.



Frictional locking devices (Fig 14)



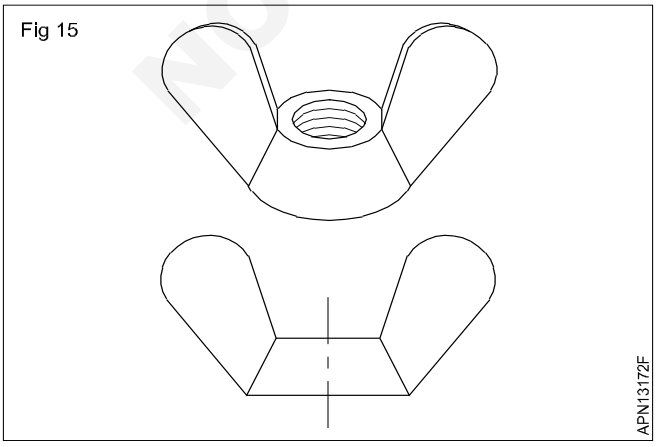
These lock nuts are easy to fit and less time consuming.

The frictional locking devices are:

- Lock-nut (chuck nut)
- Spring washer
- Wedge lock bolt
- Simmonds lock-nut.

Commonly used locking devices

Wing-nut (Fig 15)

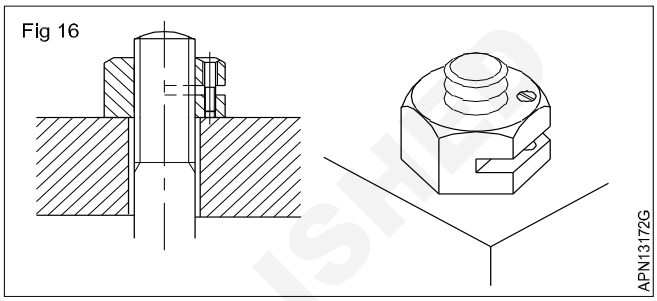


A wing-nut is used where frequent adjustment or removal is necessary. It can be loosened or tightened rapidly without the need of a wrench. These nuts are manufactured with the same material as is used for the bolts.

Thumb-nut: A thumb-nut is used where the movement of the spindle is to be locked, as in a micrometer. Stopping the movement of the spindle is necessary for taking a correct reading.

Locking ring: A locking ring is used in taper nose spindles of lathes to lock the chuck.

Castle nut (Fig 16): Slots are cut in a cylindrical collar provided on the top of the nut, thus overcoming the disadvantage of the slotted .

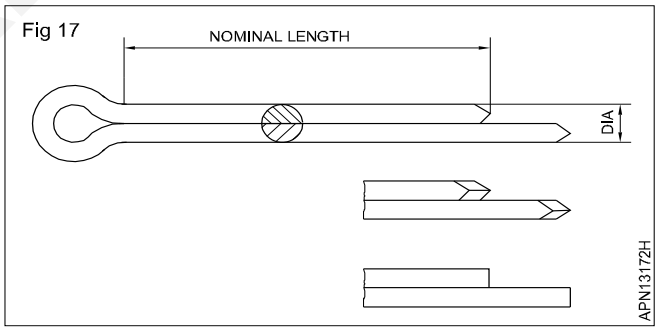


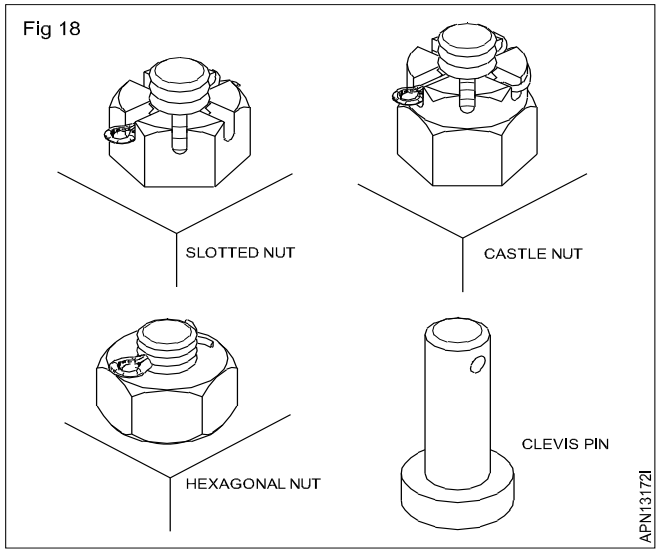
Slotted and castle nut with a split pin

The position of the nut can be locked using the split pin.

Split pins are designated by the nominal size, nominal length, the number of the Indian Standard and the material. (Figs 17 & 18)

The nominal length is the distance from the underside of the eye to the end of the short leg.

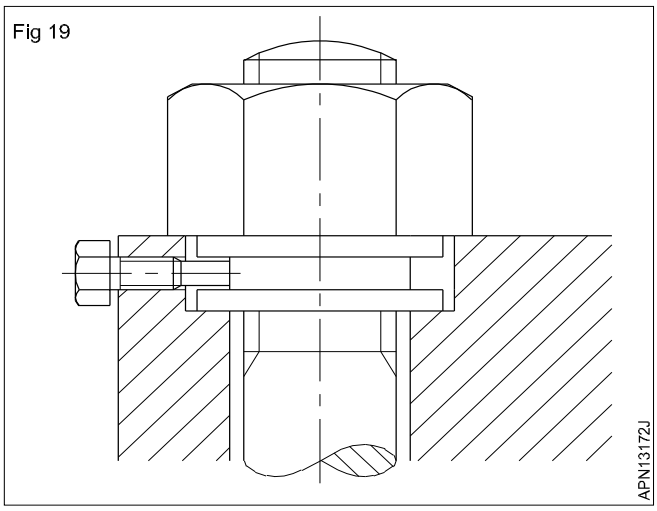




Split pins are used for locking slotted nuts, castle nuts, hexagonal nuts, clevis pins etc. and are used in different ways.

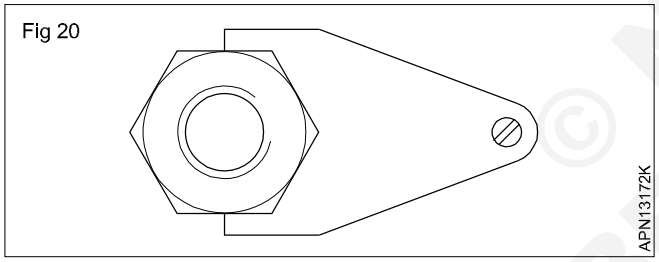
Grooved nut (Penning nut) (Fig 19)

This is a hexagonal nut with the lower part made cylindrical. On the cylindrical surface there is a recessed groove in which a set screw is used to lock the nut.

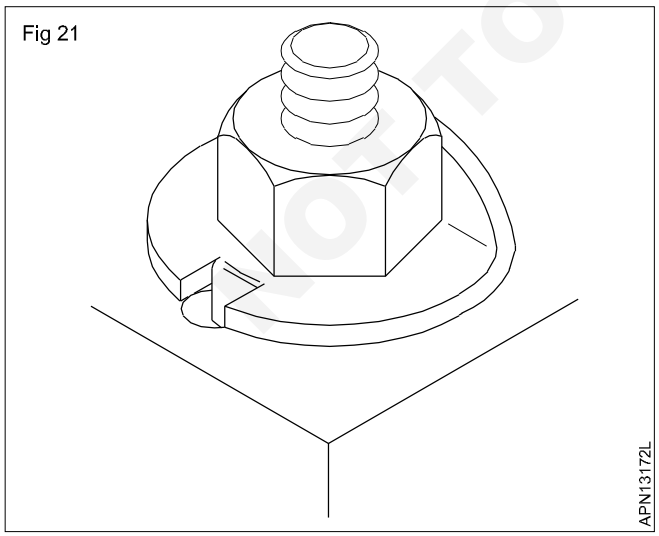


Locking plate (Fig 20)

For preventing the nut from loosening, locking plates are fixed on the outside of the hexagonal nut.



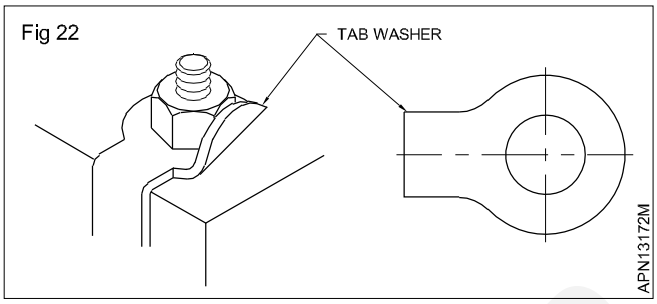
Lock washers with lug (Fig 21)



In this arrangement of locking, a hole is drilled for accommodating the lug.

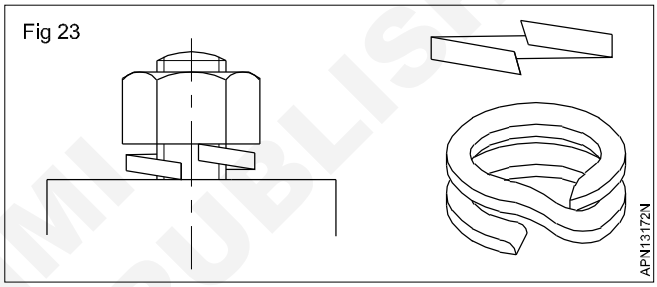
The movement of the nut is prevented by folding the washer against the nut.

Tab washers (Fig 22)



Tab washers can be used for locking the nuts which are located near an edge or corner.

Spring washer (Fig 23)



Spring washers are available with single or double coils. These are placed under a nut in the assembly as washers. The stiff resistance offered by the washer against the surface of the nuts serves to prevent loosening.

Washer's can be categorised into three types.

- **Plain washer:** Which spread a load and prevent damage to the surface being fixed or provide some sort of insulation such as electrical.
- **Spring washer:** Which have axial flexibility and are used to prevent fastening or loosing due to vibration.
- **Locking washser:** Which prevent fastening devices locking washers are usually also spring workers.

Wahser materials: Steel, Non-ferrous metal, alloy, plastic, nylon

Correction resistance: A number of technique are used to enhance the corrosion resistant properties of contain washser materials like a metallic coatings, electroplating, phosphating, browning or bluing chemical plating.

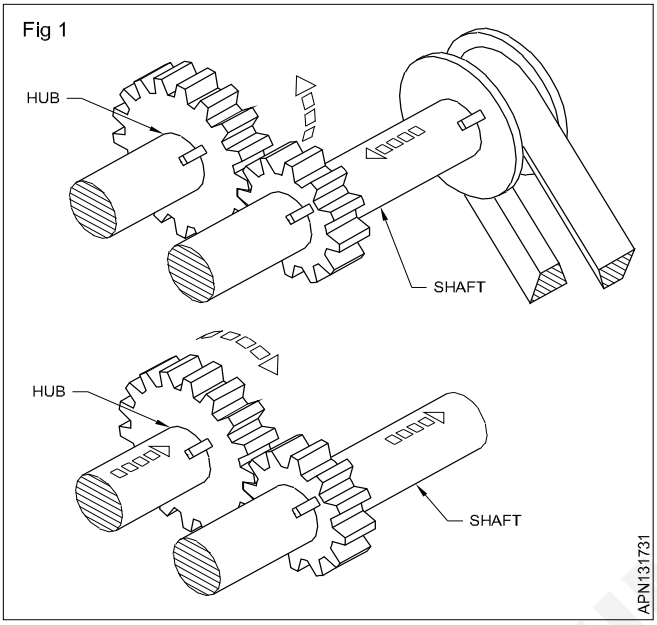
Keys and Splines

Objectives: At the end of this lesson you shall be able to
- **name the different types of keys used in transmission**
- **state the features of each type of keys.**

Keys and splines

Keys are used for transmitting torque from a rotating shaft to a hub/wheel or from a hub/wheel to the shaft. (Fig 1)

Fig 1

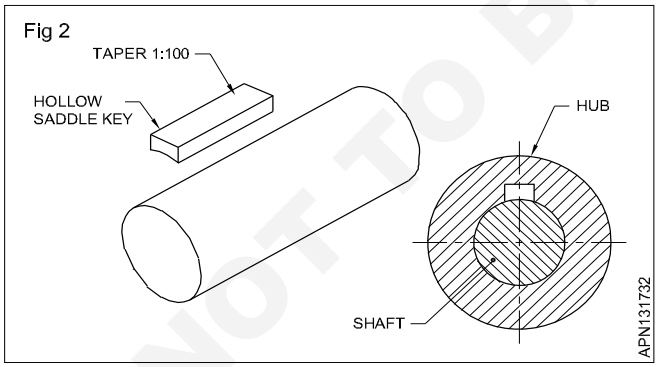


Keys of different types are used depending on the requirements of transmission.

Hollow saddle key

One face of this key has a curvature to match with that of the shaft surface. It has a taper of 1 in 100 and is driven in through the keyway. (Fig 2)

Fig 2



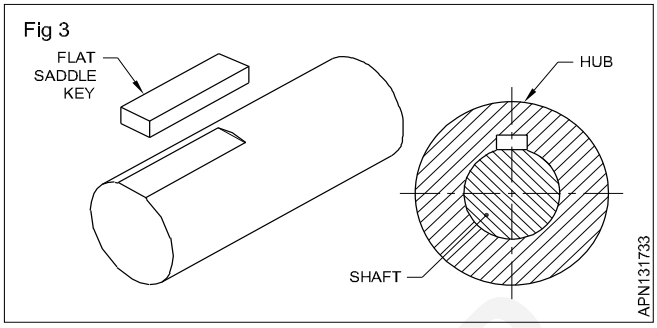
The hub is held on the shaft due to friction. This key is useful only for light duty transmission.

Flat saddle key

This key has a rectangular cross-section.

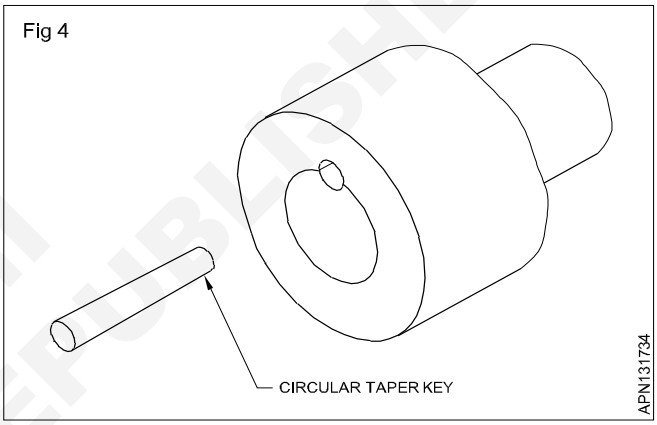
For fitting this key in the assembly a flat surface is machined on the shaft. (Fig 3). The key is placed between the flat surface of the shaft and the keyway on the hub. This is considered to be stronger than the hollow saddle key. This is not suitable for heavy duty transmission.

Fig 3



Circular taper key (Fig 4)

Fig 4



In this case both the shaft and the hub have semicircular keyways cut on them. (Fig.4) The taper key is driven in while assembling. This key is suitable only for light transmission.

Sunk key (Figs 5 & 6)

This key has a rectangular cross-section and its fits into the keyway cut on both the shaft and the hub. Sunk keys are either parallel or tapered. (Figs.5 and 6)

Fig 5

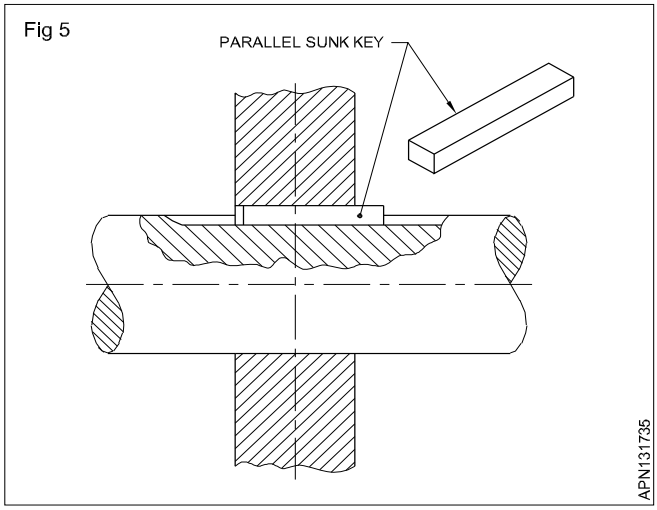
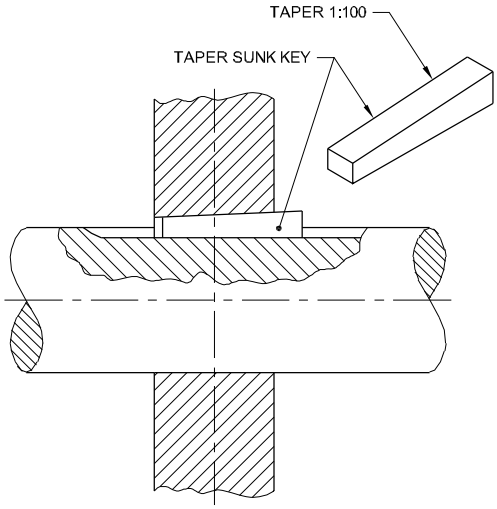
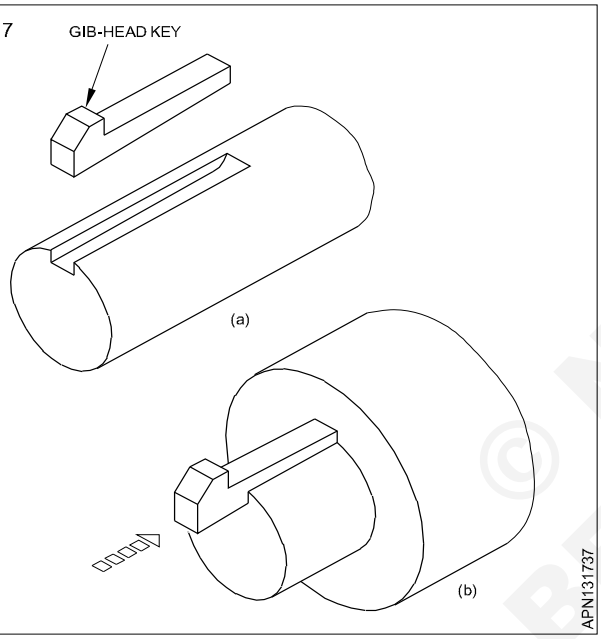


Fig 6



Gib-head key (Fig 7)

Fig 7



This is another type of sunk key. This has a gib-head to assist in fixing and removing the keys. (Figs 7a and b)

Feather key (Fig 8)

This is a parallel key with rounded ends. This is useful when the hub/pulley has to slide axially on the shaft to some distance. (Figs 8a,b and c) This key may be either tightly fitted in the keyway or screwed in.

Woodruff key (Fig 9)

This is semicircular key and it fits on to the shaft on which matching recesses are cut. The top portion of the key projects out and fits in the keyway cut on the hub. (Fig 9)

This key is particularly useful on tapered fittings of shafts.

Splined shaft & serrated shaft

Splined shafts along with splined hubs are used particularly in the motor industry. The splined hub can also slide along the shaft, wherever necessary. (Figs 10a and b)

Fig 8

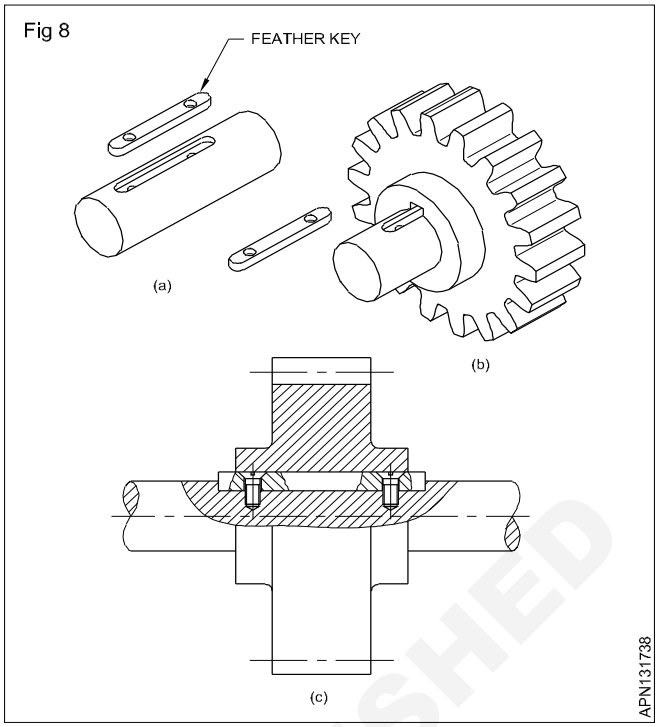


Fig 9

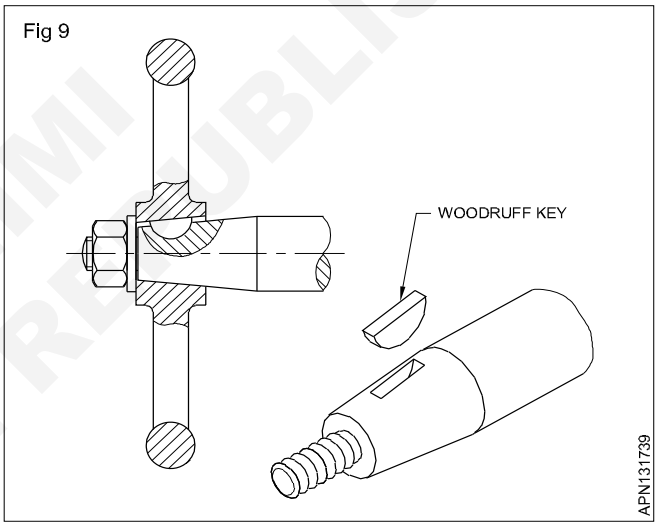
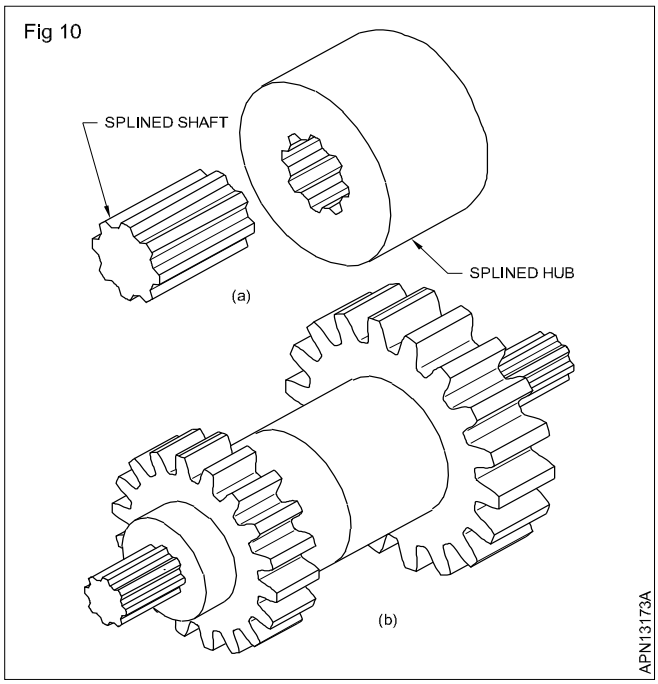
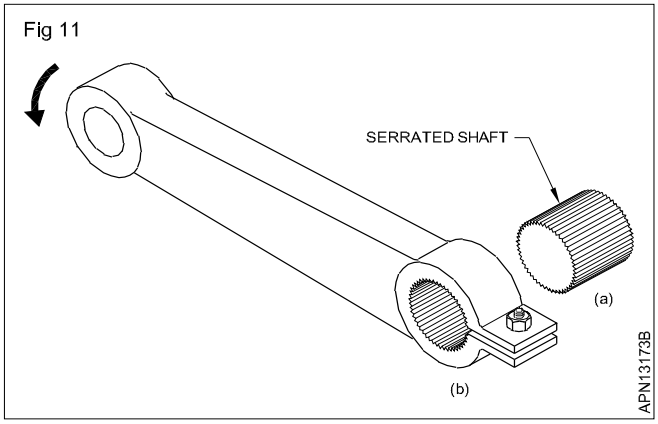


Fig 10



In certain assemblies, serrated shafts are also used for transmission. (Figs 11a and b)

Fig 11



Circlips

Objectives: At the end of this lesson you shall be able to
- **state the functions of circlips**
- **state the different types of circlips**
- **state the advantages of circlips over other fastening devices**
- **state the material used for circlips.**

Circlips are fastening devices used to provide shoulders for positioning or limiting the movement of parts in an assembly. (Fig 1) Circlips are also called `Retaining rings.

The rings are generally made of materials having good spring properties so that the fastener may be deformed elastically to a considerable degree and still spring back to its original shape. This permits the circlips to spring back into a groove or other recess in a part or they may be seated on a part in a deformed conditional so that they grip the part by functional means. Circlips are manufactured from spring steel with high tensile and yield strength.

Fig 2

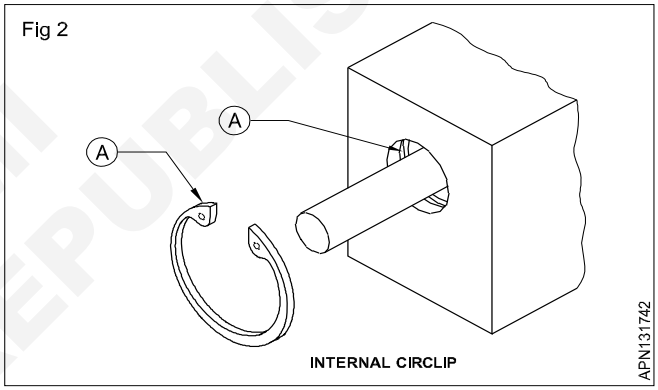


Fig 1

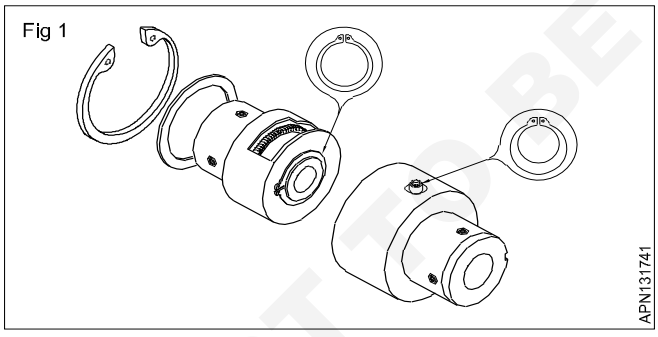
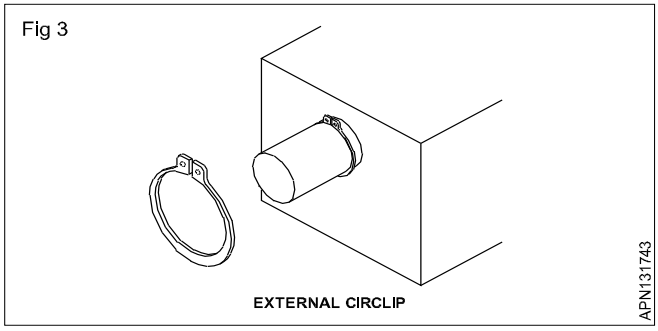


Fig 3



TYPES

There are two types.

Internal circlips (Fig 2)

This type of rings are assembled in holes, bores or housing.

External circlip (Fig 3)

This type of rings are installed on shafts, pins, studs and similar parts.

Both types offer a number of advantages over other types of fasteners.

- Their cost is relatively low when compared with other types of fasteners.
- Their use often results in savings in raw material and simplified machining operations for other parts in the assembly.
- One circlip often can replace two or more parts.
- Assembly toolings developed for circlips usually permit very rapid assembly of the fasteners, even by unskilled workers.

Material

Because retaining rings depend for their function largely on their ability to be deformed elastically during assembly and disassembly, the materials must have good spring properties. Circlips are manufactured from spring steel with high tensile and yield strength.

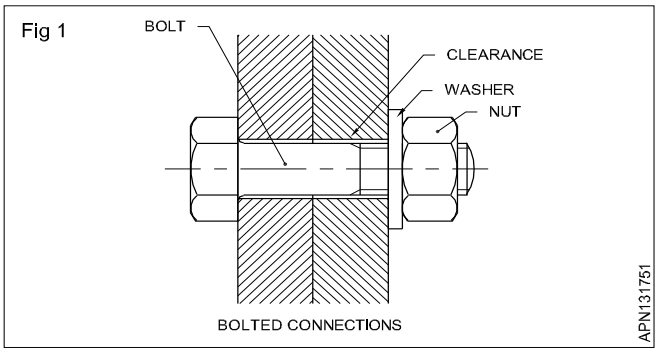
Washers - Types and uses

Objectives: At the end of this lesson you shall be able to
- **state the purpose of washers**
- **name the types of washers**
- **state the uses of each type of washers**
- **specify the washers as per B.I.S.**

Purpose

It is a common practice to provide washers under the nuts in bolted joints.

Washers help to (Fig 1)

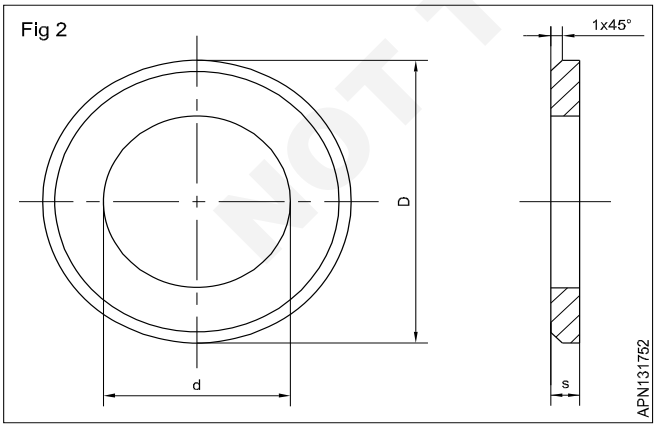


- Increase the frictional grip
- Prevent loosening of nuts due to vibration
- Prevent damage to the work piece and
- Distribute force over a larger area.

Types of washers

There are different types of washers available. They are
- Plain or flat washers
- Taper washers
- Spring washers
- Tab washers
- Toothed lock washers.

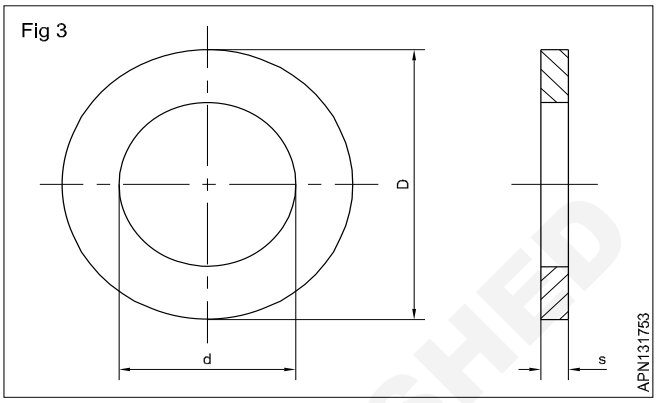
Plain or flat washers (Fig 2)



These washers are used for bolting assemblies with flat surfaces. The diameter thickness and the bore diameter are proportional to the diameter of the bolt. (I.S. 2016)

Plain washers are available as machined or punched washers.

Machined washers (Fig 3)

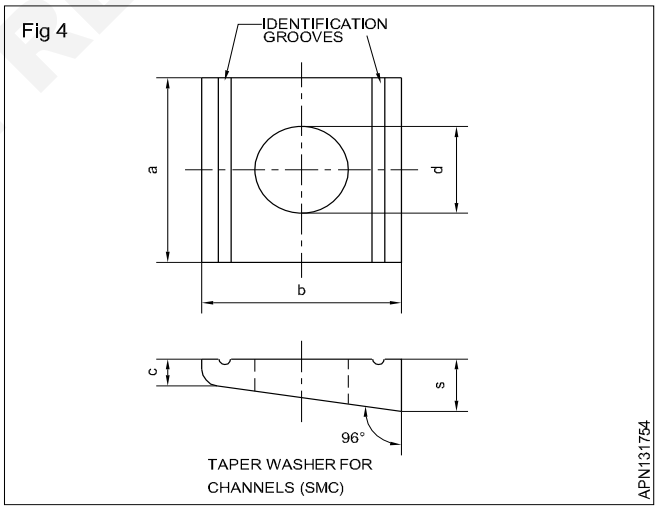


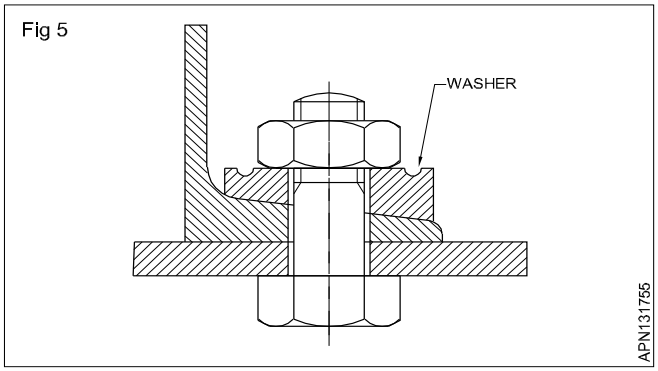
These washers are used for assemblies using machined components. These washers are available with chamber on one side or on both sides. They are heat treated and ground.

Punched washers

These do not have chamfers and are commonly used in structural fabrication work.

Tapered washers (Figs 4 & 5)





These are used in structural assemblies with tapered surfaces like the inside of beams, channels etc. These washers help bolt head or nut to seat square to the hole.

Spring washers (Figs 6 & 7)

Fig 6

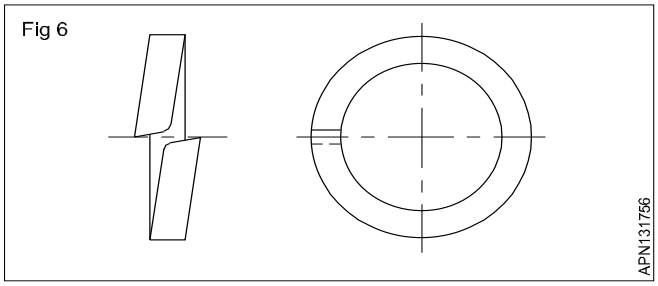
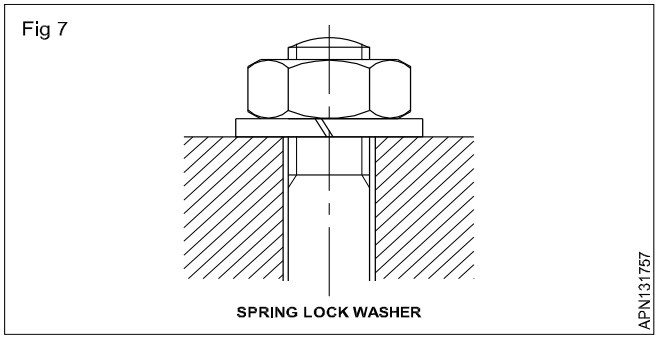


Fig 7

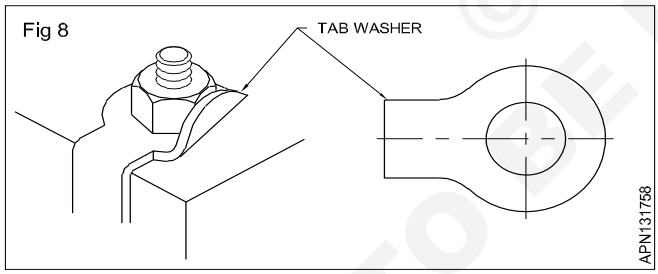


Spring washers are used under the nuts to prevent slackening of the nuts due to vibrations. They are made of spring steel, and when compressed they create tension between the bolt and the nut.

Tab washers (Fig 8)

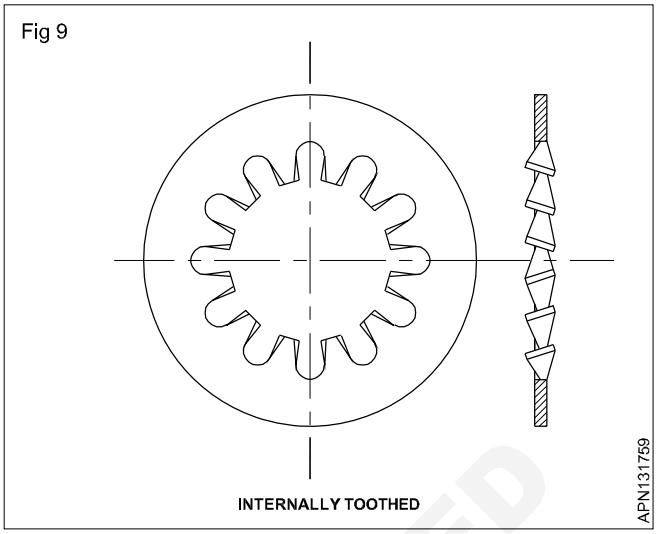
These washers are used for locking the nuts.

Fig 8



Toothed lock washers (Fig 9)

Fig 9



These washers have serrations, cut and twisted. When placed between the nut and the assembly, this washer exerts friction on both the contacting surfaces. This prevents the nuts from slackening.

Specifications

The Indian standard Is:2016-1967 designates a washer by name, type size and number of the standard and material.

Example

A machined washer of size 10.5 mm made of brass shall be designated as machined washer 10.5 IS:2016 Brass.

Note

For detailed specification of different types of washers refer to the following IS specifications.

Taper washer	-	IS: 5374 and IS: 5372
Tab washer	-	IS: 8068
Toothed lock washer	-	IS: 5371
Plain washer	-	IS: 2016

Different types of screws, nuts, studs and bolts.

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

- **name the different types of machine screws used in heavy duty assembly**
- **name the different types of machine screws used in light assembly work**
- **state the uses of different types of machine screws**
- **name the different types of set screws.**

Machine screws are used when a nut cannot be used in the assembly and the component in the assembly has a threaded hole to receive the screws. (Fig 1)

Types of machine screws (Heavy duty)

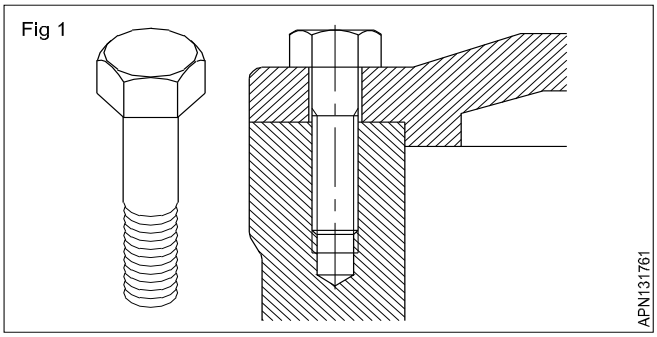
Hexagon head screws

Hexagon socket head cap screws

Square head countersink head screws

These are heavy duty screws.

Fig 1

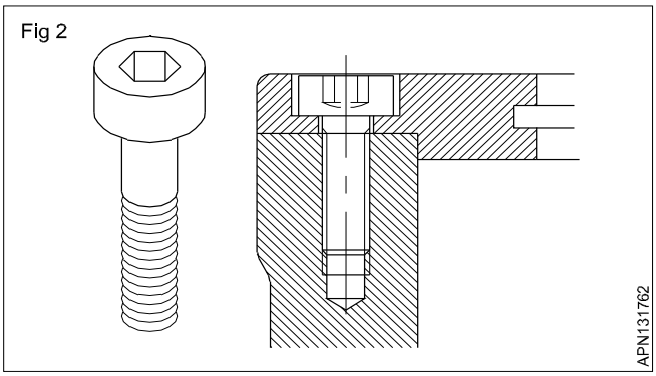


Hexagon head screws

These are used when the projection of the screw head will not be an obstruction in the assembly.

Hexagon socket head cap screws

These are used when the projection of the screw head above the surface is to be avoided. (Fig 2) The Indian Standard specification head socket cap screws cover the range from 1.6 mm to 36mm.



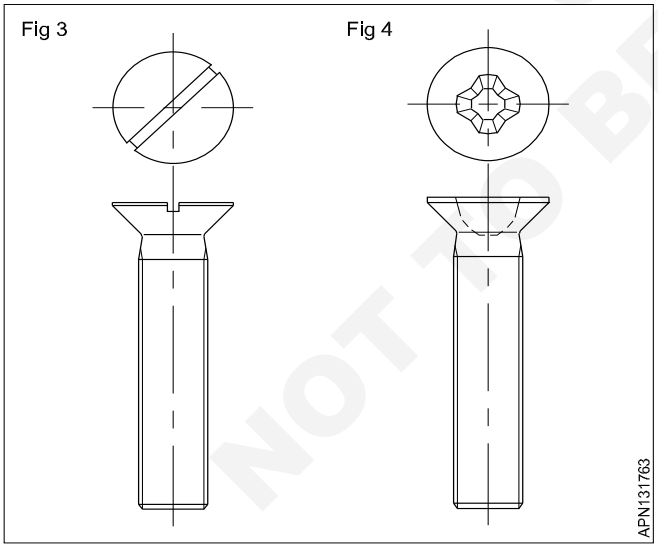
Hexagon head screws and hexagon socket head screws are made of steel. Hexagon head screws used in electrical work are made of brass.

Countersink head screws

There are four types of countersink head screws in common use.

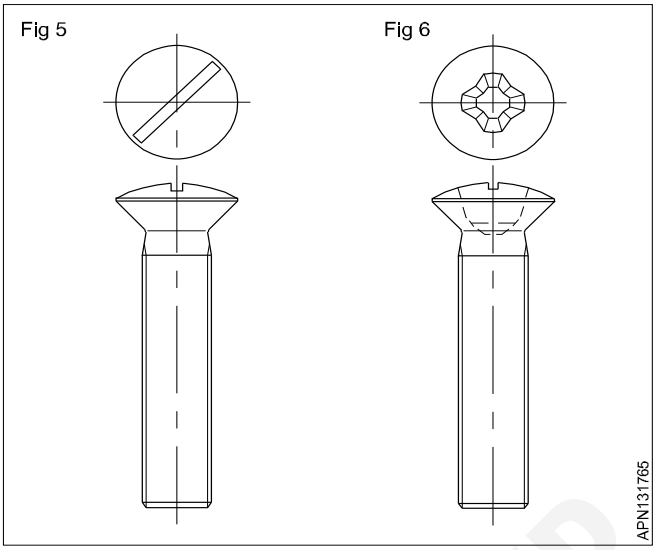
They are:

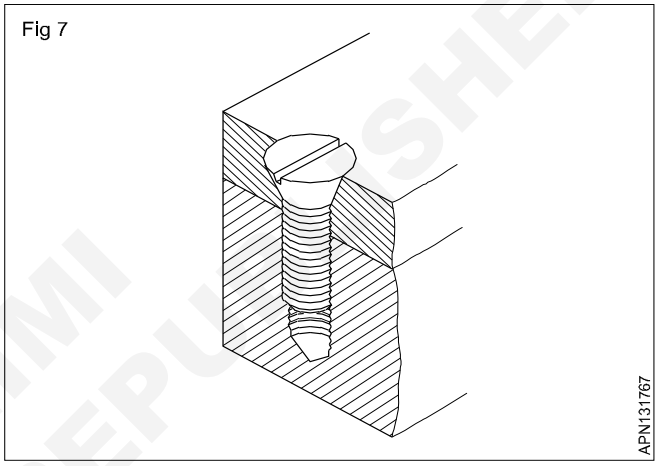
- Slotted countersink head screws (Fig 3)
- Cross-recessed countersink head screws (Fig 4)



- Slotted raised countersink head screws (Fig 5)
- Cross recessed, raised countersink head screws. (Fig 6)

Countersink screws are capable of aligning the matching component correctly with the threaded hole. (Fig 7)





The projection of the screw head above the assembly is also avoided. B.I.S. specification covers the following ranges of countersink head screw sizes in different types

- Slotted countersink head screws M1 - M20
- Cross-recessed countersink head screws M1.6 to M10.
- Slotted raised countersink head screws M1 to M20.
- Cross-recessed raised countersink head screws M1.6 to M10.

Square head screws. (Fig 8)

Square head screws are used in places where there is frequent removal and refitting of the assembly. These screws are tightened to a higher torque using a wrench. (Fig 8) Square head screws are also available with a collar. In this there is a washer at the base which is an integral part of the head. The purpose of this collar is to protect the work-surface from damages due to constant use of wrenches.

Other types of machine screws used in light assembly work are:

Pan head (Fig 9) ; Cheese head (Fig 10)

Raised cheese head (Fig 11) ; Round head (Fig 12)

These screws are also available with slotted head or as cross-recessed.

Fig 8

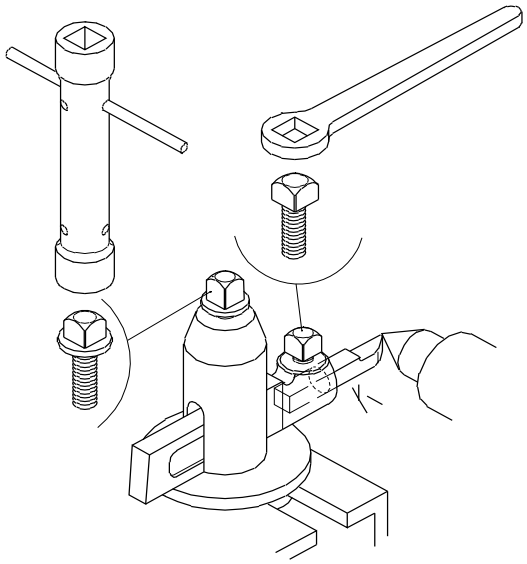


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Fig 9

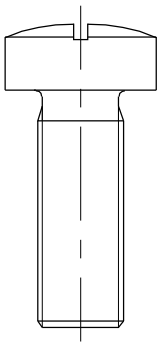

Fig 10

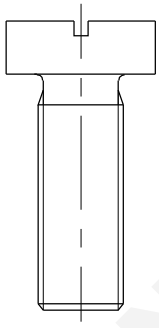

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Fig 11

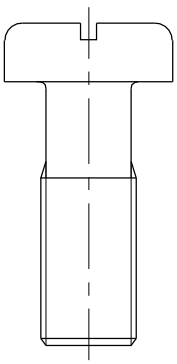
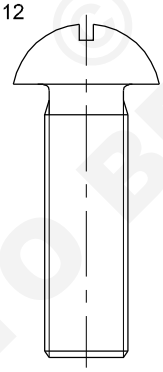


Fig 12



APN13176B

The screws used for light duty are normally available up to 10mm thread diameter.

These screws are made of steel, stainless steel or brass. These screws are either plain finished, zinc-coated or chrome-plated.

Set screws and grub screws

Hexagonal socket set screws (Fig 13)

These are headless socket screws available with different points for various functional requirements. (Fig 14)

Fig 13

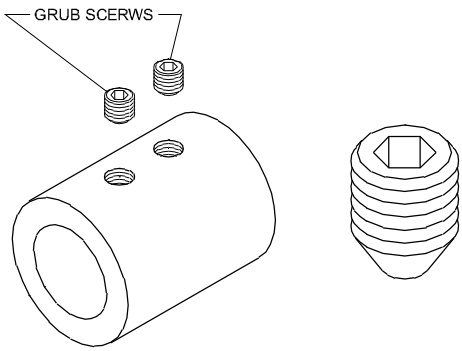


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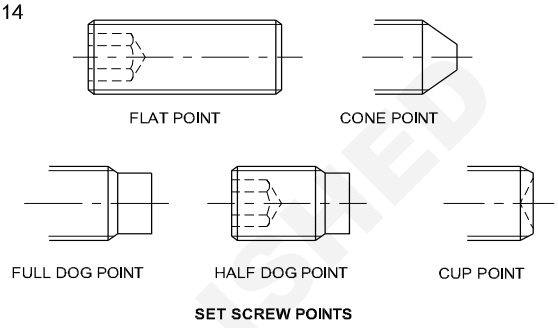
Fig 14

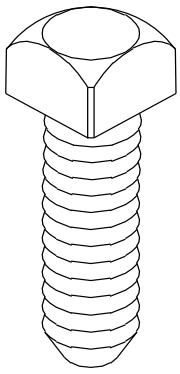


APN13176E

These points either allow to bite into the metal or tighten without damage to the work-surface. They are used to fasten pulleys, collars etc. to the shafts. They are used for higher strength applications where space is limited.

Square set screws (Fig 15)

Fig 15



APN13176F

These set screws have similar applications as hexagon socket set screws but have square heads projecting above the work-surface.

These are useful when the assembly needs frequent disassembly and setting.

Grub screws

Grubs have similar application as hexagon socket set screws but are used for light holding. (Fig 16)

Grub screws are also available with different types of points (Fig 17)

Fig 16

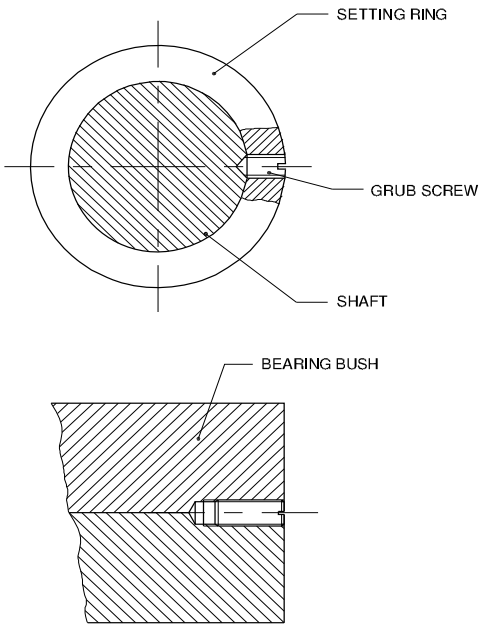
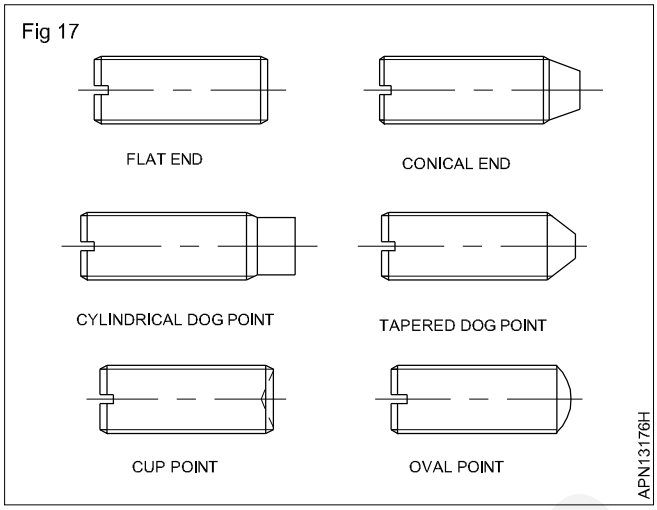


Fig 17



Thumb screws

Objectives: At the end of this lesson you shall be able to
- **state the types of thumb screws**
- **state the uses of thumb screws**
- **designate thumb screws as per B.I.S. specification**.

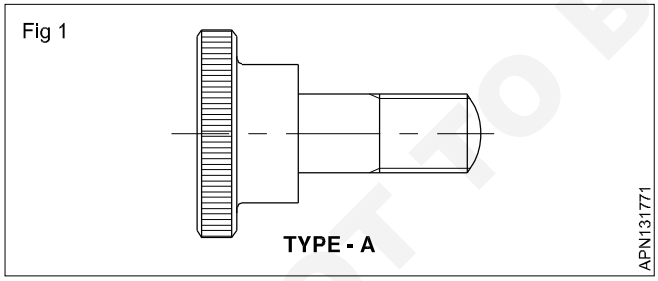
Thumb screws are used in places where fixing and removal of components are frequent. Tightening and loosening of the assembly is finger tight only.

Types

As per the Indian standard specification IS:3726-1972 there are five types of thumb screws.

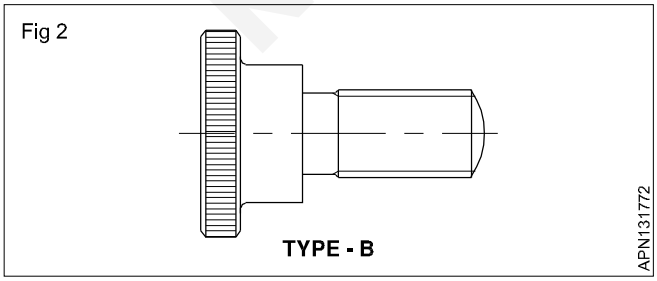
Type-A Thumb screws partially threaded (Fig 1)

Fig 1



Type-B Thumb screws fully threaded (Fig 2)

Fig 2



Type-C Slotted thumb screw partially threaded (Fig 3)

Type-D Slotted thumb screw fully threaded (Fig 4)

Fig 3

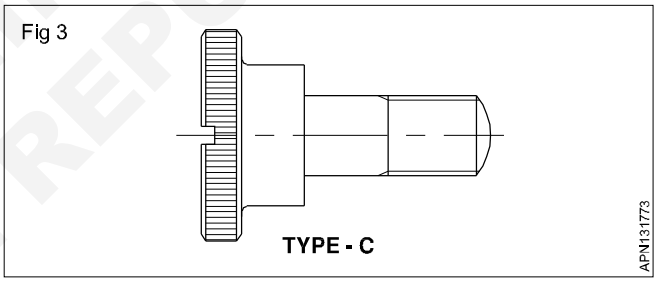
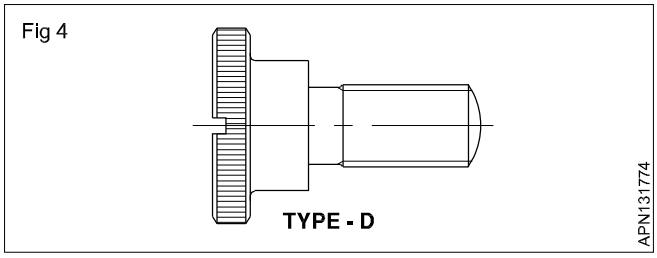


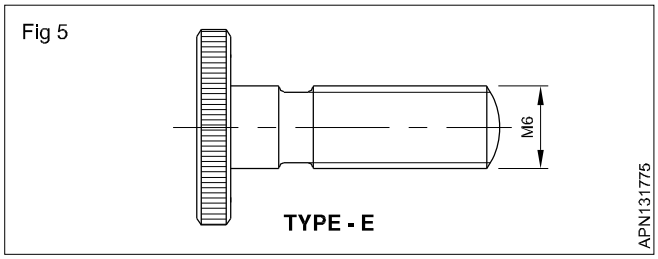
Fig 4



Type-E Flat thumb screws (Fig 5)

The type of thumb screw selected depends on the actual requirement in the assembly.

Fig 5



Sizes

Thumbs screws are available in the following sizes as per B.I.S.

M1.6, M2, M2.5, M3, M4, M5, M6, M8 and M10.

Designation of thumb screws

Thumb screws shall be designated by the nomenclature, type, thread size, nominal length, the number of Indian Standard and the symbol for mechanical properties.

Example

A thumb screw of Type `A', size M6, nominal length 12mm and of property class 4.6 shall be designated as:

Thumb screws A M6 x 12 IS: 3726-4.6

When brass or any other non-ferrous metal is used for the manufacture of thumb screws, the word Brass or the name of the non-ferrous metal used will replace the property class number in the designation.

Types of nuts

Objectives: At the end of this lesson you shall be able to
- **name the common types of nuts**
- **state the features and uses of the common types of nuts.**

Different types of nuts are used depending on the requirement of the assembly.

Hexagonal nuts (Figs 1 & 2)

Fig 1

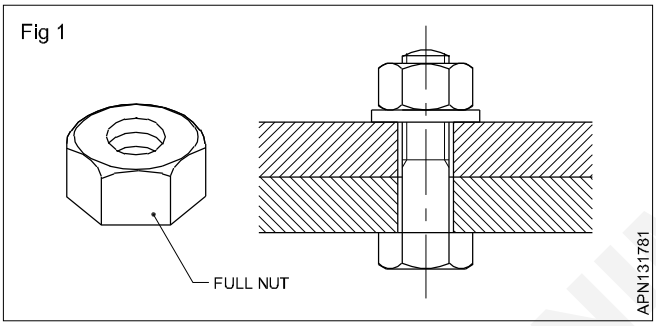
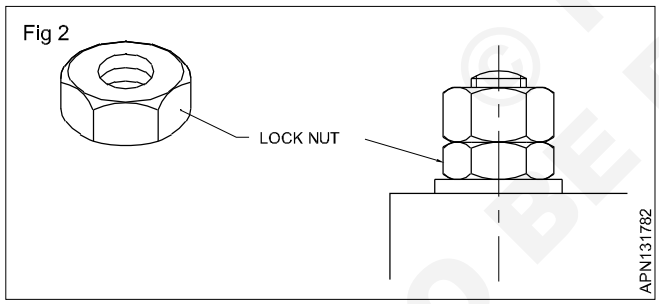


Fig 2



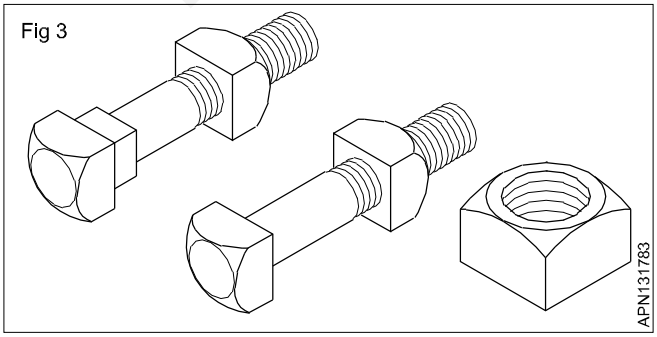
This is the most commonly used type of nut in structural and machine tool construction.

Hexagonal nuts are available in different thicknesses. Thin nuts are used as lock-nuts.

Square nut (Fig 3)

Square bolts are provided with square nuts. In bolts for coaches mostly square nuts are used.

Fig 3



Self-locking nuts (Simmonds lock-nut)

This nut has an internal groove cut in which a fiber or nylon ring is inserted. This ring holds the nut tightly on the bolt and serves as a locking device.

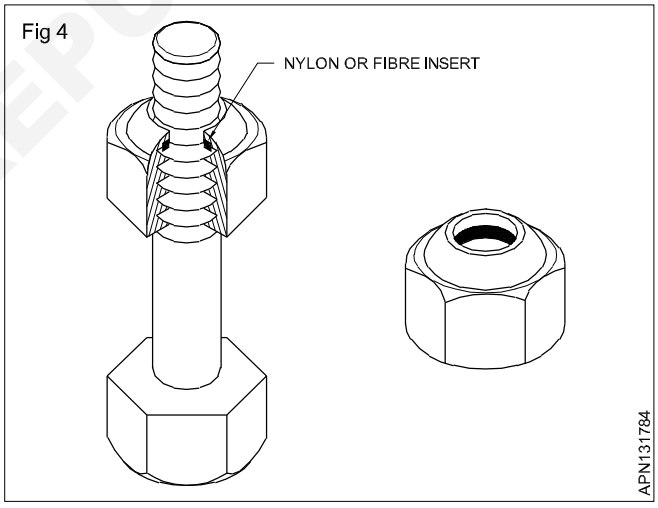
Self-locking nuts are not used with studs.

T-nuts

T-nuts are used along with studs on machine tools for fixing/holding devices or workpieces.

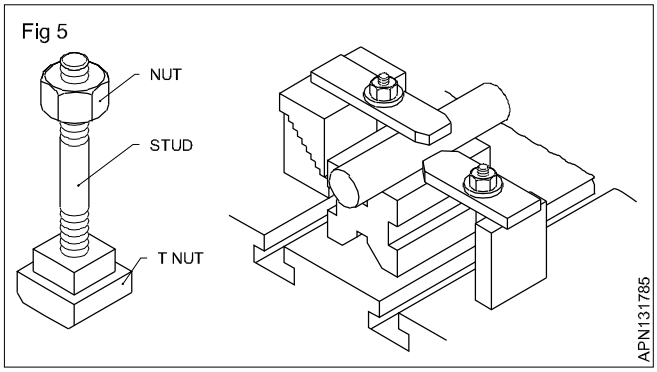
Slotted and castle nuts (Fig 4)

Fig 4



Round nuts (Fig 5)

Fig 5



Round nuts of different types are available for special applications.

Slotted round nut (Figs 6, 7, 8, 9 & 10)

Fig 6

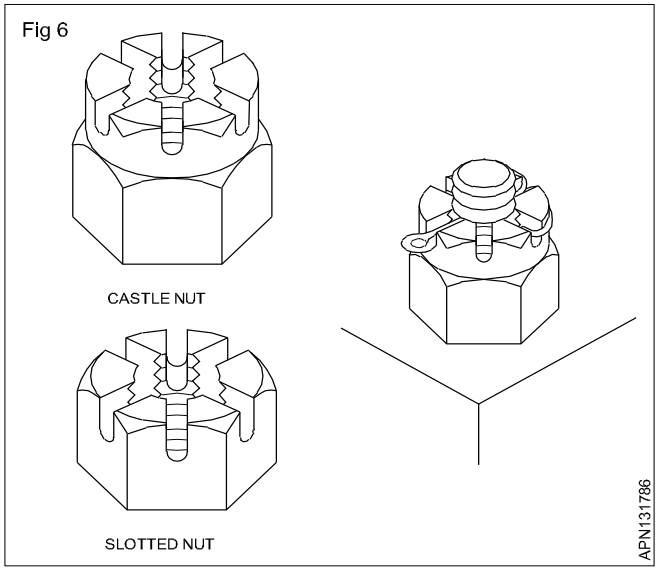


Fig 7

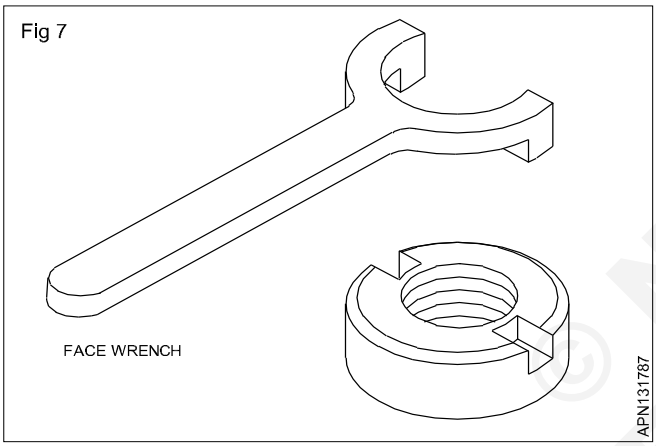


Fig 8

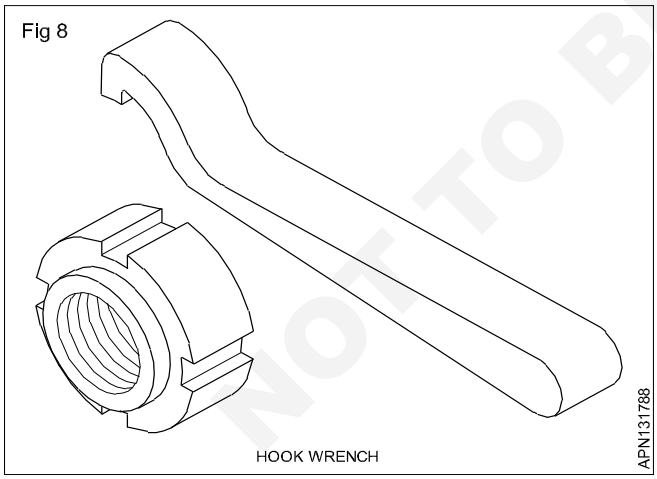


Fig 9

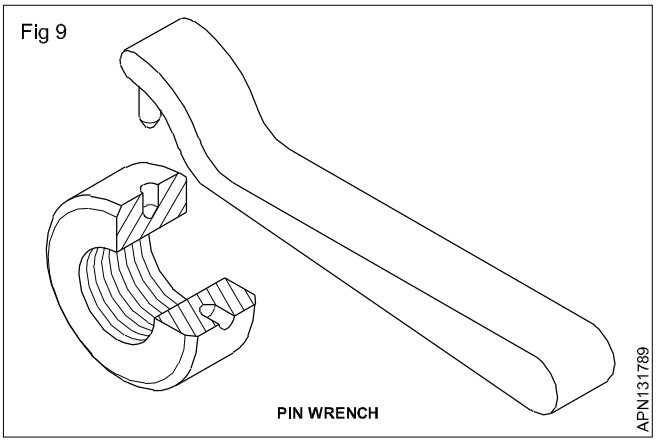
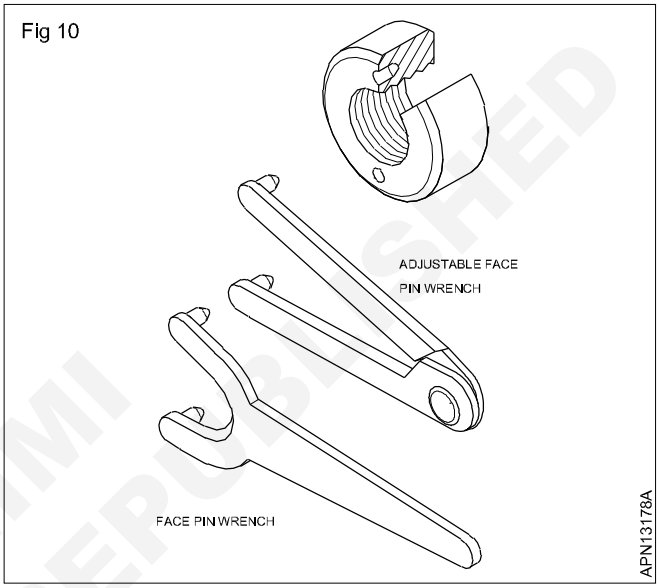


Fig 10



Slotted round nut for hook wrench.

Round nut with set pin holes on sides

Round nut with holes in the face.

Methods of removing broken studs

Objectives: At the end of this lesson you shall be able to
- **state the reasons for breakage of studs**
- **state the different methods for removing broken studs.**

The stud is used in the place of a bolt. Where hole cannot be had for the bolt to pass through or to avoid the use of an unnecessarily long bolt. Studs are generally used to fix up cover plates or to connect cylinder covers to engine cylinders.

Reasons for breakage of stud/bolt: Excessive torque is applied while screwing the stud into the hole/tightening the nut.

Threads are corroded excessively.

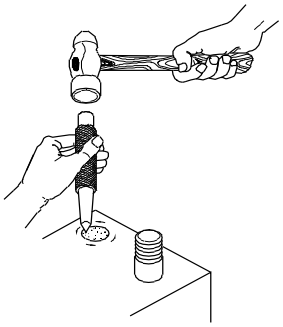
Matching threads are not of proper formation.

Threads are seized.

Methods of removing broken studs

Prick punch method (Fig 1)

Fig 1



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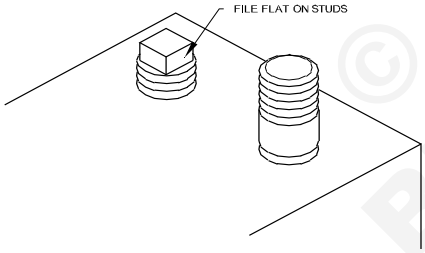
If the stud is broken very near to the surface, drive it in an anticlockwise direction, using a prick punch and hammer to remove it.

Filing square form (Fig 2)

When the stud is broken a little above the surface, form a square on the projecting portion to suit a standard spanner. Then turn it anticlockwise using a spanner to remove stud.

Fig 2



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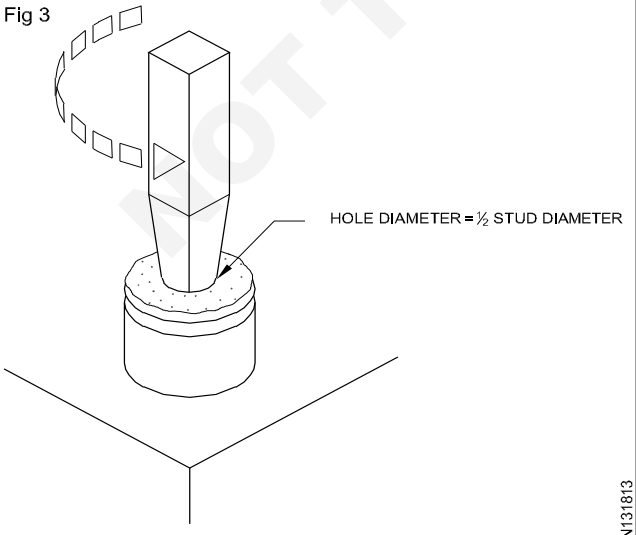
Using square taper punch (Fig 3)

Fig 3



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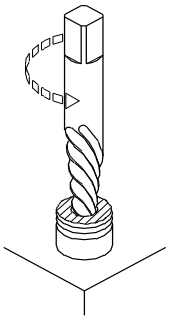
Broken studs can also be removed by drilling a blind hole (hole diameter equal to half of stud diameter) and driving a square taper punch into the hole as shown Fig 3. Turn the punch using a suitable spanner in an anticlockwise direction to unscrew the stud.

Ezy-out method (Fig 4)

Fig 4



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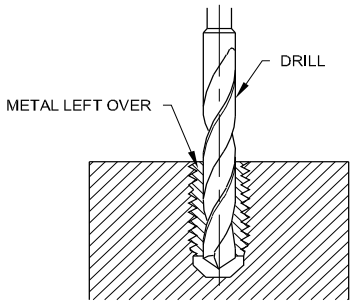
Ezy-out or a stud extractor is a hand tool, some what similar to the form of a taper reamer but it has left hand spiral. It is available in a set of 5 pieces. The recommended drill size is punched on each ezy-out.

Drilling the hole, the recommended ezy-out is set on and turned in an anticlockwise direction by a tap wrench. As it is rotated it penetrates into the hole increasing its grip and in the process the broken stud gets unscrewed.

Making drill hole (Fig 5): Correctly find out the centre of the broken stud and drill a hole nearly equal to the core diameter of the stud down the centre so that the threads only remain (Fig 5). Remove the thread portion by the point of a scriber in the form of broken chips. Re-tap the drill hole to clear the threads.

Fig 5



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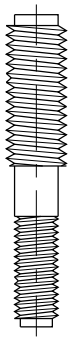
If all other methods fail drill a hole equal to the size of the stud size or a little over and tap the hole with an oversize tap. Now a special oversize stud as shown in figure 6 is to be made and fitted in position. (Fig 6)

Fig 6



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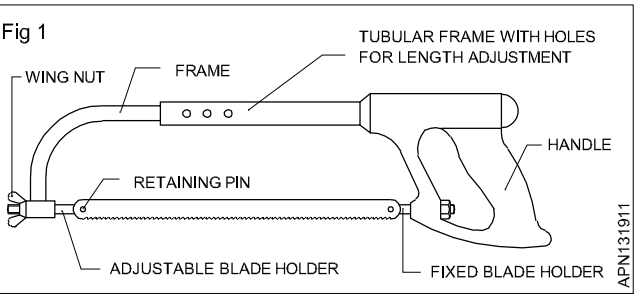
Hacksaw frame and blade

Objectives: At the end of this lesson you shall be able to
- **name the parts of a hacksaw frame**
- **specify hacksaw frames**
- **state the different types of hacksaw frames and their uses.**

The hand hacksaw is used along with a blade to cut metals of different sections. It is also used to cut slots and contours.

The parts are identified in the (Fig 1)

Fig 1



Types of hacksaw frames

The two different types of hacksaw frames are solid frame and adjustable frames.

Solid frame

Only a particular standard length of blade can be fitted to this frame.

Adjustable frame (Flat type)

Different standard lengths of blades can be fitted to this frame.

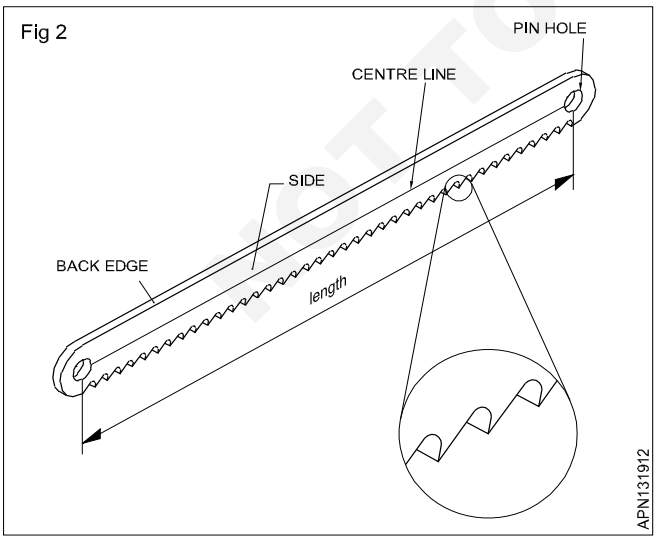
Adjustable frame (Tubular type)

This is the most commonly used type. It gives a better grip and control, while sawing.

For proper working. It is necessary to have frames of rigid construction.

Hacksaw blades (Fig 2)

Fig 2



A hacksaw blade is a thin narrow steel band with teeth and two pin holes at the ends. It is used along with a hacksaw frame. The blade is made of either low alloy steel (LAS) or high speed steel (HSS) and is available in standard lengths of 250 mm and 300 mm.

Types of hacksaw blades

Two types of hacksaw blades are available - all hard blades and flexible blades.

All hard blades

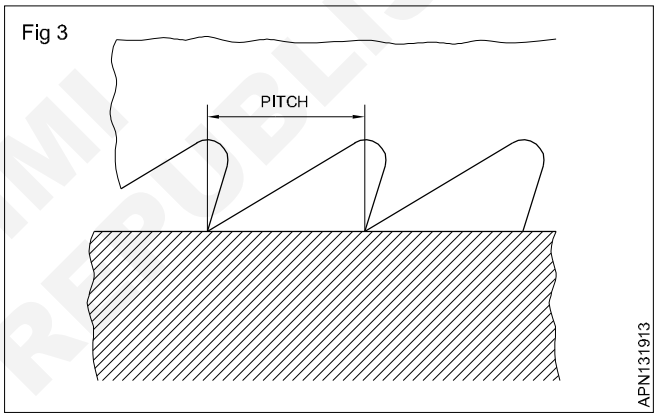
These are hardened to the full width between the pin holes.

Flexible blades

For these types of blades. Only the teeth are hardened. Because of their flexibility, these blades are useful for cutting along curved lines.

Pitch of the blade (Fig 3)

Fig 3



The distance between adjacent teeth is known as the pitch of the blade.

Classification	Pitch
Coarse	1.8 mm
Medium	1.4 mm & 1.0 mm
Fine	0.8 mm

Hacksaw blades are designated according to their length, pitch and type.

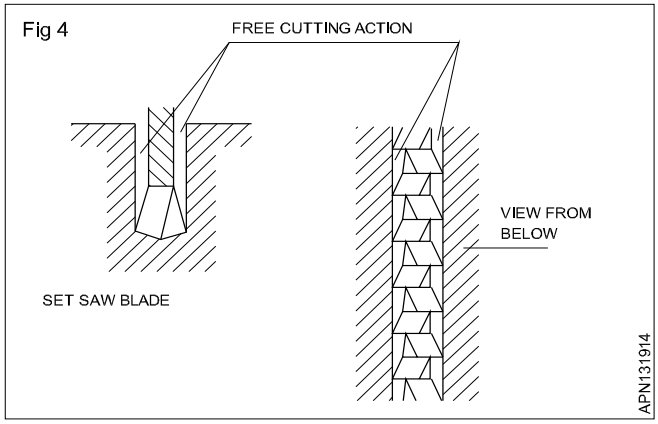
To prevent the saw blade binding when penetrating into the material and to allow free movement of the blade, the cut is to be border than the thickness of the saw blade. This is achieved by the setting the saw teeth. There are two types of saw teeth settings.

Staggered set (Fig 4)

Alternate teeth or groups of teeth are staggered. This arrangement helps for free cutting and provides for good chip clearance.

Wave set (Fig 5)

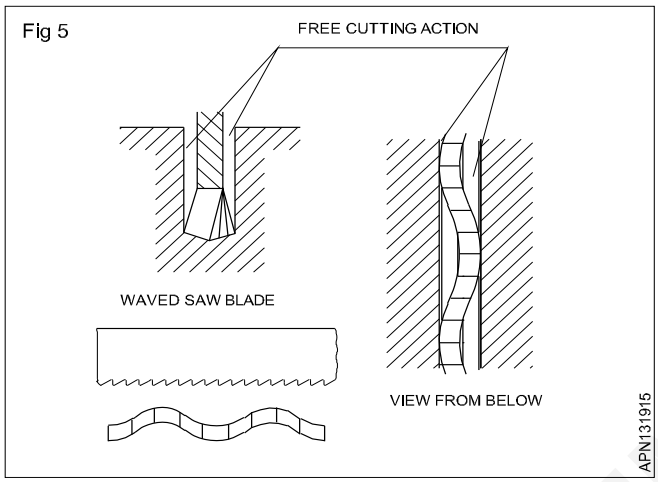
In this, the teeth of the blade are arranged in a wave form.



Sets of blades can be classified as follows

Pitch	Type of Set
0.8 mm	Wave -set
1.0 mm	Wave or staggered
Over 1.0 mm	Staggered

For the best results, the blade with the right pitch should be selected and fitted correctly.

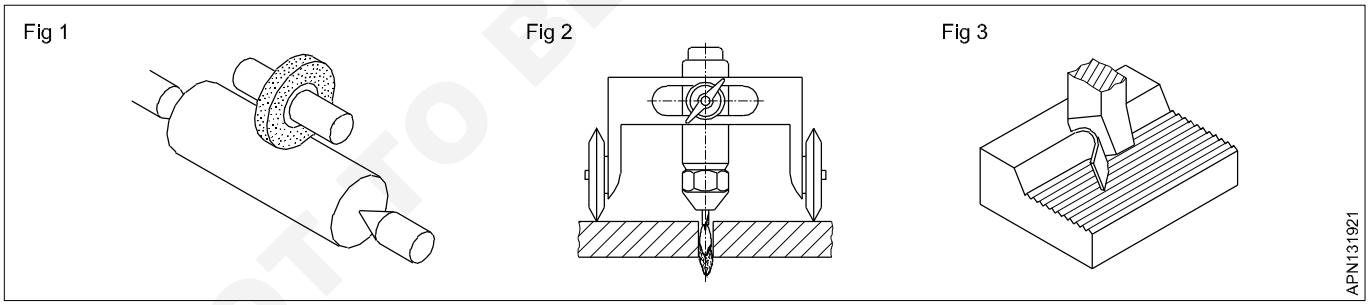


Elements of a file

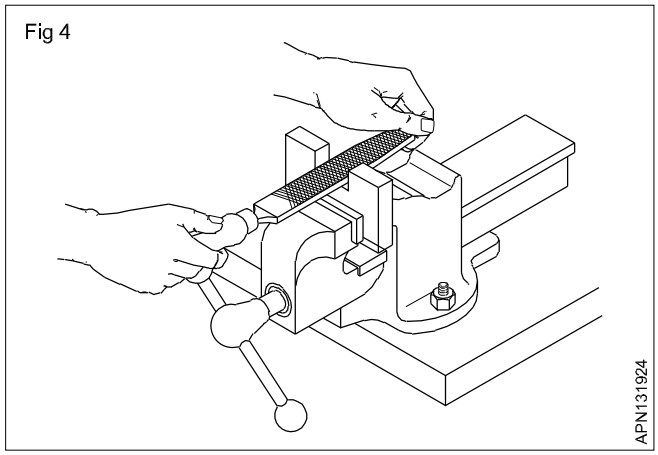
Objective: At the end of this lesson you shall be able to
- **name the parts of a file.**

Methods of Material Cutting

The three methods of metal cutting are abrasion (Fig 1). Fusion (Fig 2) and Incision (Fig 3)



Filing is a method for removing excess material from a work pieces by using a file which acts as a cutting tool. (Fig 4) shows how to hold a file. Files are available many shapes and sizes.



Parts of a file (Fig 5)

The parts of a file as can be seen in figure 5, are

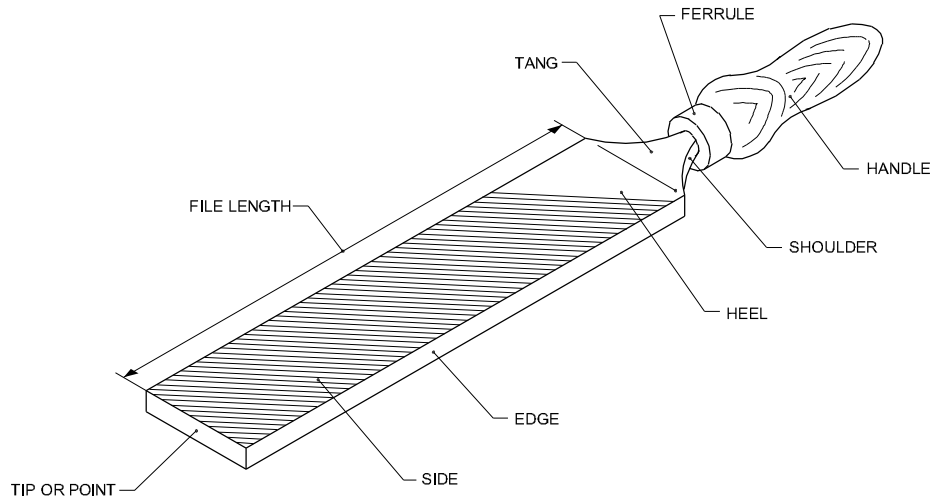
Tip or Point

The end opposite to tang

Face or side

The broad part of the file with teeth cut on its surface

Fig 5



Edge

The thin part of the file with a single row of parallel teeth

Heel

The portion of the broad part without teeth.

Shoulder

The curved part of the file separating tang from the body

Tang

The narrow and thin part of a file which fits into the handle

Handle

The part fitted to the tang for holding the file

Parts of a file (Fig 5)

Ferrule

A protective metal ring to prevent cracking of the handle.

Materials

Generally files are made of high carbon or high grade cast steel. The body portion is hardened and tempered. The tang is however not hardened.

Cut of files

Objectives: At the end of this lesson you shall be able to
- **name the different cuts of files**
- **state the uses of each type of cut.**

The teeth of a file are formed by cuts made on its face. Files have cuts of different types. Files with different cuts have different uses.

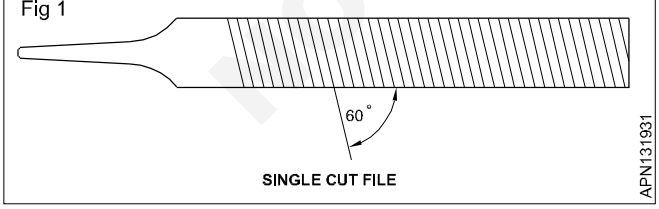
Types of cuts

Basically there are four types.

Single cut. Double cut. Rasp cut and curved cut.

Single cut file (Fig 1)

Fig 1

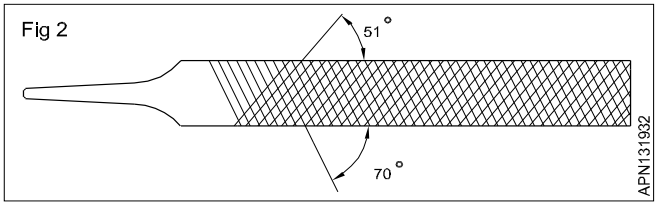


A single cut file has rows of teeth cut in one direction across its face. The teeth are at an angle of 60° to the centre line. It can chips as wide as the cut of the file. Files with this cut are useful for filing soft metals like brass, aluminium, bronze and copper.

Single cut files do not remove stock as fast as double cut files, but the surface finish obtained is much smoother.

Double cut file (Fig 2)

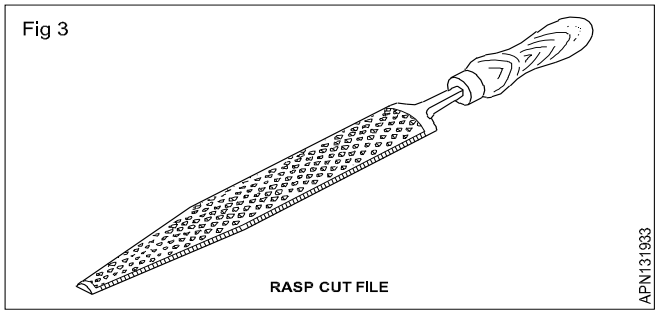
Fig 2



A double cut file has two rows of teeth cut diagonal to each other. The first row of teeth is know as OVERCUT and they are cut at an angle of 70°. The other cut, made diagonal to this, is known as UPCUT and is at an angle of 51°. This removes stock faster then the single cut file.

Rasp cut file (Fig 3)

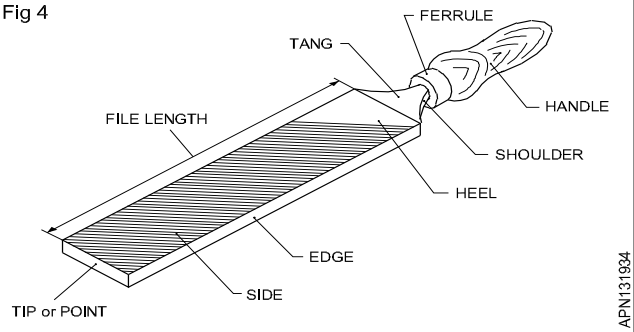
Fig 3



The rasp cut has individual sharp pointed teeth in a line and is useful for filing wood, leather and other soft materials. These files are available only in half round shape.

Curved cut file (Fig 4)

Fig 4



These files have deeper cutting action and are useful for filing soft materials like - aluminium, tin, copper and plastic. The curved cut files are available only in a flat shape.

The selection of a file with a particular type of cut is based on the material to be filed. Single cut files are used for filing soft materials. But certain special files, for example, those used for sharpening saws are also of single cut.

File specifications and grades

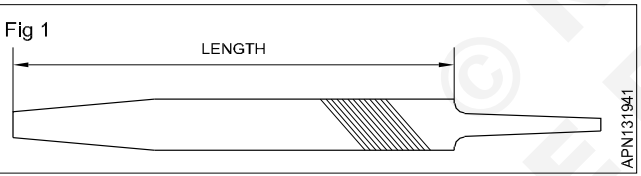
Objectives: At the end of this lesson you shall be able to
- **state how files are specified**
- **name the different grades of files**
- **state the application of each grade of file.**

Files are manufactured in different types and grades to meet the various needs.

Files are specified according to their length, grade, cut and shape.

Length is the distance from the tip of a file to the heel. (Fig 1)

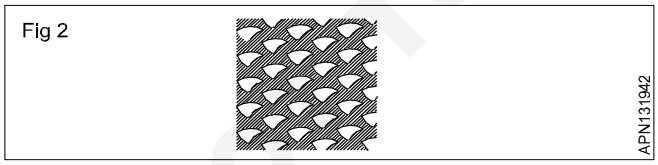
Fig 1



File grades are determined by the spacing of the teeth.

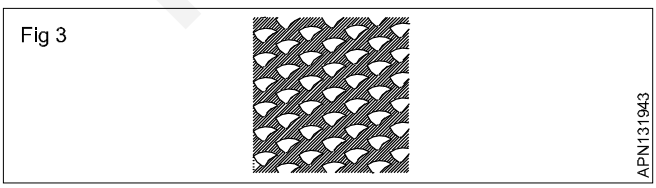
A round file (Fig 2) is used for removing rapidly a larger quantity of metal. It is mostly used for trimming the rough edges of soft metal castings.

Fig 2



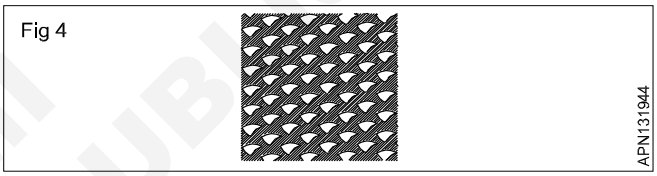
A bastard file (Fig 3) is used in cases where there is a heavy reduction of material.

Fig 3



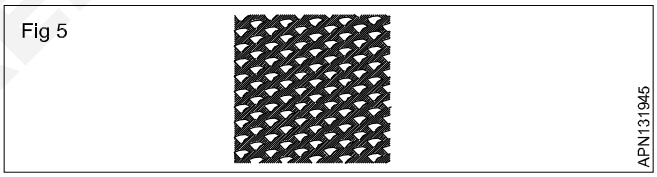
A second cut file (Fig 4) is used to give a good finish on metals. It is excellent to file hard metals. It is useful for bringing the jobs close to the finishing size.

Fig 4



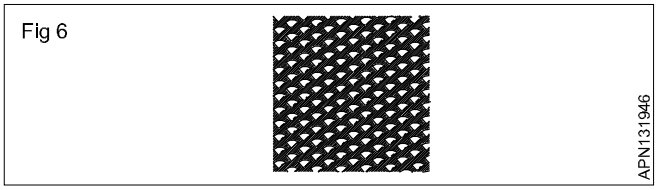
A smooth file (Fig 5) is used to remove small quantity of material and to give a good finish.

Fig 5



A dead smooth (Fig 6) file is used to bring to accurate size with a high degree of finish.

Fig 6



The most used grades of files are bastard, second cut, smooth and dead smooth. These are the grades recommended by the Bureau of Indian Standers. (BIS)

Different sizes of files with the same grade will have varying sizes of teeth. In longer files, the teeth will be coarser.

File - Applications

Objectives: At the end of this lesson you shall be able to
- **state the features of flat and hand files**
- **state the application of flat and hand files.**

Files are made in different shapes so as to be able to file and finish components to different shapes.

The shape of files is usually specified by their cross section.

The files useful for this exercise are flat files and hand files.

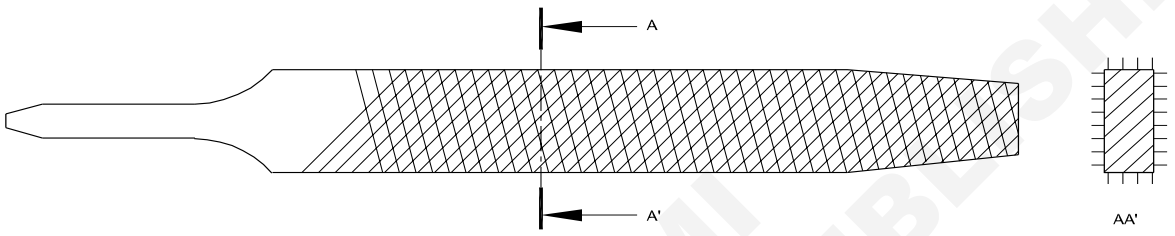
Flat files

These files are of a rectangular cross section. The edges along the width of these files are parallel up to two-thirds of the length, and then they taper towards the point. The faces are double cut, and the edges single cut. These files are used for general purpose work. They are useful for filling and finishing external and internal surfaces.

Hand files (Fig 1)

These files are similar to the flat files in their cross section. The edges along the width are parallel through the length. The faces are double cut. One edge is single cut whereas the other is safe edge. Because of the safe edge, they are useful for filling surfaces which are at right angles to surfaces already finished.

Fig 1



Shapes of files

Objectives: At the end of this lesson you shall be able to
- **name the different shapes of files**
- **state the uses of Square, Round, Half Round, Triangular and Knife-edge files.**

For filing and finishing different profiles, files of different shapes are used.

The shape of files is stated by its cross section.

Common files of different shapes

Flat file, Hand file, Square file, Round file

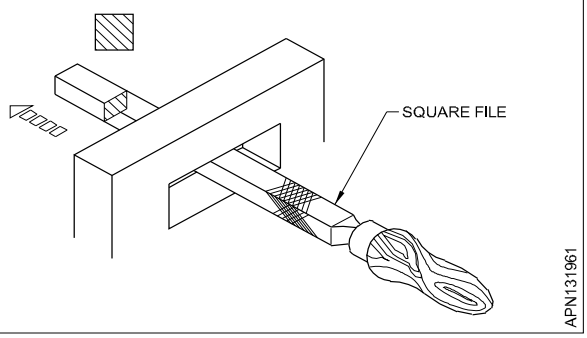
Half found file, Triangular file and Knife-edge file.

(Flat and hand files have already been discussed).

Square File

The square file is square in its cross section. It is used for filling square holes, internal square corners, rectangular opening, keyways and spines. (Fig 1)

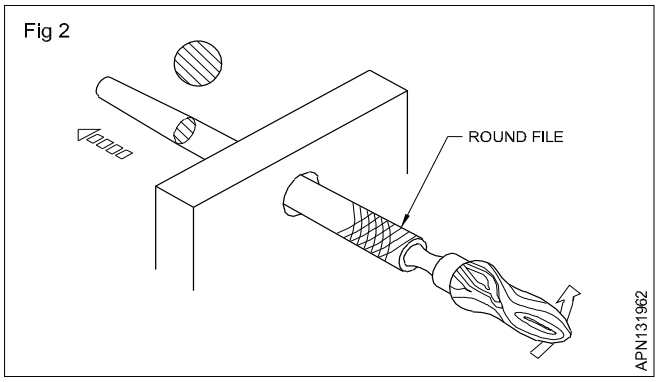
Fig 1



Round file

A round file is circular in its cross section. It is used for enlarging the circular holes and filing profiles with fillets. (Fig 2)

Fig 2



Half round File

A half round file is in the shape of a segment of a circle. It is used for filing internal curved surfaces (Fig 3)

Triangular File

A triangular file is of a triangular cross section. It is used for filing corners and angles which are more than 60^0. (Fig 4)

Fig 3

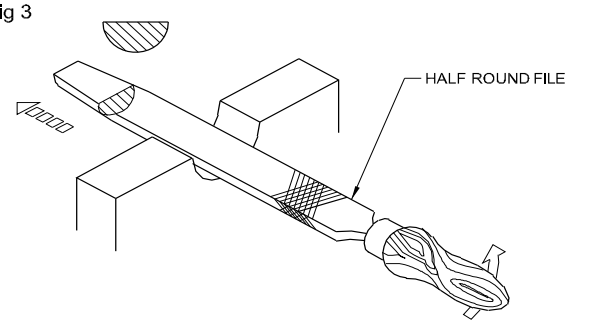
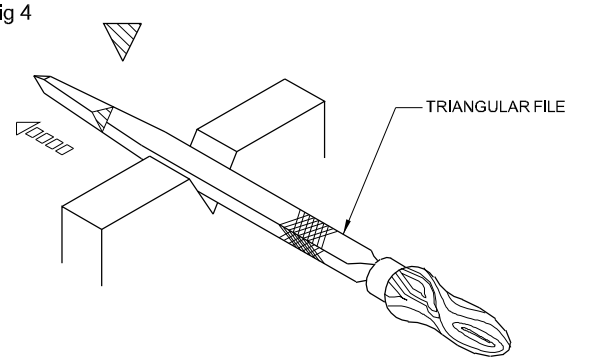


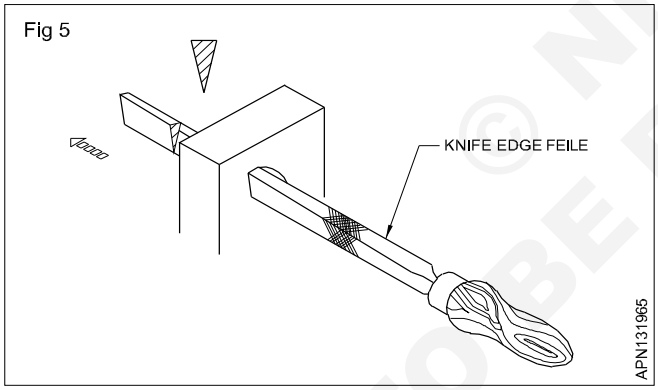
Fig 4



Knife-edge File

A knife-edge file has the cross section of a sharp triangle. It is used for filing narrow grooves and angles above 10°. (Fig 5)

Fig 5



The above files have one third of their lengths tapered. They are available both in single and double cuts.

Square, round, half-round and triangular-files are available in lengths of 100, 150, 200, 250, 300 and 400 mm. These files are made in bastard, second cut and smooth grades.

Wheel grinding

Adjust the tool-rest as close to the wheel as possible. The maximum recommended gap is 2 mm. This will help to prevent the work from being caught between the tool-rest and the wheel. (Fig 5)

Small jobs should be held with pliers or other suitable tools. (Fig 5)

Never hold jobs with cotton waste or similar materials.

Use gloves for your hands while grinding heavy jobs.

Fig 4

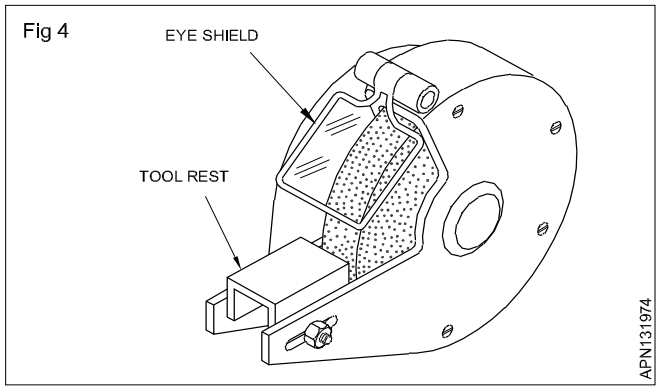
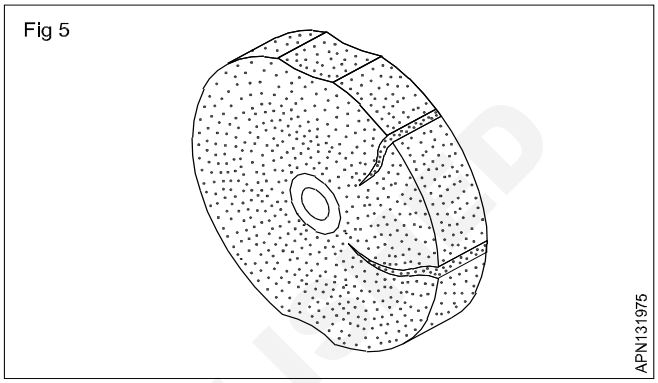
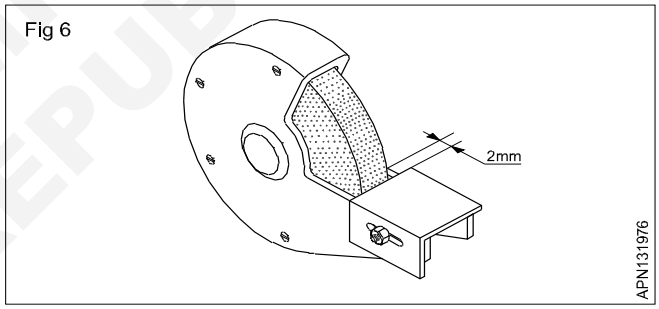


Fig 5



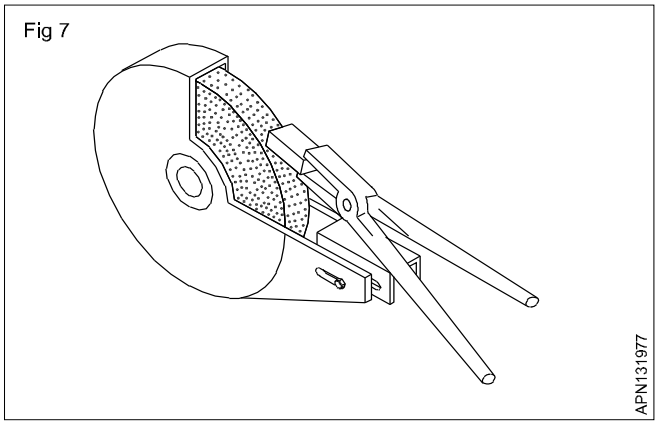
Do not grind on the side of the grinding wheels. (Fig 6)

Fig 6



Move the work across the full face of the wheel to prevent uneven wearing of the grinding wheel. (Fig 7)

Fig 7



Safe working on off - hand grinders

Objective: At the end of this lesson you shall be able to
- **work safety on an off-hand grinder.**

How to work on an off-hand grinder?

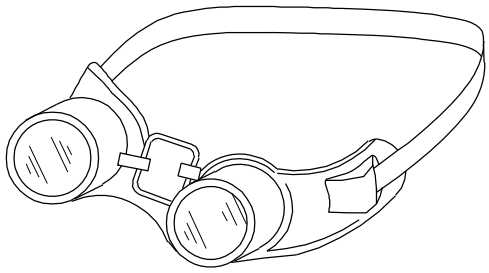
While working on off-hand grinders, it is important to observe the following safety measures.

BEFORE STARTING

Make sure the grinding wheel guards are in place.

Wear safety goggles while grinding. (Fig 1)

Fig 1



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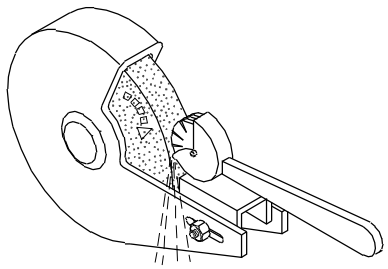
Do not work on grinding wheels which are loaded or glazed. Dress and true wheels whenever necessary. (Fig 2)

Fig 2



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If any abnormal sound is noticed, stop the machine. Cracked or improperly balanced wheels are dangerous.

Stand on one side of the machine while starting.

Zero line

In graphical representation of the above terms, the zero line represents the basic size. This line is also called as

Drilling machine (Portable type)

Objectives: At the end of this lesson you shall be able to
- **name the different types of portable drilling machines**
- **state their distinctive features and uses.**

Necessity

Portable hand drills of different types are used for certain jobs which cannot be handled on stationary drilling machines.

Types

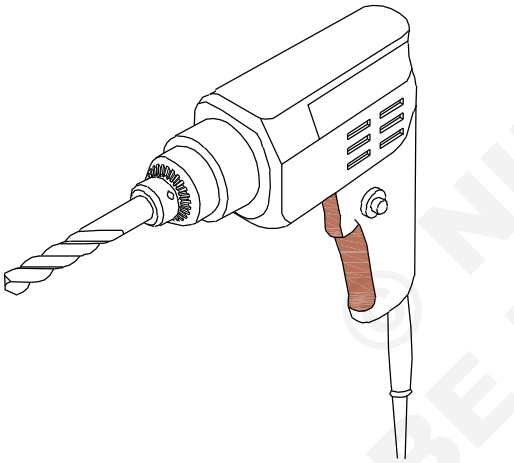
There are two types of portable drilling machines,

power operated and hand operated.

Power Operated drilling machines

Electric hand drill (light duty) (Fig 1)

Fig 1



These are available in different forms. The electric hand drill has a small electrical motor for driving the drill. On the end of the spindle, a drill chuck is mounted. Electric hand drills used for light duty will have, usually, a single speed.

Electric hand drill (heavy duty) (Figs 2 and 3)

This drill has an additional feature by which the drill speed can be varied through a system of gears. This is particularly useful for drilling larger diameter holes.

Fig 2

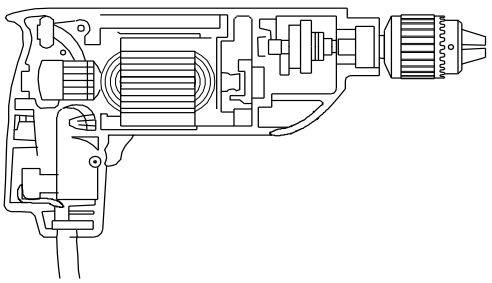
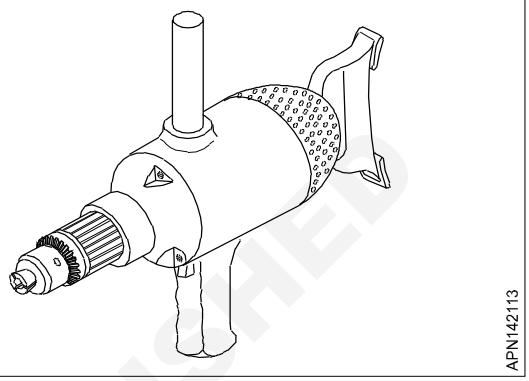
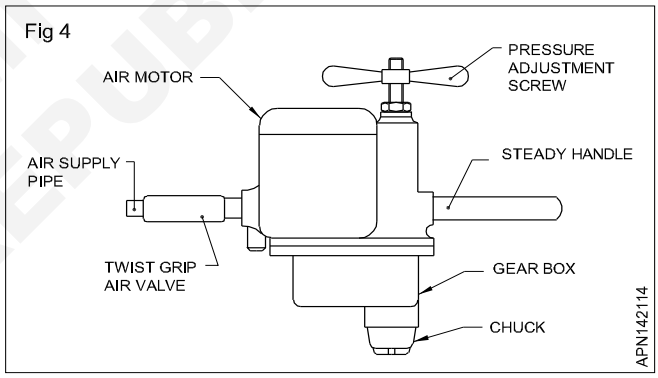


Fig 3



Pneumatic hand drill (Fig 4)

Fig 4



This type of drill is operated by compressed air. An air driven motor is housed in the casing, and a handle is fitted along with an air pipe to operate the drill conveniently.

This drill is used where electrically operated drills are prohibited i.e. explosives factories, petroleum refineries etc.

Hand operated drilling machines

Different types of hand operated drilling machines are shown below. They are used in structural fabrication, sheet metal and carpentry, particularly where electricity or pneumatic supply is not available.

The ratchet drilling machine (Fig 5) is commonly used in structural fabrication. Square head, taper shank drills are used on these machines.

The bevel gear type drilling machine (Fig 6) is used for drilling small diameter holes up to 6mm.

The breast drilling machine (Fig 7) is used for drilling holes of larger diameter as more pressure can be exerted. Drills between 6 mm to 12 mm can be used on these machines.

Fig 5

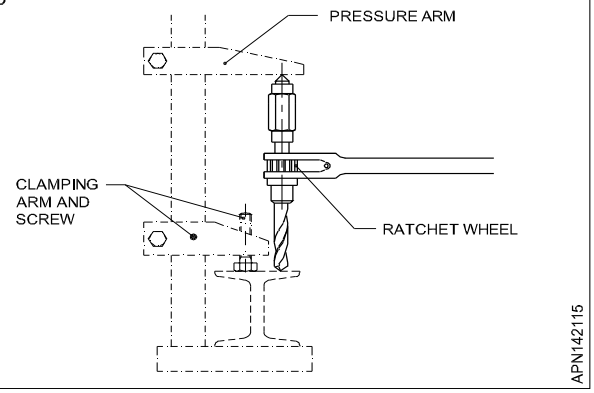


Fig 6

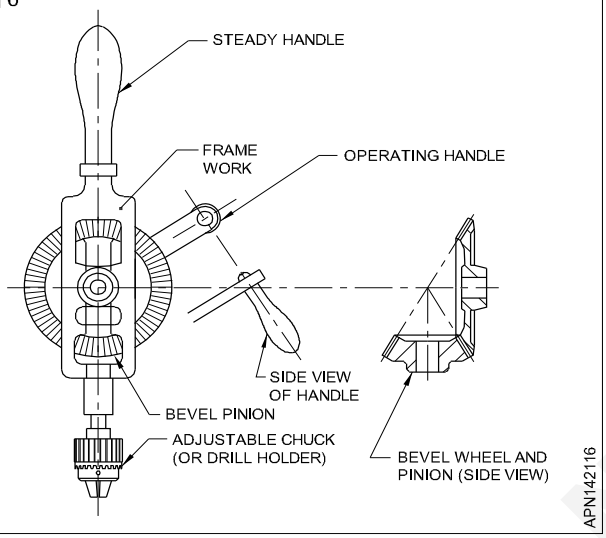
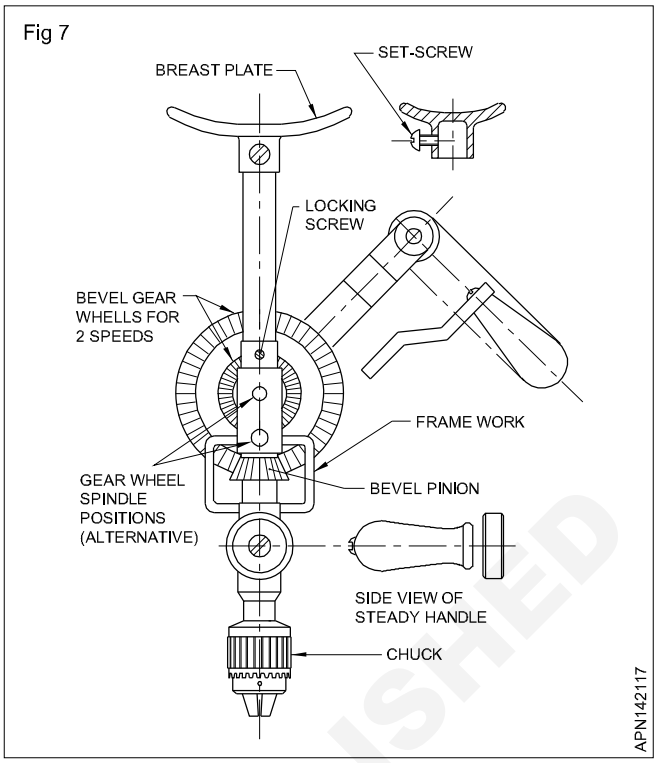


Fig 7



Drilling machines (bench and pillar type)

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

- **name the types of drilling machines**
- **list out the parts of bench type, pillar type and radial drilling machines**
- **compare the features of the bench type, pillar type and radial drilling machines.**

The principal types of drilling machines are :

- The sensitive bench drilling machine
- The pillar drilling machine
- The column drilling machine
- The radial arm drilling machine (radial drilling machine).

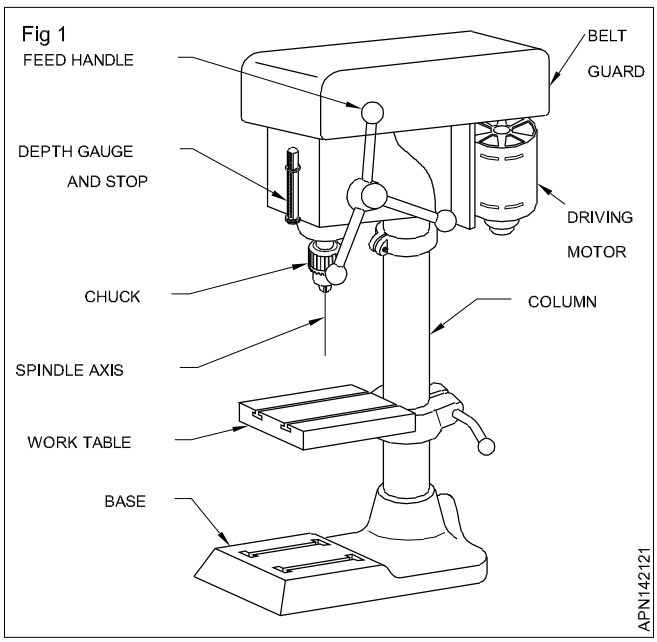
(You are not likely to use the column and radial types of drilling machines now. Therefore, only the sensitive and pillar type machines are explained here.)

The sensitive bench drilling machine (Fig 1)

The simplest type of sensitive drilling machines is shown in the figure with its various parts marked. This is used for light duty work.

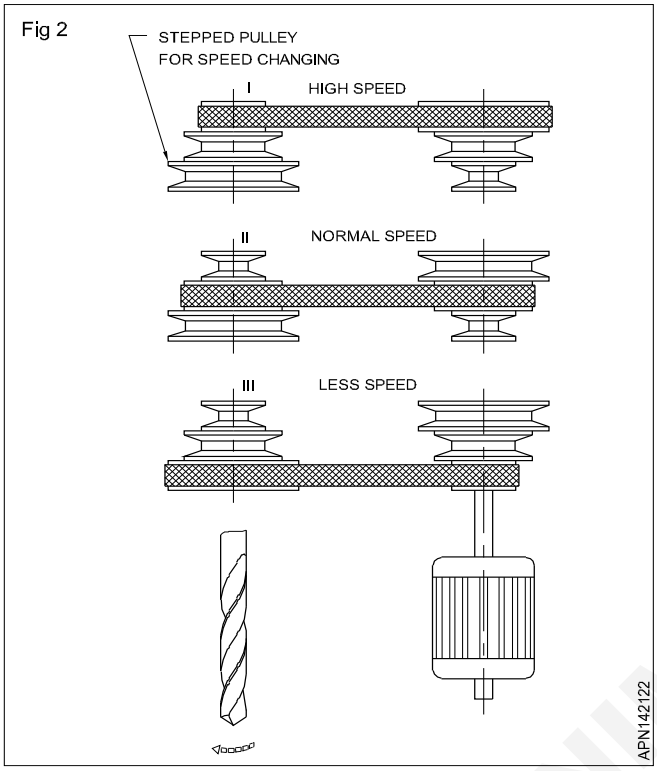
This machine is capable of drilling holes upto 12.5 mm diameter. The drills are fitted in the chuck or directly in the tapered hole of the machine spindle.

Fig 1



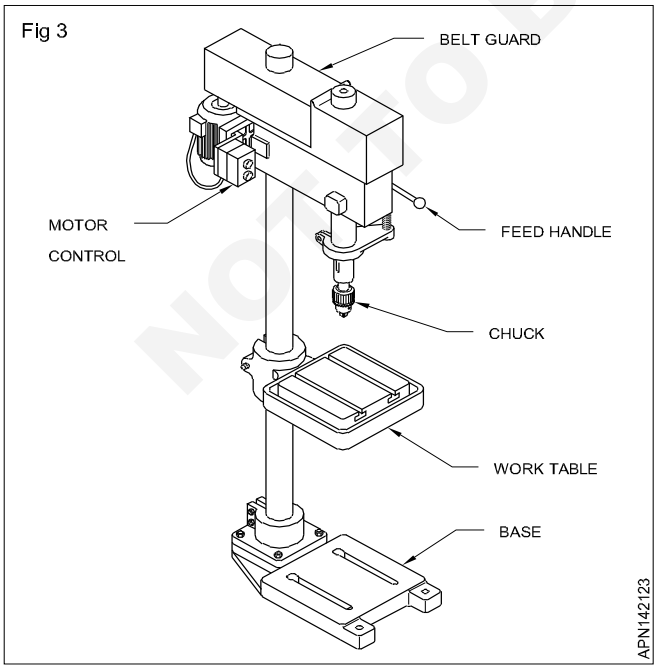
For normal drilling, the work-surface is kept horizontal. If the holes are to be drilled at an angle, the table can be tilted.

Different spindle speeds are achieved by changing the belt position in the stepped pulley. (Fig 2)



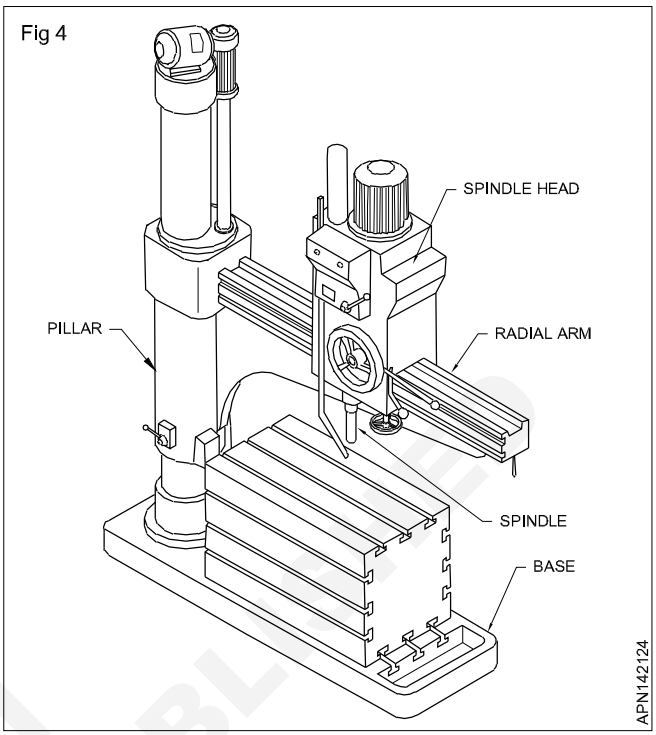
The pillar drilling machine (Fig 3)

This is an enlarged version of the sensitive bench drilling machine. These drilling machines are mounded on the floor and driven by more powerful electric motors. They are used for heavy duty work. Pillar drilling machines are available in different sizes.



Large machines are provided with a rack and pinion mechanism for moving the table for setting the work.

Radial drilling machines (Fig 4)



These are used to drill :

- Large diameter holes
- Multiple holes in one setting of the work
- Heavy and large workpieces.

FEATURES

The radial drilling machine has a radial arm on which the spindle head is mounted.

The spindle head can be moved along the radial arm and can be locked in any position.

The arm is supported by a pillar (column). It can be rotated about with the pillar as centre. Therefore, the drill spindle can cover the entire working surface of the table. The arm can be lifted or lowered.

The motor mounted on the spindle head rotates the spindle.

The variable-speed gearbox provides a large range of r.p.m

Drill - holding devices

Objectives: At the end of this lesson you shall be able to
- **name the types of drill-holding devices**
- **state the features of drill chucks**
- **state the functions of drill sleeves**
- **state the function of drift.**

For drilling holes of material, the drills are to be held accurately and rigidly on the machines.

The common drill-holding devices are drill chucks and sleeves and sockets.

Drill Chuck

Straight shank drills are held in drill chucks. For fixing and removing drills, the chucks are provided either with a pinion and key or a knurled ring.

The drill chucks are held on the machine spindle by means of an arbor fitted or the drill chuck. (Fig 1)

Taper Sleeves and Sockets (Fig 1)

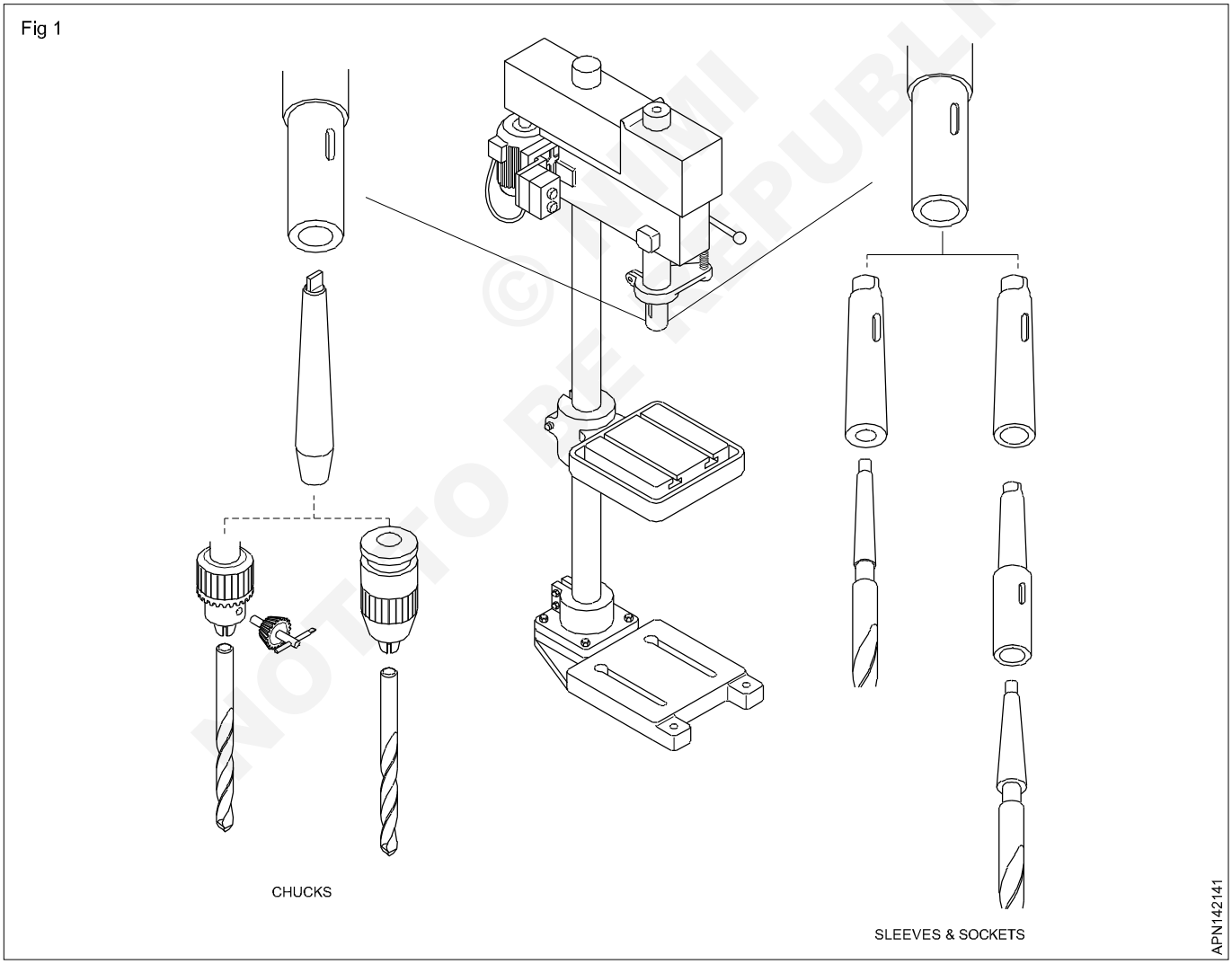
Taper shank drills have a morse taper.

Sleeves and sockets are made with the same taper so that the taper shank of the drill. When engaged, will give a good wedging action. due to this reason morse tapers are called self-holding tapers.

Drills are provided with five different sizes of morse tapers, and are numbered from MT 1 to MT5.

In order to make up the difference in sizes between the shanks of the drills and the type of machine spindles, sleeves of different sizes are used. When the drill taper shank is bigger than the machine spindle, taper sockets are used. (Fig 1)

Fig 1



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

Use a drift remove drills and sockets from the machine spindle. (Fig 3)

Fig 2

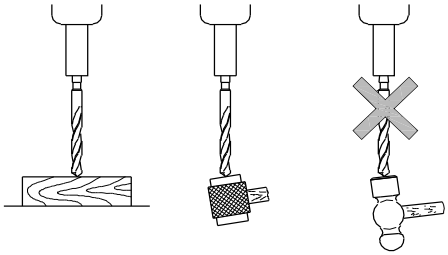


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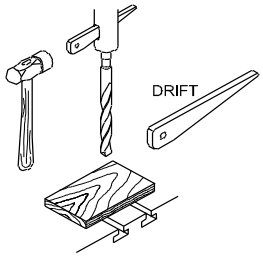
Fig 3



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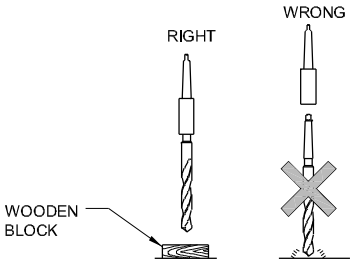
While removing the drill from the sockets sleeves, don't allow it to fall on the table or jobs. (Fig 4)

Fig 4



REMOVING A TAPER SHANK DRILL

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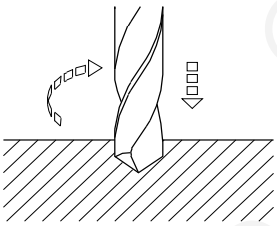
Drill Bits

Objectives: At the end of this lesson you shall be able to
- **state the functions of drills**
- **name the parts of a drill**
- **state the functions of each part of a drill.**

Drilling is a process of making holes on workpieces. The drill used as a tool. For drilling the drill is rotated with a downward pressure causing the tool to penetrate into the material (Fig 1)

Fig 1



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Parts of a Drill (Fig 2)

The Various parts of a drill can be identified from fig. 2

Point

The cone shaped end which does the cutting is called point. It consists of a dead centre, lips or cutting edges and a heel.

Shank

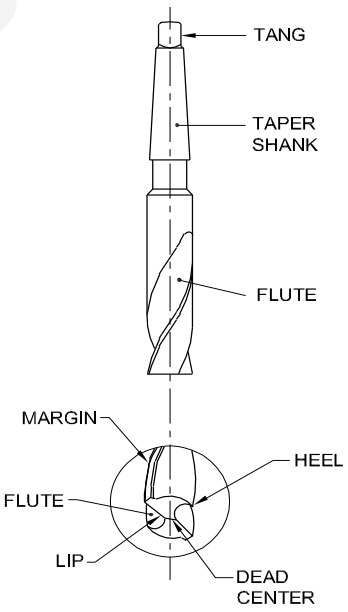
This is the driving end of the drill which is fitted on to the machine. Shanks are of two types.

Taper shanks, used for larger diameter drills, and straight shank, used for smaller diameter drills.

Tang

This is a part of the taper shank drill which fits into the slot of the drilling machine spindle.

Fig 2



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Body (Fig 3)

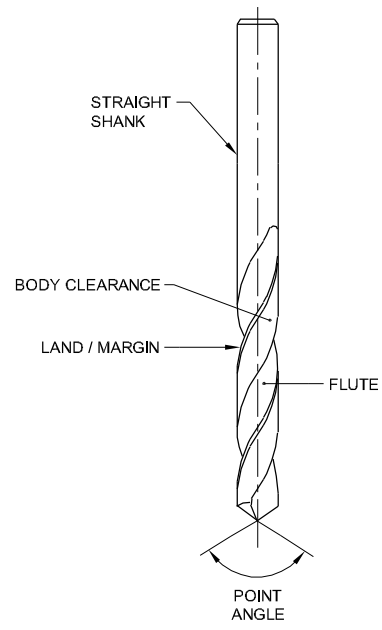
The portion between the point and the shank is called the body of a drill.

The parts of the body are flute, land/margin, body clearance and web.

Flutes

Flutes are the spiral grooves which run to the length of the drill. The flutes help,

Fig 3



- To form the cutting edges
- To curl the chips and alow these to come out
- The coolant to flow to the cutting edge.

Land/Margin

The land/margin is the narrow strip which extends to the entire length of the flutes.

The diameter of the drill a measured across the land margin.

Body Clearance

Body clearance is the part of the body which is reduced in diameter to cut down the function between the drill and the hole being drilled.

Web

Web is the metal column which separates the flutes. It gradually increases in thickness towards the shank.

Hand taps and dies

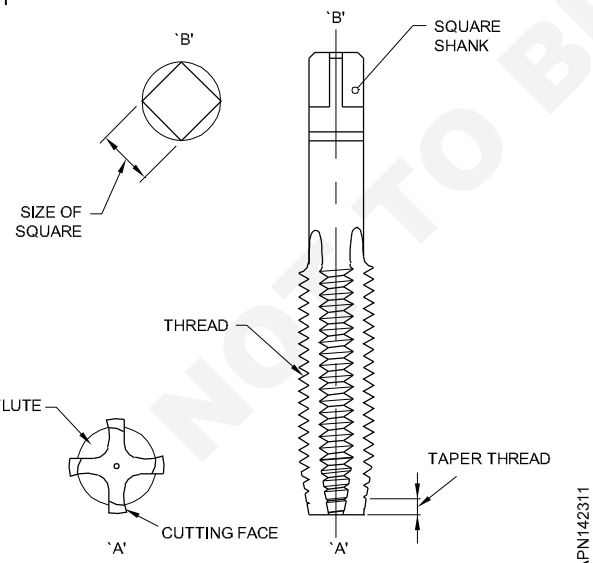
Objectives: At the end of this lesson you shall be able to
- **state the uses of threading hand taps**
- **state the features of hand taps**
- **distinguish between different taps in a set**
- **name the different types of tap wrenches**
- **state the uses of different types of wrenches.**

Use of Hand Taps

Hand taps are used for internal threading of components.

Features (Fig 1)

Fig 1



They are made from high carbon steel of high speed steel hardened and ground

Threads are cut on the surface and are accurately finished.

To form the cutting edges, the flutes are cut across the thread.

For holding and turning the taps while cutting threads the ends of the shanks are squared.

The ends of the taps are chamfered (taper lead) for assisting aligning and starting of the thread.

The size of the taps and the type of the thread are usually marked on the shank.

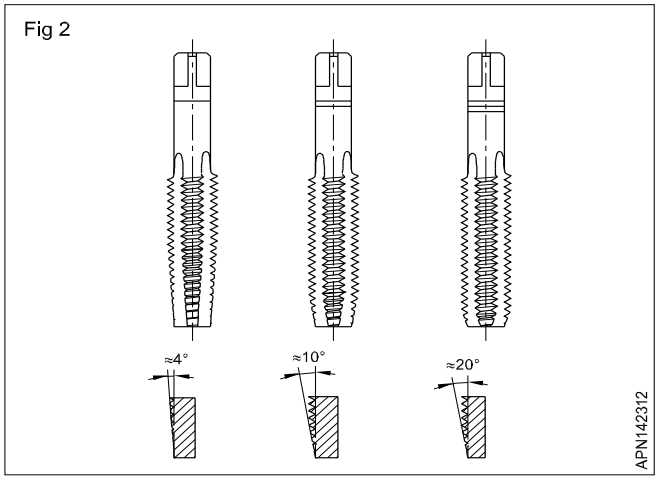
In certain cases the pitch of the thread will also be marked.

Markings are also made to indicate the type of tap i.e first, second final or plug tap.

Types of Taps in a set

Hand taps for a particular thread are available as a set consisting of three pieces. (Fig 2)

Fig 2



These are

First tap or taper tap

Second tap or intermediate tap

Plug or bottoming tap

These taps are identical in all features except in the taper lead.

The taper tap is to start the thread. It is possible to form full threads by the taper tap in through holes which are not deep.

The bottoming tap (plug) is used to finish the threads of a blind hole to the correct depth.

for identifying the type of taps quickly - the taps are either numbered as 1,2 and 3 or rings are marked on the shank.

The taper tap has one ring the intermediate tap has two rings and the bottoming tap has three rings (Fig 2)

Tap Wrenches

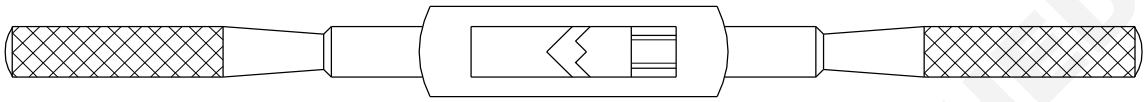
Tap Wrenches are used to align and drive the hand taps correctly into the hole to be threaded.

Tap Wrenches are of different types.

Double ended adjustable wrench, T handle tap wrench and solid type tap wrench.

Double ended adjustable tap Wrench or Bar Type Tap Wrench (Fig 3)

Fig 3



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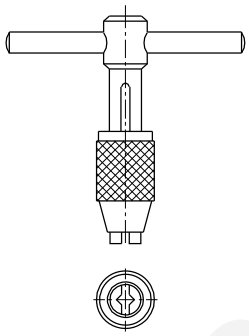
This is the most commonly used type of tap wrench. It is available in various sizes. These tap wrenches are more suitable for large diameter taps and can be used in open places where there is no obstruction to turn the tap. It is important to select the correct size of wrench.

T- Handle Tap Wrench (Fig 4)

Fig 4



APN142314

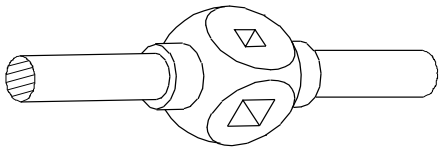
These are small adjustable chucks with two jaws and a handle to turn the wrench.

This tap wrench is useful to work in restricted places and is turned with one hand only.

This is not suitable for holding large diameter taps.

Solid Type Tap Wrench (Fig 5)

Fig 5



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These Wrenches are not adjustable

They can take only certain sizes of taps. This eliminates the use of wrong length of the tap wrenches and thus prevents damage to the taps.

Tap drill size

Objectives: At the end of this lesson you shall be able to
- **state the tap drill size**
- **choose the tap drill sizes for different threads from tables**
- **calculate the tap drill sizes for ISO metric and ISO inch.**

Tap drill Size

Before a tap is used for cutting internal threads, a hole is to be drilled. The diameter of the hole should be such that it should have sufficient material in the hole for the tap to cut the thread.

Tap Drill Sizes for Different Threads

ISO Metric Thread

Tapping drill size

for M10 x 1.5 thread

Minor diameter = Major diameter – 2 x depth

depth of thread = 0.6134 x pitch of a screw

2 depth of thread = 0.6134 x 2 x pitch

=1.226 x 1.5 mm = 1.839 mm

Minor dia (D1)=10 mm – 1.839 mm

=8.161mm or 8.2 mm

This tap drill will produce 100% thread because this is equal to the minor diameter of the thread. For most fastening purposes a 100% formed thread is not required.

A standard nut with 60% thread is strong enough to be tightened until the bolt breaks without stripping the thread. Further it also requires a greater force for turning the tap if a higher percentage formation of thread is required.

Considering this aspect, a more practical approach for determining the tap drill sizes is

Tap drill size = Major diameter – pitch

= 10 mm - 1.5 mm

= 8.5 mm

Compare this with the table of tap drill sizes for ISO metric threads.

ISO Inch (Unified) threads Formula

Tap Drill size =

Major diameter –

For calculating the tap drill size for 5/8" UNC thread

Tap drill size = 5/8" – 1/11"

= 0.625" – 0.091"

= 0.534"

The next drill size is 17/32" (0.531 inches)

Compare this with the table of drill sizes for unified inch threads.

What will be the tapping size for the following threads?

a M 20

b UNC 3/8

Refer to chart for determining the pitches of the thread.

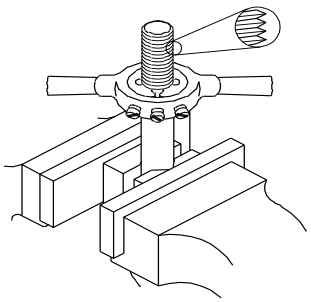
Die and die stock

Objectives: At the end of this lesson you shall be able to
- **name the different types of dies**
- **state the features of each type of die**
- **state the use of each type of die**
- **name the type of diestock for each type of die.**

Uses of Dies

Threading dies are used to cut external threads on cylindrical workpieces. (Fig 1)

Fig 1



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Types of Dies

The following are the different types of dies.

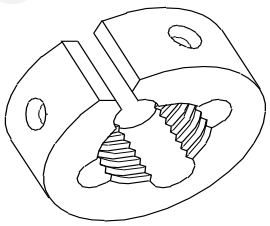
Circular Split Die (Button die)

Half Die

Adjustable Screw Plate Die

Circular Split Die/Button Die (Fig 2)

Fig 2



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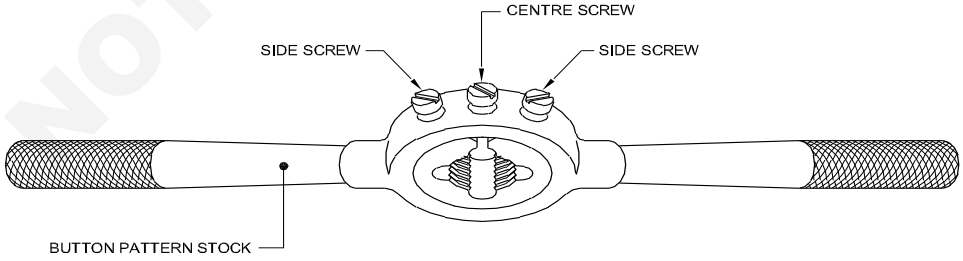
This has a slot cut to permit slight variation in size.

When held in the diestock, variation in the size can be made by using the adjusting screws. This permits increasing or decreasing of the depth of cut. When the side screws are tightened the die will close slightly. (Fig 3)

Fig 3



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For adjusting the depth of the cut, the centre screw is advanced and locked in the groove. This type of die stock is called button pattern stock.

Half Die (Fig 4)

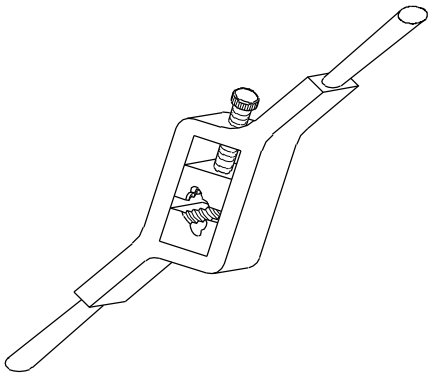
Half dies are stronger in construction.

Adjustments can be made easily to increase or decrease the depth of cut.

These dies are available in matching pairs and should be used together.

By adjusting the screw of the diestock, the die pieces can be brought closer together or can be moved apart.

Fig 4



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They need a special die holder.

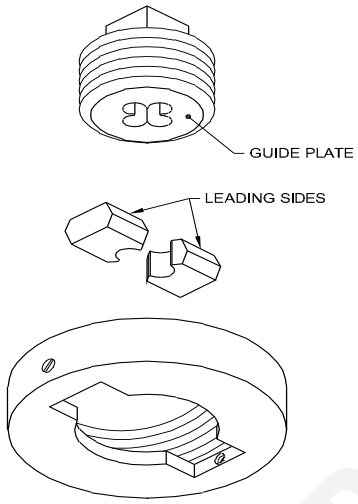
Adjustable Screw Plate Die (Fig 5)

This is another type of a two piece die similar to the half die.

This provides greater adjustment than the split die.

The two die halves are held securely in a collar by means of a threaded plate (guide plate) which also acts as a guide while threading.

Fig 5



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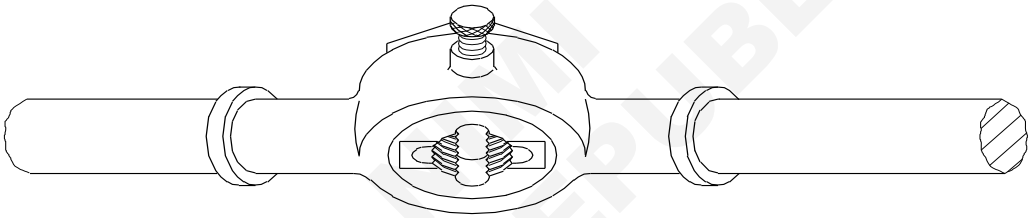
When the guide plate is tightened after placing the die pieces in the collar, the die pieces are correctly located and rigidly held. (Fig 5)

The die pieces can be adjusted, using the adjusting screws on the collar. This type of die stock used is called quick cut diestock. (Fig 6)

Fig 6



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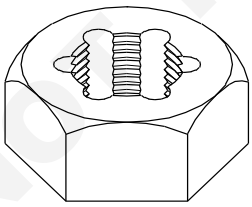
The bottom of the die halves is tapered to provide the lead for starting the thread. On one side of each die head, the serial number is stamped.

Both pieces should have the same serial numbers.

Die Nut (Solid Die) (Fig 7)

Fig 7



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The die nut is used for chasing or reconditioning the damaged threads.

The die nut is turned with a spanner.

The die nuts are available for different standards and sizes of threads.

Die nuts are not to be used for cutting new threads.

Screw Extractor

Fig 8

A screw extractor is a tool for removing broken or sized screws. A potential issue with these extractors is that they may cause the fasterners to expand as they dig in making it more difficult to remove but they can make a reliable extraction on all but the most stuck fasteners.

To use after drilling a hole into the fasteners tap the screw extractor into the fastener top the screw extractor into the hole using a hammer.

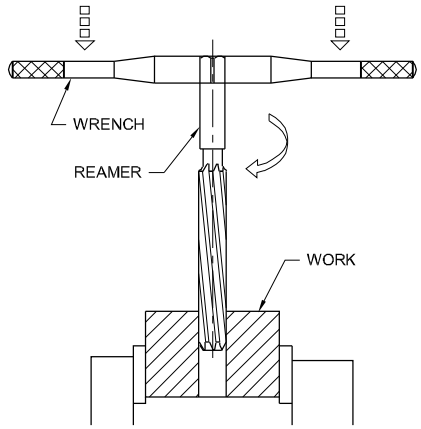
Hand Reamers

Objectives: At the end of this lesson you shall be able to
- **state the uses of reamers**
- **state the advantages of reaming**
- **distinguish between hand and machine reaming**
- **name the elements of a reamer.**

What is reamer?

A reamer is a multi-point cutting tool used for enlarging and finishing previously drilled holes to accurate sizes. (Fig 1)

Fig 1

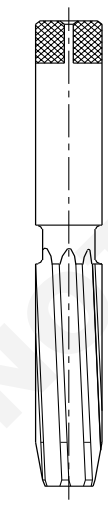


Advantages of 'reaming': Reaming produces high quality surface finish and dimensional accuracy to close limits.

Also small holes which cannot be finished by other processes can be finished.

Classification of reamers: Reamers are classified as hand reamers and machine reamers. (Figs 2 and 3)

Fig 2



Reaming by using a hand reamer is done manually for which great skill is needed.

Hand reamers have straight shanks with 'square' at the end for holding with tap wrenches. (Fig 2)

Machine reamers are fitted on spindles of machine tools by means of a floating chuck and are rotated for reaming.

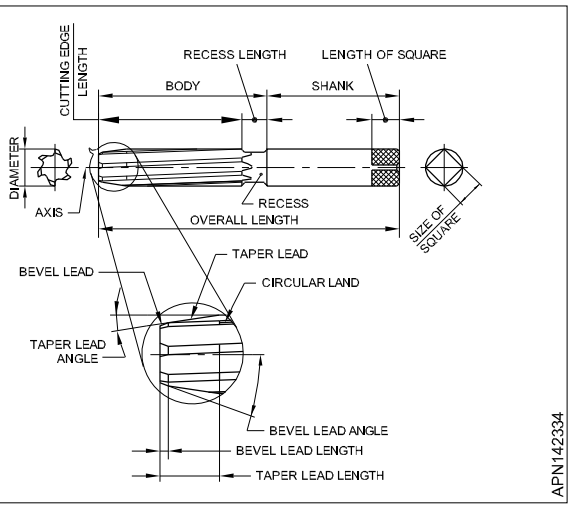
Machine reamers are provided with Morse taper shanks for holding on machine spindles.(Fig 3)

Fig 3

Parts of a hand reamer

The parts of a hand reamer are shown in Fig 4

Fig 4



Hand Reamers Lapping

Objectives: At the end of this lesson you shall be able to
- **state the purpose of lapping**
- **state the features of a flat lapping plate**
- **state the use of changing a flat lapping plate**
- **state the method of charging a cast iron plate.**

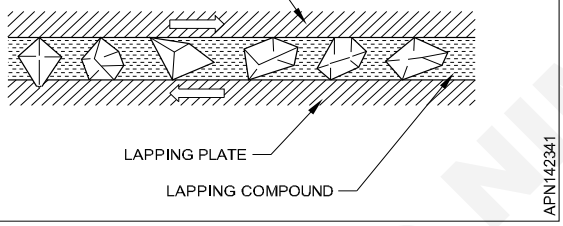
Lapping is a precision finishing operation carried out using line abrasive materials.

Purpose: This process

- improves geometrical accuracy
- refines surface finish
- assists in achieving a high degree of dimensional accuracy.
- improves the quality of fit between the mating components.

Lapping process: in the lapping process small amounts of material are removed by rubbing the work against a lap charged with a lapping compound. (Fig 1)

Fig 1

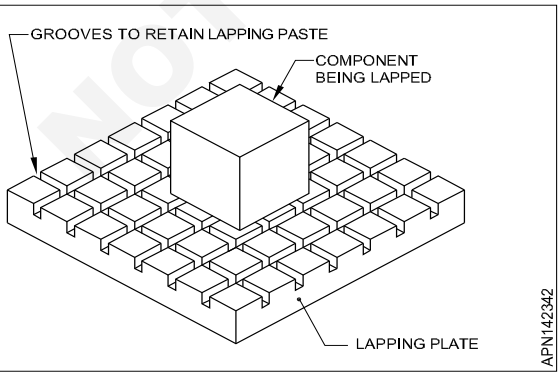


The lapping compound consists of the abrasive particles. Suspended in a vehicle such as oil, paraffin, grease etc.

The lapping compound which is introduced between the workpiece and the lap chips away the material from the workpiece. Light pressure is applied when both are moved against each other. The lapping can be carried out manually or by machine.

Hand lapping of flat surfaces: Flat surfaces are hand lapped using lapping plates made out of close grained cast iron. (Fig 2) The surface of the plate should be in a true plane for accurate results in lapping.

Fig 2



The lapping plate generally used in tool rooms will have narrow grooves out on its surface both lengthwise and crosswise forming a series of squares.

These grooves are usually about 12mm apart.

While lapping the lapping compound collects in the serrations and rolls in and out as the work a moved.

Before commencing lapping of the component, The cast iron plate should be CHARGED with abrasive particles.

This is a process by which the abrasive particles are embedded on to the surfaces of the laps which are comparatively softer than the component being lapped.

For charging the cast iron lap apply a thin coating of the abrasive compound over the surface of the lapping plate.

Use a finished hard steel block and press the cutting particles into the lap. While doing so, rubbing should be kept to the minimum. When the entire surface of the lapping plate is charged, the surface will have a uniform grey appearance. If the surface is not fully charged, bright spots will be visible here and there.

Excessive application of the abrasive compound will result in the rolling action of the abrasive between the work and the plate developing in accuracies.

The surface of the flat lap should be finished true by scraping before charging. After charging the plate, wash of all the loose abrasives using kerosene.

Then place the worpiece on the plate and move along and across, covering the entire surface areas of the plate. When carrying out fine lapping, the surface should be kept moist with the help of kerosene.

Wet and dry lapping: Lapping can be carried out either wet or dry.

In wet lapping there is surplus oil and abrasives on the surface of the lap. As the workpiece which is being lapped is moved on the lap, there is movement of the abrasive particles also.

In the dry method the lap is first charged by rubbing the abrasives on the surface of the lap. The surplus oil and abrasives are then washed off. The abrasives embedded on the surface of the lap will only be remaining. The embedded abrasives act like a fine oilstone when metal pins to be lapped are moved over the surface with light pressure. However, while lapping, the surface being lapped is kept moistened with kerosene or petrol. Surfaces finished by the dry method will have better finish and appearance. Some prefer to do rough lapping by wet method and finish by dry lapping.

Lap Materials and lapping compounds

Objectives: At the end of this lesson you shall be able to
- **name the different types of lap materials**
- **state the qualities of different lap materials**
- **name the different types of abrasive materials used for lapping**
- **distinguished between the application of different lapping abrasives**
- **state the function of lapping vehicles**
- **name the solvents used in lapping.**

The material used for making laps should be softer than the workpiece being lapped. This helps to charge the abrasives on the lap. If the lap is harder than the workpiece, the workpiece will get charged with the abrasives and cut the lap instead of the workpiece being lapped.

Laps are usually made of

- close grained iron
- copper
- brass or lead.

The best material used for making lap is cast iron, but this cannot be used for all applications.

When there is excessive lapping allowance, copper and brass laps are preferred as they can be charged more easily and cut more rapidly than cast iron.

Lead is an in expensive form of lap commonly used for holes. Lead is cast to the required size on steel arbor. These laps can be expanded when they are worn out. Charging the lap is much quicker.

Lapping abrasives: Abrasives of different types are used for lapping.

The commonly used abrasives are:

- silicon carbide
- aliminium oxide
- boron carbide
- diamond.

Silicon carbide: This is an extremely hand abrasive. Its grit is sharp and brittle. While lapping the sharp cutting edges continuously break down exposing new cutting edges. Due to this reason this is considered as very ideal for lapping hardened steel and cast iron, particularly where heavy stock removal is required.

Aluminium oxide: Aluminium oxide is sharp but tougher than silicon carbide. Aluminium oxide is used in un-fused and fused forms.

Un-fused alumina(aluminium oxide) removes stock effectively and is capable of obtaining high quality finish.

Fused alumina is used for lapping soft steels and nonferrous metals.

Boron Carbide: This is an expensive abrasive material which is next to diamond in harness. While it has excellent cutting properties, it is used because of the high cost only in special application like dies and gauges.

Diamond: This being the hardest of all materials. It is used for lapping tungsten carbide. Rotary diamond laps are also prepared for accurately finishing very small holes which cannot be ground.

Lapping vehicles: In the preparation of lapping compounds the abrasive particles are suspended in vehicles. This helps to prevent concentration of abrasives on the lapping surfaces and regulates the cutting action and lubricates the surfaces.

The commonly used vehicles are:

- water soluble cutting oils
- vegetable oils
- machine oils
- petroleum jelly or grease
- vehicles with oil or grease base used for lapping ferrous metals.

Metals like copper and its alloys and other non-ferrous metals are lapped using slouble oil, bentonite etc.

In addition to the vehicles used in making the lapping compound, solvents like water, kerosene, etc are also used at the time of lapping.

Gasket

Objectives: At the end of this lesson you shall be able to
- **state the need of gaskets**
- **state the materials of gaskets.**

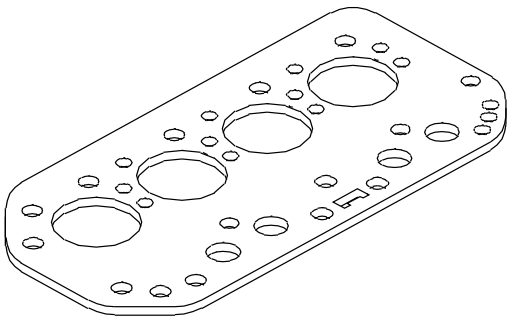
The gasket (Fig 1) in automobiles has to combat sealing problems caused by high and low temperatures, expansion and contraction, vibration, pressure or vaccum, corrosion and oxidation, inadequate sealing reduces the service life and efficiency of the components.

The seals which are used between two stationary components are called static seats. The most common static seal is gasket. Gaskets are designed to suit particular needs and are manufactured from different materials like copper, aluminium, cork fibre, asbestos, synthetic rubber, paper and various combinations of these

materials. In latest In latest semi-liquid is also used as gasket.

Cylinder head gaskets are the most complicated in design and construction because they must withstand extreme pressure, vibration, high temperature and expansion changes. They must seal against compression, oil and coolants. They must resist extrusion, elongation, oxidation and chemicals. The cylinder head gasket consists of a multi-layer of materials with coolant and oil passages.

Fig 1



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Oil seal

Objectives: At the end of this lesson you shall be able to
- **state the use of oil seals**
- **explain different types of oil seals**
- **state the material used for oil seals.**

Seals: Seals are sealing parts on static or moving inter faces of machines, devices pipes and tank reservoir seals are used for sealing spaces as different pressure against each other, ie combustion chamber & oilways etc. oil seals have flexible lip that rubs against a shaft or housing to prevent leakage of fluid (grease, oil etc.)

All seal are used to retain or separate lubricant on fluid

Types of oil seal

i Flexible lip

ii Radial lip

iii Rotary shaft seal

Configuration

a Single lip

b Double lip

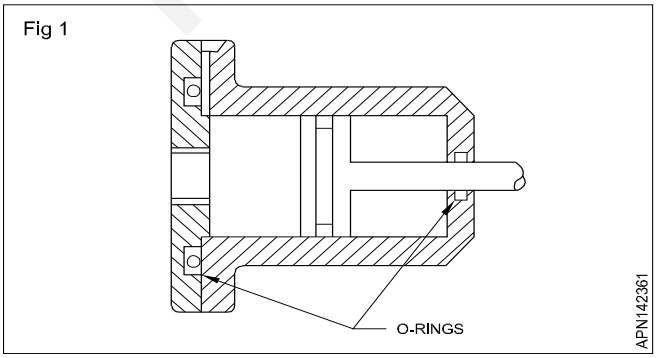
c Triple lip

d Fan lip

Seals capable of sealing two components which move or rotate insulation to each other are called dynamic seals. The most common dynamic seal is called 'O' rings which are moulded to close tolerances in the cross-sectional areas and to the inner and outer diameters.

Bearing Isolator (Fig 1): Bearing Isolator are dynamised designed to protect bearing from outside contaminant. The contain potor (rotating) & starter (Stationary) member same bearing Isolator are of labyrinth construction of other use o-rings.

Fig 1



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Specifications

Sealing orientation (Figs 2 & 3)

Fig 2

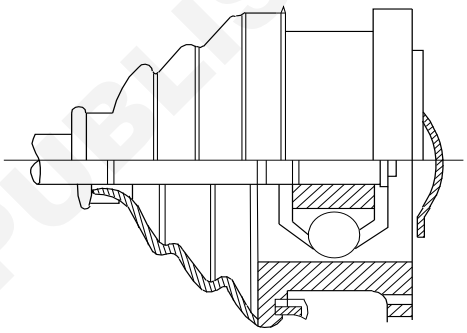

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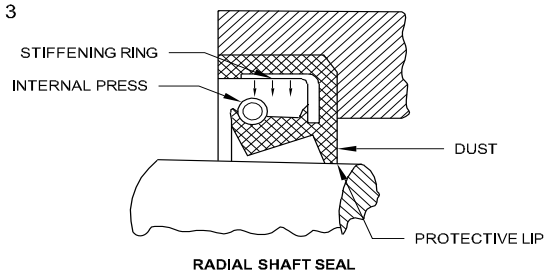
Fig 3



RADIAL SHAFT SEAL

APN142363

- Rod seals or shaft seals are type of radial seal.
- Radial seal are press fit into a housing bore with the sealing up contacting the shaft.
- Piston seals are radial seal. These seals are fit on a shaft with sealing lip contacting the housing bore. 'O' rings are external lip seals.
- Symmetrical seal works equally as a rod or piston seal.
- An axial seals axially against a housing or machine component.
- Material - Nylon, Rubber, polythene, PTFE etc.

Sealants

Type of sealant: There are three types of sealant used.

1 The Teflon tape

2 Pipe tape

3 Anaerobic resin compound

1 Teflon tape: The purpose of this Teflon tape (whir), no sticking tape is the serve as a lubricant when threaded part of pipe a piping system are being assembles.

2 Pipe tape: This material relies on a solvent carrier and hardware when the solvent evaporator. The resulting seal adheres to all plastic, metal pipes and effective blocks leak paths.

3 Anaerobic resin compound: This sealant is confined within the threads of the metal pipe connection and air in exuded. It maintains the sealing properties even after heat aging, excellent then prelature and solvent remittance.

Key concepts

- Tape does not truly seal, it lubricator.
- Tape can harden and become brittle.
- Anaerobic must be combatable with pipe fitting material.

Sealant selection factors

- Material
- Temperature
- Pressure
- Vibration

Riveting tasks: Industrial manufactures a broad range of standard and recoilless rivet hammer, rivet squeezer and riveting tool accessories in both hand operated and pneumatic styles. All tools are C.E certifies and manufactured from quality materials for long service life. A rivet set in used for bringing the places closely together after inserting the rivet in the hole. Following tools required to riveting work.

1 Rivet gun

2 Riveting tool accessories

3 Backing bars of kits

4 Rivet set

5 Squeeze riveter accessories

6 Squeezer set

7 Trailor body tool

8 Rivet shavers

9 Cold riveter of hot dimples

10 Air craft brake riveter

11 Bench top compression riveters

12 Cherry riveters tooling

13 Blind riveter

14 Rive-nut of hi-lock hand tool

15 Lock-fasteners tools

16 Dolly

17 Snap

18 Hand riveter

19 Pop riveter

Rivet hammers and rivet squeeze tools are furnished with a sure grip powder coat and rivet hammers come with beehive type retainer spring and air regular.

Electricity principles

Objectives: At the end of this lesson you shall be able to
- **describe an atom**
- **describe electricity and electron flow**
- **describe conductors and insulators**
- **describe semiconductors and shielding.**

Introduction

Electricity is one of today's most useful sources of energy. Electricity is of utmost necessity in the modern world of sophisticated equipment and machinery.

Electricity in motion is called electric current. Whereas the electricity that does not move is called static electricity.

Examples of Electric current

- Domestic electric supply, industrial electric supply.

Examples of static electricity

Shock received from door knobs of a carpeted room. Attraction of paper of the comb.

Structure of matter

To understand electricity, one must understand the structure of matter. Electricity is related to some of the most basic building blocks of matter that are atoms. All matter is made of these electrical building blocks, and, therefore, all matter is said to be 'electrical'.

Matter is defined as anything that has mass and occupies space. A matter is made of tiny, invisible particles called molecules. A molecule is the smallest particle of a substance that has the properties of the substance. Each molecule can be divided into simpler parts by chemical means. The simplest parts of a molecule are called atoms.

Basically, an atom contains three types of sub-atomic particles that are of relevance to electricity. They are the electrons, protons and neutrons. The protons and neutrons are located in the centre, or nucleus, of the atom, and the electrons travel around the nucleus in orbits.

Atomic Structure

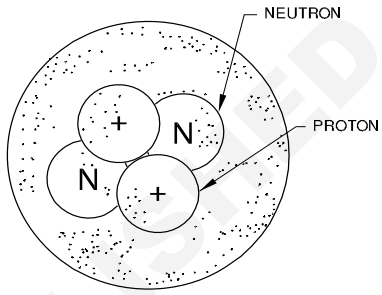
The Nucleus

The nucleus is the central part of the atom. It contains the protons and neutrons of an atom as shown in Fig 1

Protons

The proton has a positive electrical charge. (Fig 1) It is almost 1840 times heavier than the electron and it is the permanent part of the nucleus; protons do not take an active part in the flow or transfer of electrical energy.

Fig 1

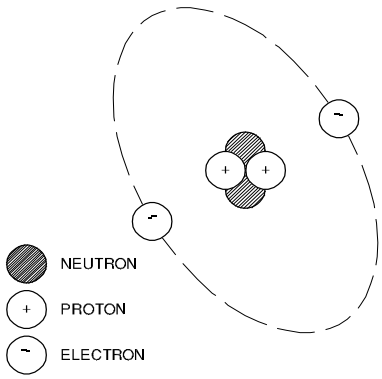


NUCLEUS OF AN ATOM

Electron

It is a small particle revolving round the nucleus of an atom as shown in (Fig 2). It has a negative electric charge. The electron is three times larger in diameter than the proton. In an atom the number of protons is equal to the number of electrons.

Fig 2



Neutron

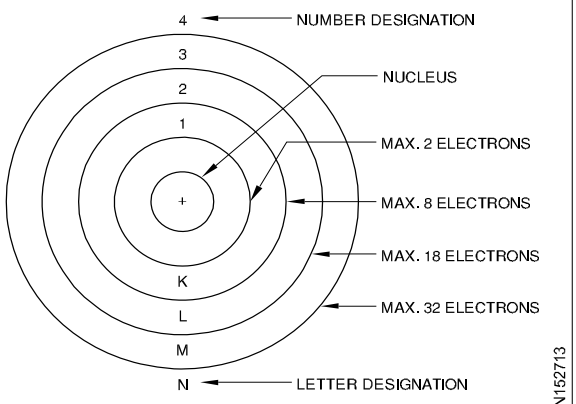
A neutron is actually a particle by itself, and is electrically neutral. Since neutrons are electrically neutral, they are not too important to the electrical nature of atoms.

Energy Shells

In an atom, electrons are arranged in shells around the nucleus. A shell is an orbiting layer or energy level of one or more electrons. The major shell layers are identified by

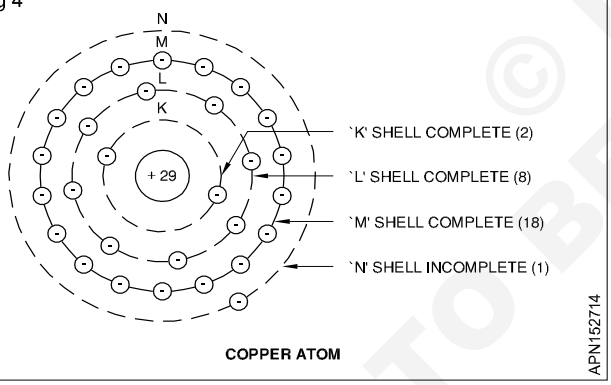
numbers of by letters starting with 'K' nearest the nucleus and continuing alphabetically outwards. There is a maximum number of electrons that can be contained in each sheel. (Fig 3) illustrates the relationship between the energy shell level and the maximum number of electrons it can contain.

Fig 3



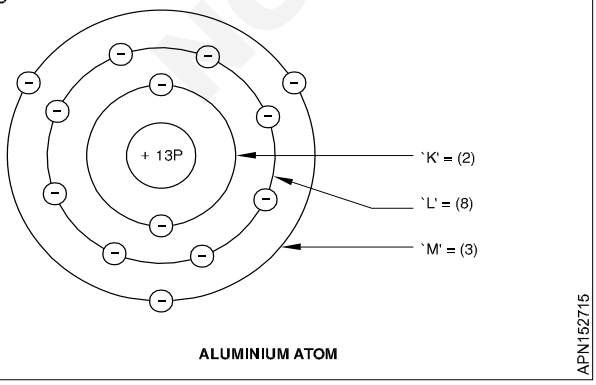
If the total number of electrons for a given atom is known, the placement of electrons in each shell can be easily determined. Each shell layer, beginning with the first, is filled with the maximum number of electrons in sequence. For example, a copper atom which has 29 electrons would have four shells with a number of electrons in each shell as shown in (Fig 4).

Fig 4



Similarly an aluminium atom which has 13 electrons has 3 shell as shown in (Fig 5).

Fig 5



Electron distribution

The chemical and electrical behavior of atoms depends on how completely the various shell and sub-shells are filled.

Atoms that are chemically active have one electron more or one less than a completely filled shell. Atoms that have the outer shell exactly filled are chemically inactive. They are called inert elements. All inert elements are gases and do not combine chemically with other elements.

Metals possess the following characteristics

- They are good electric conductors.
- Electrons in the outer shell and sub-shells can move more easily from one atom to another.
- They carry charge through the material.

The outer shell of the atom is called the valence shell and its electrons are called valence electrons. Because of their greater distance from the nucleus, and because of the partial blocking of the electric field by electrons in the inner shells, the attracting force exerted by nucleus on the valence electrons is less. Therefore, valence electrons can be set free most easily. Whenever a valence electron is removed from its orbit it becomes a free electron. Electricity is commonly defined as the flow of these free electrons through a conductor. Though electrons flow from negative terminal to positive terminal, the conventional current flow is assumed as from positive to negative.

Conductors Insulators and Semi conductors

Conductors

A conductor is a material that has many free electrons permitting electrons to move through it easily. Generally, conductors have incomplete valence shells of one, two or three electrons. Most metals are good conductors.

Some common good conductors are Copper, Aluminium, Zinc, Lead, Tin, Eureka, Nichrome, Silver and Gold.

Insulators

An insulator is a material that has few, if any, free electrons and resists the flow of electrons. Generally, insulators have full valence shells of five, six or seven electrons. Some common insulators are air, glass, rubber, plastic, paper, porcelain, PVC, fibre, mica etc.

Semiconductors

A semiconductor is a material that has some of the characteristics of both the conductor and insulator. Semiconductor have valence shells containing four electrons.

Common examples of pure semiconductor materials are silicon and germanium. Specially treated semiconductors are used to produce modern electronic components such as diodes, transistors and integrated circuit chips.

Ohm's Law

Objectives: At the end of the lesson you shall be able to
- **describe an atom**
- **describe electricity**
- **describe electron flow**
- **describe electron flow .**

Electrical terms and definitions EMF and Pd

The force tending to make electrons to move along a conductor is called the potential difference (pd) in the conductor and is expressed in volts. This is also called the electric pressure or voltage.

The voltage developed by a source such as a generator is called as electromotive force. (emf)

When one ampere current flows through one ohm resistance the p.d. across the resistance is said to be one "Volt". Voltmeter is used to measure the voltage of a supply and is connected in parallel to the supply. EMF/Pd is denoted by letter "V".

Current

The flow of electrons is called current. Its unit is ampere. When one volt is applied across a resistance of one ohm the amount of current passes through the resistance is said to be one "Ampere". It is denoted by "A". Smaller units are milli ampere and microampere. Ammeter should be connected in series with the load.

Resistance

It is the property of a substance which opposes the flow of electricity. Its unit is ohm. The resistance of a conductor, in which a current of one ampere flows when potential difference of one volt is applied across its terminals, is said to be one ohm.

An ohmmeter is used to measure the resistance of an electric circuit. It is denoted by "Ω" Bigger units are Kilo ohms and Mega ohms.

1 K $\Omega = 10^3$ ohms

1 Mega $\Omega = 10^6$ ohms

Ohmmeter should be connected in parallel with the load and should not be connected when there is a supply.

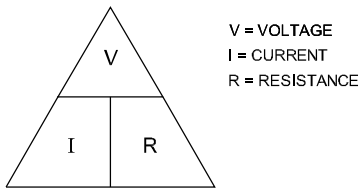
There is a definite relationship between the three electrical quantities of Voltage, Current and Resistance.

Ohm's Law states

`The current is directly proportional to the voltage and inversely proportional to the resistance' when the temperature remains constant.

An aid to remember the Ohm's law relationship is shown in the divided triangle.(Fig 1)

Fig 1



Written as a mathematical expression, Ohm's Law is -

$$\text{Current } (I) = \frac{\text{Voltage } (V)}{\text{Resistance } (R)}$$

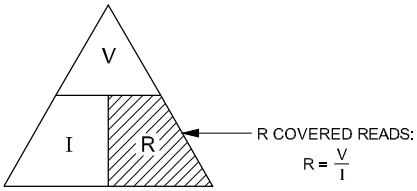
$$\text{or } I = \frac{V}{R}$$

Of course, the above equation can be rearranged as:

$$\text{Resistance } (R) = \frac{\text{Voltage } (V)}{\text{Current } (I)}$$

$$\text{or } R = \frac{V}{I}$$ (Refer Fig 2)

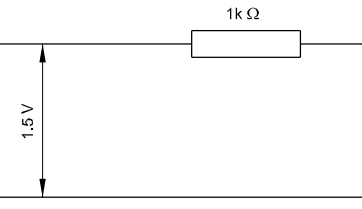
Fig 2



Example

How much current(I) flows in the circuit shown in (Fig 3)

Fig 3



Given:

Voltage(V) = 1.5 volts

Resistance(R) = 1 k ohm

= 1000 ohms.

Find:

Current(I)

Known:

$$I = \frac{V}{R}$$

Solution:

$$I = \frac{1.5\ V}{1000\ ohms} = 0.0015\ amp$$

Answer:

The current in the circuit is 0.0015 A

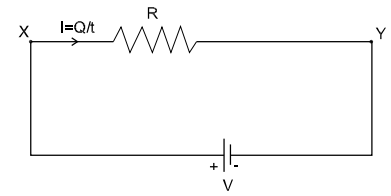
or

the current in the circuit is 1.5 mill ampere (mA).

(1000 milliamps = 1 ampere)

Electrical power (Fig 4)

Fig 4



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The rate which work is done in an electric circuit is called electrical power.

When voltage is applied to a circuit, it causes current to flow through it or in other words it causes electrons or charge through it, clearly certain amount of work is being done in moving these electrons in the circuit. This work done in moving the electrons in unit time is called as electrical power, From Fig 4.

V = P.D. across xy in colts,

I = Current in amps.

R = resistance between xy in

t = time in sec for which current flows.

The total charge flows in t secs is Q = I X T coulombs

As per earlier definition the P.d, $V = \frac{work}{charge} = \frac{work}{Q}$

$\therefore$ Work = VQ.

= VIt (Q = IT).

$\therefore$ Electrical power $P = \frac{Workdone}{time} = \frac{Vit}{t}$

W = VI joules/secs. (or) watts.

Wattmeter is used to measure the electrical power.

Electrical power in watts = Voltage in volts X current in ampere

The digger units of electric power are kilowatts (KW) and Megawatts (MW).

1 KW = 1000 watts(or) 10^3 watts

1 MW = 1000000 watts (or) 10^6 watts

Electrical Energy: (E)

The total work done in an Electric circuit is called as Electrical Energy.

Electrical Energy = Electrical power X time

= VI X t = VIT

i.e. Electrical power multiplied by the time for which the current flows in the circuit is known as Electrical energy. The meter used to measure electrical energy is energy meter. The symbol for electrical energy is E.

The unit of electrical energy will depend upon the units of electric power and time.

a If power is in watts and time is in seconds then the unit of Electrical energy will be watt-sec.

i.e. Electrical energy in watt - secs. = Power in watts Time In secs.

b If power is in watts and time is in hours then the unit of Electrical Energy will be watt-hours.

i.e. Electrical energy in watt - hours = power in watts time in hours

c If Power is in kilowatts (10 watts (or)1000 watts) and time is in hours then the unit of electrical energy will be kilowatt - hour (Kwh).

i.e. Electrical energy in kwh = power in kilowatt time in hours

In practice the electrical energy is measured in kilowatt-hours (KWh). The electricity bills are made on the basis of total electrical energy consumed by the consumer. 1KWh of electrical energy is called as Board of Trade (B.O.T.) Unit or simply 1 unit. i.e. 1KWh = 1Unit.

Thu when we say a consumer has consumed 75 units of electricity means the electrical energy consumed by the consumer is 75 KWh.

In and Electrical circuit if 100 watts (or) 1Kw of power is supplied for 1 hour then the electrical energy expended is one kilowatt-hour (1KWH) or 1 electrical unit (Or) 1 unit.

1Kwh = 1 Unit = power in watts time in secs

= Watts, secs (or) joules.

= 1000 60 60 joules

= 36 105 joules (or) watt-sec.

1 calorie = 4. 186 joules (or)

1 kilo calorie = 4186 joules.

1kwh = calories = 860009.557

= 860000 calories = 860 10^3 calories

= 860 kilo calories.

$\therefore$ 1 kwh = 860 Kcal.

Identification of AC and DC Meters

AC and DC meters can be identified as follows

1 By the symbol available on the dial / scale.

(a) Direct current

(b) Alternating current

2 By seeing the graduation on the dial / scale

a) If the graduation of dial is uniform throughout, it is a D C meter.

(b) If the graduation of dial is cramped at the beginning and at the end, it is an A.C. meter

3 By seeing the terminals

(a) In the d C meter the terminals are marked with + and– The positive (+) terminal is Red in colour and the negative (–) terminal is Black in colour.

(b) In the A.C. meter there is no marking on the terminals and no difference in colour.

(iii) current :

$I = V / R$

$= P / V$

$= \sqrt{P / R}$

(iv) Voltage :

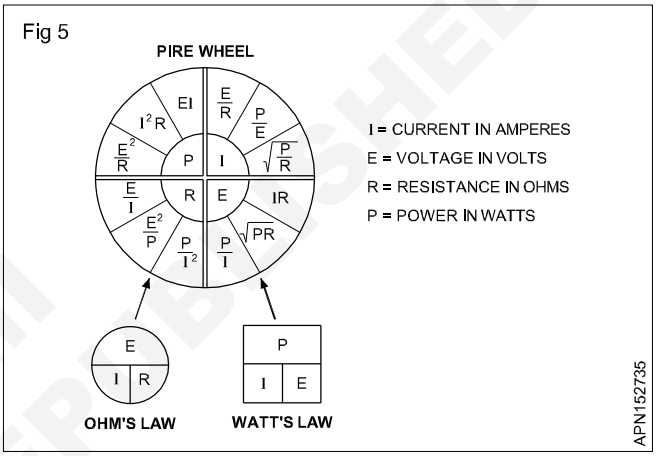
$V = I R$

$= P / I$

$= \sqrt{PR}$

The formulae (or equations) to solve for unknown voltage, current, resistance or power can be obtained by combining Ohm's law and Power law. This is shown in Fig 5.

Fig 5



Basic types of electrical meters

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

- **describe the connection of an ammeter in the circuit**
- **describe resistance symbols used in wiring diagram**
- **state the use and care of an ammeter**
- **describe the connection, use and care to be taken of a voltmeter**
- **describe the connection, use and are to be taken of an ohmmeter**
- **describe the maintenance of meters**
- **state the simple electric circuit, open electric circuit and short electric circuit**
- **state the series circuits & parallel circuits**

There are three basic types of meters used to test the electric circuit and accessories. The following meters are used in automobiles.

– Ammeter

– Voltmeter

– Ohmmeter

Ammeter (Fig 1): The ammeter (1) is fitted on the vehicle panel board/dashboard.

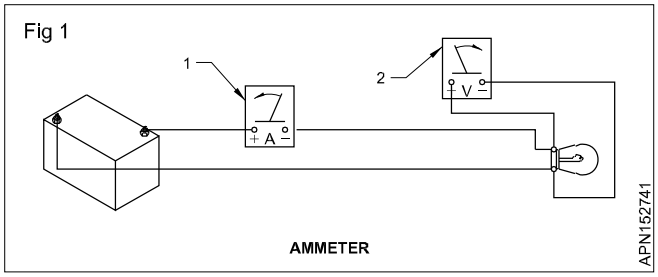
It is connected in series in the circuit as shown in the fig 1.

Uses of ammeter: An ammeter is used to measure the amount of current flowing in the circuit.

This is connected in series with the load.

It is used to indicate the rate at which the battery is being charged or discharged.

Fig 1



Care: Do not connect an ammeter in parallel in the circuit.

Take care of "+" and "-" mark on terminals.

Use DC meter for automobile charging system.

Select and use an ammeter as per the required range.

Voltmeter: A voltmeter (2) is used to measure electrical voltage. It is not fitted permanently on the vehicle but used separately whenever required. It is connected in parallel with the circuit. Use DC voltmeter for automobiles.

Uses of a voltmeter: To measure the voltage at any point of circuit.

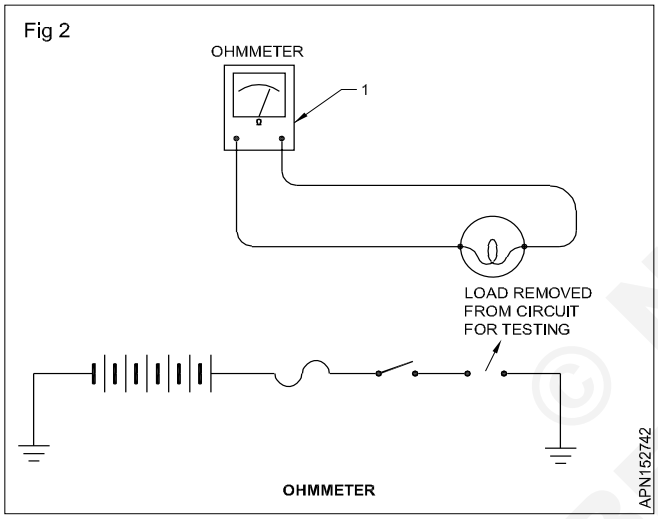
To measure the voltage drop in the circuit.

To check the condition of the battery.

Care: Select the voltmeter as per the required range.

Do not connect the voltmeter in series in the circuit.

Ohmmeter (Fig 2): An ohmmeter (1) is also known as resistance meter.



It is not fitted permanently on the vehicle but is used separately whenever required.

It has its own built-in power source. Hence the device/ circuit being checked with the ohmmeter should be disconnected from the power supply as shown in the figure, to prevent damage to the ohmmeter.

The unit of resistance is an ohm.

Uses of ohmmeter

An ohmmeter is used:

– To measure the resistance of any conductor

– To measure the resistance of any load

– To check the continuity of the field coils.

Care

Do not connect an ohmmeter to any part of a live circuit.

Do not connect an ohmmeter across the terminals of a battery.

Maintenance of meters

Handle the meters with care.

Keep the connections tight while the meters are in use.

Use the meters within specified loads.

After use, keep the meters in a separate place.

Electrical circuits

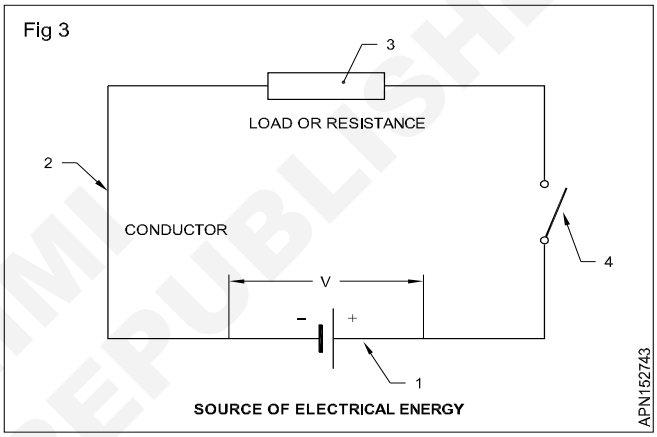
Simple electrical circuit (Fig 3): A simple electric circuit is a complete pathway of the current flow from the battery via the switch and load and back to the battery. An electric circuit consists of :

– A voltage source (1)

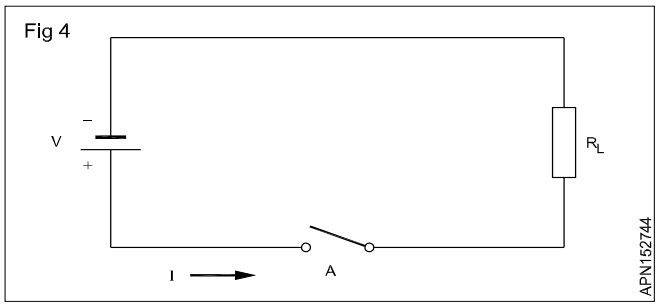
– Connecting wires (conductors) (2)

– A load (lamp or motor) (3)

– Switch (4).



Open circuit (Fig 4): In an open circuit, an infinite resistance is provided, most of the time by the open switch (A). Therefore no current can flow.

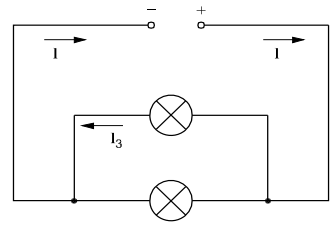


Short circuit : A short circuit will occur when two terminals of the same circuit touch each other. A short circuit may also occur if the insulation between the two cores of the cable are defective. This results in a lower resistance. This causes a large current to flow which can become a hazard.

Parallel circuit (Fig 5): In this circuit two or more loads are connected. Each load is provided with its own path to the source of supply.

Example: A pair of head lights is connected in parallel circuit. When wired in parallel the failure of one bulb will not effect the operation of the other bulb. Each load receives full system voltage.

Fig 5



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The formula to calculate resistance in a parallel circuit is:

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

where

I = Current

R = Resultant resistance

R_1, R_2, R_3 = Resistance of each load.

Series circuit : This circuit consists of only one load and one source of supply. It has one continuous path for the flow of current. Hence the current flows through all the load in a sequence in circuit. If any of the parts fails the circuit breaks and the current stops flowing.

$$\text{Resistance (R)} = \frac{\text{Voltage (V)}}{\text{Current (I)}}$$

$$\text{Current (I)} = \frac{\text{Voltage (V)}}{\text{Resistance (R)}}$$

Voltage = Current (I) x Resistance (R)

Types of resistance: Based on the ohmic value of resistance it is grouped as low, medium and high resistance.

Low resistance

Range : 1 Ohm and below.

Uses : Armature winding, ammeter.

Medium resistance

Range : Above 1 Ohm up to 1,00,000 Ohm.

Uses : Bulbs, heaters, relay starters.

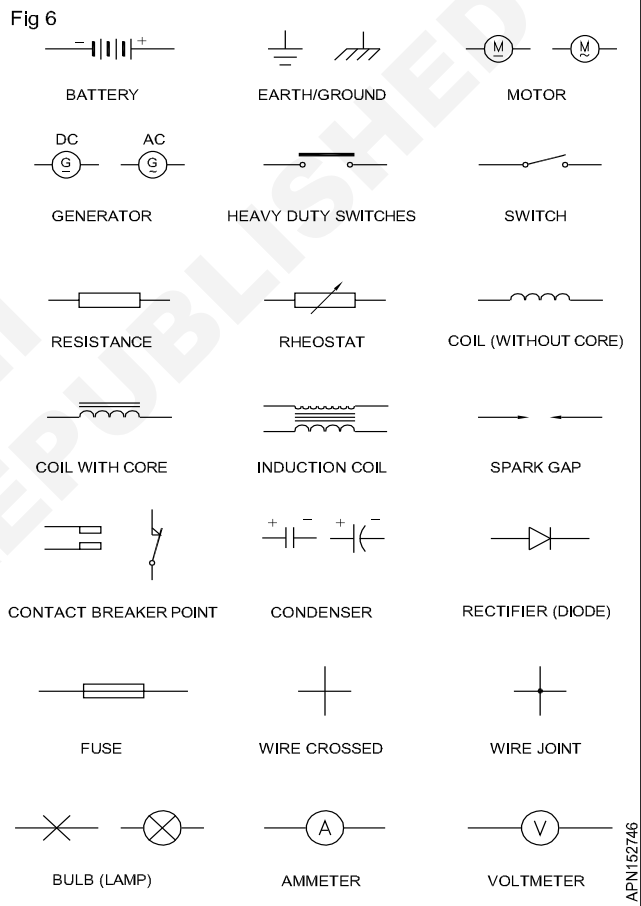
High resistance

Range : Above 1,00,000 Ohm (100 k.Ohms).

Use : Lamps.

Electrical symbols used in a wiring diagram (Fig 6): Automotive circuits are generally shown by wiring diagrams. The parts in those diagrams are represented by symbols. Symbols are codes or signs that have been adopted by various automobile manufacturers as a convention.

Fig 6



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Multimeter

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

- **state the function of multimeter controls**
- **explain about the dial (scale) of the multimeter**
- **explain about zero adjustment during ohmmeter function**
- **state the function of digital multimeter**
- **state the application of the multimeter**
- **state the precautions to be followed while using a multimeter.**

A multimeter is an instrument in which the functions of an ammeter, voltmeter and ohmmeter are incorporated for measurement of current, voltage and resistance respectively. Some manufacturers call this a VOM meter as this meter is used as volt, ohm and milli ammeter, Multimeters use the basic d' Arsonval (PMMC) movement for all these measurements. This meter has facilities through various switches to change the internal circuit to convert the meter as voltmeter, ammeter or ohmmeter.

There are two major types of multimeters

1 Ordinary multimeters having passive components.

2 Electronic multimeters having active and passive components. An electronic multimeter may be of the analog type or digital type.

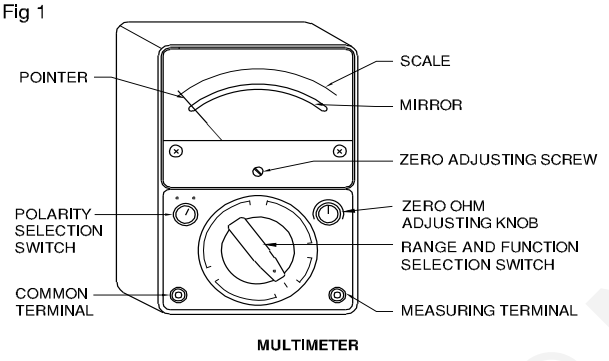
Most of the ordinary multimeters will have a sensitivity of 20k ohms per volt in the voltmeter mode whereas electronic multimeters have internal resistances to the tune of 5 to 10 megohms, irrespective of the selected voltage range.

There are several types of multimeters available in the market, manufactured by various manufactures. Each model differs from the others by the extra facilities available. It is a versatile tool for all automobile. With proper usage and care, it could give service for many years.

Rectifiers are provided inside the meter to convert AC to DC in the AC measurement circuit.

Parts of a multimeter : A standard multimeter consists of these main parts and controls as shown in (Fig 1).

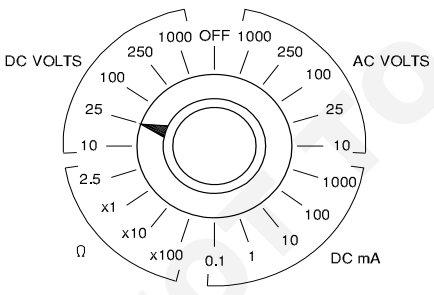
Fig 1



MULTIMETER

Controls: The meter is set to the required current, voltage or resistance range - by means of the range selector switch. in (Fig 2), the switch is set to DC, 25 volts.

Fig 2



FUNCTION AND RANGE SWITCH

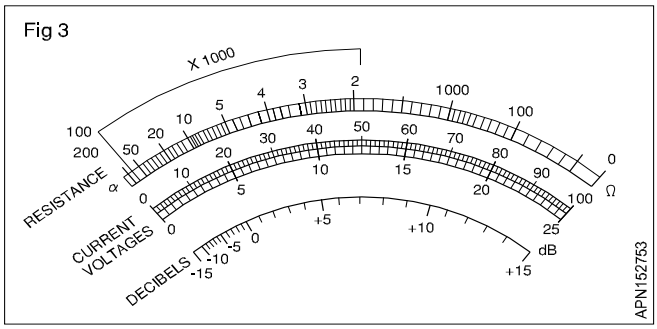
Scale of multimeter: Separate scales are provided for :

- Resistance
- Voltage and current.

The scale of current and voltage as uniformly graduated (Fig 3)

The scale for resistance measurement is non-linear. That is, the divisions between zero and infinity (α) are not equally spaced. As you move from zero to the left across the scale, the division become closer together.

Fig 3



The scale is usually 'backward', with zero at the right.

Zero adjustment: When the selector switch is in the resistance range and the leads are open, the pointer is at left side of scale, indicating infinite (α) resistance (open circuit). When the leads are shorted, the pointer is at right side of the scale, indicating zero resistance.

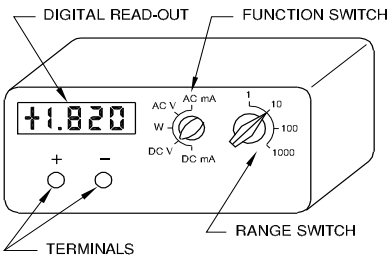
The purpose of the zero ohm adjusting knob is to vary the variable resistor and adjust the current so that the pointer is at exactly aero when the leads are shorted. It is used to compensate for changes in the internal battery voltage due to aging.

Multiple range: Shunt (parallel) resistors are used to provide multiple ranges so that the meter can measure resistance values from very small to very large values. For each range, a different value of shunt resistance is switched on. The shunt resistance increases for the higher ohm ranges and is always equal to the centre scale reading on any range. These range settings are interpreted differently from those of the ammeter or voltmeter. The reading on the ohmmeter scale is multiplied by the factor indicated by the range setting.

Remember, when a multimeter is set for the ohmmeter function, the multimeter must not be connected to the circuit with the circuit's power is on.

Digital multimeter (DMM): In a digital multimeter the meter movements is replaced by a digital read - out. (Fig 4) this read-out is similar to that used in electronic calculators. The internal circuitry of the digital multimeter is made up of digital integrated circuits. Like the analog-type multimeter, the digital multimeter has also a front panel switching arrangement. The quantity measured is displayed in the form of a four digit number with a properly placed decimal point. When d quantities are measured, the polarity is identified be means of a + or - sign displayed to the left of the number.

Fig 4



DIGITAL MULTIMETER

Tracing of auto electrical components in a circuit

Objectives: At the end of this lesson you shall be able to
- **describe automobile cables**
- **state the colour coding in wiring**
- **state the purpose of colour coding.**

Description of automobile cables

The cable consists of multi - strand copper conductor covered with good quality PVC insulation.

The current to the various electrical accessories is carried through cables.

The various cables used in wiring are :

- Starting system cable
- General purpose cable
- High tension cable

The specification of the cable refers to the number of stands and diameter of each strand. Eg. 25/012 indicates, the cable consists of 25 strands of 0.012” gauge diameter of each strand.

Recent trends and developments

Objectives: At the end of this lesson you shall be able to
- **state the history of auto industry**
- **state the leading manufacturers**
- **state the automobile industry, new product.**

Auto industry - History, leading manufacturing: In 1887 first car rolled out in the streets of Calcutta the next year there were four cars in the street of Bombay.

1940 Indian company like Hindustan motors and premier started to manufacture car of other firm, the same decade started Mahindra and Mahindra also started utility vehicle.

1980 Hindustan Motors ambassador and premier were challenged by a new entrant, maruti udyog limited.

The alliance between maruti and Suzuki was first joint venture between an Indian company.

2000-2010, almost every major car company establishing manufacturing facilities across different parts of the country.

Chennai, Mumbai, Pune, North NCR are majority of Indian car industry

Top and major manufactures in Automobile industry

- Maruti udyog
- General motors' India
- Ford India
- Eicher motors
- Bajaj Auto
- Daewoo motors India
- Hero motors
- Hindustan motors
- Hyundai Motor India.
- Royal Enfield motors
- Telco
- Swaraj mazda
- BMW

The pioneer Mr. J.R.D. Tata's role in setting up the Tata group (ERC).

In India maruti 800, Car launched by SMT, Indira Gandhi - In 1983.

India in the largest three wheeler and two wheeler market in the world and second largest tractor manufacture in the world , fifth largest commercial vehicle manufacture in the world and second largest producer of motorcycle in the world after china.

In India some Industries are manufacturing the vehicle spare parts and exporting them to other countries.

Example: TATA, Hindustan Motor and ashok leyland etc.

In India some vehicle parts are importing and assembling in the plants

Example: Ford, Hyundai, Audi etc.

Development in automobile industry: Due to the recent developments in electronics and computers lots of changes have come in the automobile also a mini computer named (ECM) electronic control module takes the control of Engine control, transmission control, Brake and steering system controls, Safety controls, and suspension control system.

More number of sensors and transducers are employed in all systems to send information to their corresponding electronic control units to achieve precise control on all activities.

Due to this precise controls we could achieve,

Fuel efficient engines, clean emission engine, Easy steering, and anti locking brakes, keyless entry, Navigation and smart dash board etc.

Gasoline Direct Injection (GDI): Fuel is injected directly into the cylinders, not mixed with air in the inlet manifold or inlet ports before being drawn into the cylinders. The advantages of direct injection are that the fuel can be placed in the combustion space in a more controlled manner than the conventional inlet injection system.

Hybrid vehicles: Hybrid vehicle that combines a conventional internal combustion engine with an electric propulsion system (hybrid vehicle drive train). The presence of the electric power train is intended to achieve either better fuel economy than a conventional vehicle or better performance.

Electric vehicle (EV): India has plans to make a major shift to electric vehicles by 2030.E-commerce companies, Indian car manufactures like Rava Electric Car Company (RECC), and Indian app-based transportation network companies like Ola are working on making electric cars in the near future.

The electric cars available in India are:

Mahindra e2oplus

Mahindra e-Verito.

Tata Tigor Electric

Mahindra e-KUV 100

Tata Tiago Electric.

Fuel cells: The fuel cell as used in space-craft, reverses this reaction combining hydrogen and Oxygen to release electrical energy with pure water as a byproduct.

The attraction of using in an internal combustion engine, is that the fuel cell is very efficient indeed, achieving 45 to 60% efficiency versus petrol engine 15 to 35%.

A danger involved in fuel cell is the hydrogen is an explosive gas that is difficult to store and handle.

Lean burn engines: This engine are designed for Lean-burning, They have higher compression ratios and thus provide better performance, efficient fuel usage and low exhaust hydrocarbon emissions compare with the conventional gasoline engines. Lean mixtures with very high air-fuel ratios can only be achieved by direct injection engines.

Driverless Cars: This is a vehicle that is capable of sensing its environment and navigating without human input.

Driverless cars combine a variety of techniques to perceive their surroundings, including radar, laser light, GPS and computer vision. Advanced control systems interpret sensory information to identify appropriate navigation paths, as well as obstacles and relevant signage.

The potential benefits of driverless cars include reduced mobility costs and infrastructure costs, increased safety, increased mobility, increased customer satisfaction, and reduced crime. And also potentially significant reduction in traffic collisions, resulting injuries and related costs, including less need for insurance.

Waymo is a self-driving technology development company and it is a subsidized by Google.

Alternate fuel: Bio fuels are also considered a renewable source. Although renewable energy is used mostly to generate electricity, it is often assumed that some form of renewable energy of a percentage is used to create alternative fuels. Research is going on the search of more suitable bio fuel crops and improving the oil yields of these crops, Using the current yields, Vast amount of land and fresh water in needed to produce enough oil to completely replace fossil fuel usage. Alternative fuels, known as non -conventional and advanced fuels, any materials or substances that can be used as fuels, other than conventional feels like; fossil fuels (Petroleum (oil), coal, and natural gas.

Some well-known alternative fuels includes biodiesel, bio alcohol (Methanol, ethanol), vegetable oil, propane and other biomass sources.

Classification of vehicles

Objective: At the end of this lesson you shall be able to
- **classify the vehicles.**

Classification of vehicles

Based on central motor vehicle act

- Motor cycle
- Invalid carriage
- Three wheelers
- Light motor vehicle
- Medium passenger motor vehicle
- Medium goods vehicle
- Heavy passenger motor vehicle
- Heavy goods vehicle
- Any other motor vehicle of a specified description

Based on wheel

Two wheeler

Three wheelers

Four wheelers

Six wheelers

Multi axles

Based on fuel used

Petrol vehicle

Diesel vehicle

Gas vehicle (CNG & LPG)

Electric vehicle

Based on body

Saloon (BMW,AUDI)

Sedan (Maruti Ciaz, Ambassador etc)

Hatch back (Alto, i10, Santro, Tata Tiago)

Convertible (Jeep, Maruti gypsy)

Station wagon (Innova, Ertiga, etc)

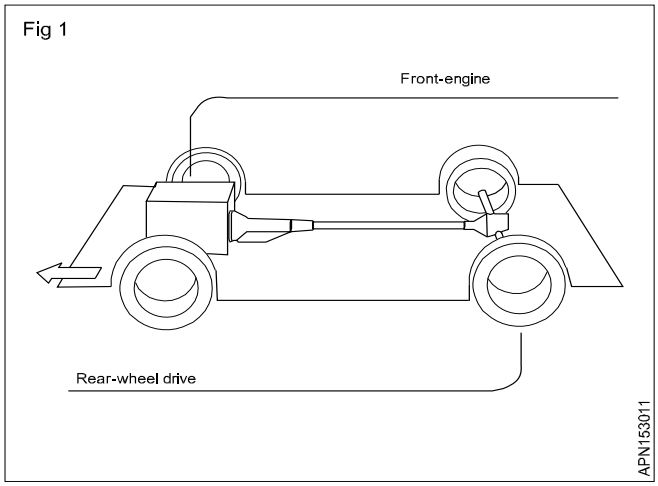
Van (Omni, Touristor)

Special purpose (Ambulance, Milk van, etc)

Based on drive

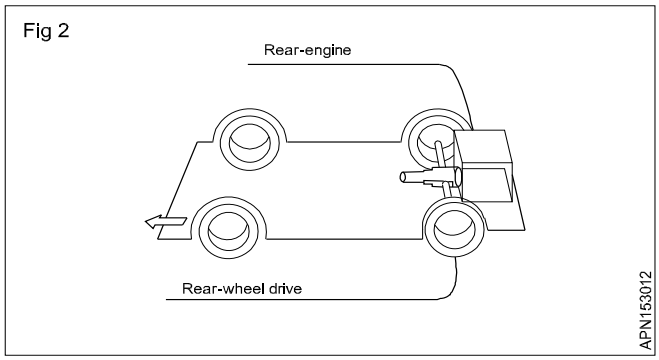
Front engine rear wheel drive (Sumo, Omni, Ambassador, etc) (Fig 1)

Fig 1



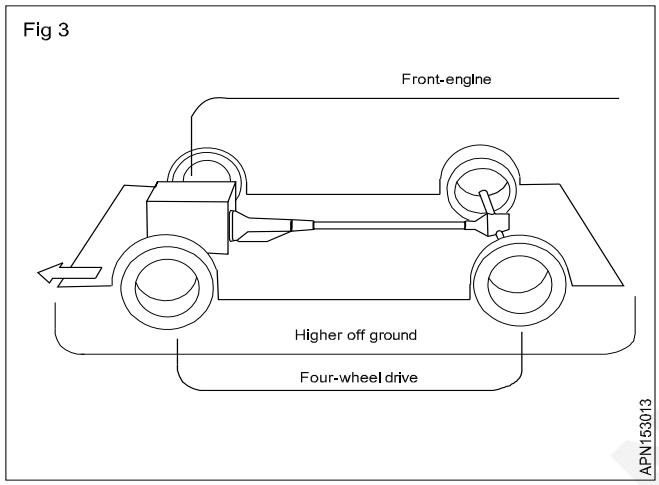
Rear engine rear wheel drive (Tata Nano, Bajaj auto, Valvo bus etc) (Fig 2)

Fig 2



Four wheel/ All wheel drive (jeep, Scorpio, Gypsy etc) (Fig 3)

Fig 3



Front engine front wheel drive (Alto, Ertiga, santro, Tiago etc) (Fig 4)

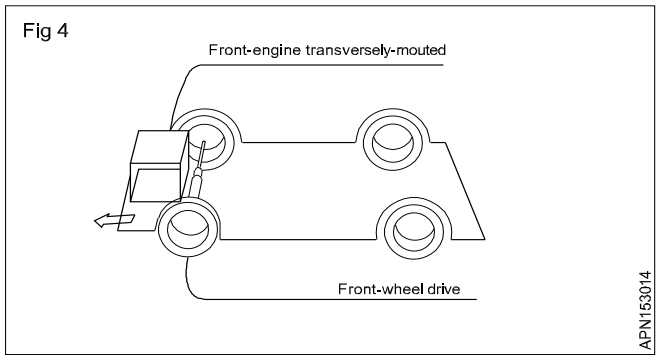
Based on position of engine

Front transverse engine (Example ; Maruti 800)

Front longitudinal engine (Example ; Maruti Omni)

Rear Transverse engine (Example ; Volvo bus)

Fig 4



Based on steering

Conventional manual steering

Power steering hydraulic

Power steering electric

Based on transmission

Manual transmission

Automatic transmission

This is transmission that uses a torque converter, planetary gears set and clutches or bands to shift a vehicle's forward gears automatically.

Automated manual transmission (AMT)

This is an automated manual transmission it employs a mechanical clutch, but the action of the clutch is not controlled by the driver's clutch pedal. Gears shifts done by using automated electronic, pneumatic or hydraulic controls.

Continuously Variable Transmission (CVT)

This transmission has a continuously variable drive ratio and uses belts, pulleys and sensors rather than gears to maintain a steady acceleration curve with no pauses for gear changes. Because of this, a CVT can keep the engine in its optimum power range, thereby increasing efficiency and gas mileage.

Ministry of road transport & high ways

Objectives: At the end of this lesson you shall be able to
- **state the function of ministry of road transport & highways**
- **state the function of NATRIP**
- **state the function of ARAI**

Ministry of road Transport & Highways: This is an apex organization under the central Government, is entrusted with the task of formulating and administering, in consultation with other central Ministries/Departments, State Governments/ UT Administrations, organisations and individuals, policies for Road transport, National highways and transport research with a view to increasing the mobility and efficiency of the road transport system in the country. The ministry has two wings: Roads wing and Transport wing.

Roads wing

Deals with development and maintenance of National Highway in the country

Main Responsibilities

- Planning development and maintenance of national Highways in the country
- Extends technical and financial support to state Governments for the development of state roads and the roads of inter-state connectivity and economic importance.
- Evolves standard specifications for roads and bridges in the country.
- Serves as a repository of technical knowledge on roads and bridges.

Transport wing

It deals with road transport relating matters

Main Responsibilities of transport wing

- Motor vehicle legislation
- Administration of the Motor Vehicles Act, 1988
- Taxation of motor vehicles.
- Compulsory insurance of motor vehicles.
- Administration of the Road transport corporations Act, 1950.
- And promotion of transport co-operatives in the field of motor transport
- Evolves road safety standards in the form of a national policy on road safety and by preparing and implementing the Annual road safety plan.
- Collects, compiles and analyses road accident statistics and takes steps for developing a road safety culture in the country by involving the members of public and organizing various awareness campaigns.
- Provides grants-in-aid to non-governmental Organisations in accordance with the laid down guidelines.

National automotive testing and R&D infrastructure project (NATRIP): The largest and one of the most significant initiatives in Automotive sector so far, represents a unique joining of hands between the Government of India, a number of state Governments and Indian Automotive industry to create a state of the art testing, Validation and R&D infrastructure in the country.

The project aims at creating core global competencies in Automotive sector in India and facilitate seamless integration of Indian Automotive industry with the world as also to position the country prominently on the global automotive map.

Create state- of - art research and testing infrastructure to drive India into the future of global automotive excellence.

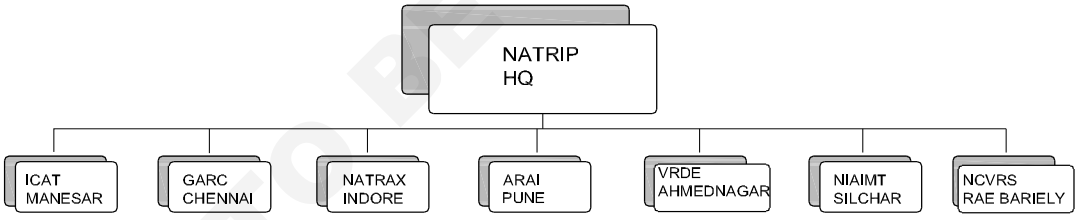
(NATRIP) aims at setting up of seven-of-the-art automotive testing and R&D centers across the country and thereby (Fig 1)

- Creating core global competencies.
- Enhancing competitive skills for product development leading to deepening of manufacturing.
- Synergizing Indias unique capabilities in information technology with the automotive sector.
- Facilitating seamless integration of Indian automotive industry with the world to put India strongly on the global automotive map.

Automotive Research Association of India (ARAI) The Automotive Research Association of India (ARAI) has been Playing a crucial role in assuring safe, less polluting and more efficient Vehicles. ARAI provides technical Expertise in R & D, testing, certification, homologation and framing of vehicle regulations.

ARAI is research association of the Automotive Industry with Ministry of Heavy Industries and Public Enterprises, Government of India, It works in harmony and complete confidence with it members, customers and the Government of India to offer the finest services, which earned for itself ISO 9001,ISO 14001, OHSAS 18001 and NABL accreditations.

Fig 1



ARAI has a strong base of state-of-the-art technology equipments, laboratory facilities and highly qualified and experienced personnel. With these assets, ARAI has goals, strategies and action plans to achieve customer satisfaction. These are as follows.

To compete in service with excellence

To cover global market

To obtain recognition and accreditation

To build commitment of all personnel

To develop team sprit and sense of belonging amongst all.

Automotive research association of India: ARAI has been providing various services to the Indian Automotive Industry in the areas of design & development and know-how for manufacture & testing of components/system to national /international standards. ARAI shall strive to achieve international recognition in these areas.

ARAI shall seek the valuable guidance and support from association members, from time to time to achieve growth and stability.

With the globalization of economy and business, ARAI shall enlarge its scope of services to meet the requirements of automotive industries anywhere in the world.

ARAI strongly believes that satisfaction of the customer needs on continuing basis is of prime importance to earn the loyalty of the customers. Therefore, emphasis shall be on meeting and exceeding the customer needs through continuing quality improvement with active participation of employees and also the customer.

Uses of hoists, jacks and stands

Objectives: At the end of this lesson you shall be able to
- **state the function of vehicle hoists**
- **state the function of engine hoists**
- **sate the function of jacks**
- **state the function of axle stand stand.**

The modern automobile service stations are used the various types of equipments to lift the vehicles. They are as follows.

Single post hydraulic car hoist

Two post car hoist

Four post car hoist

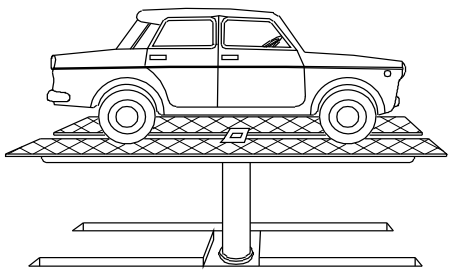
Engine hoist

Jacks

Stands

Single post hydraulic car hoist (Fig1) : It is facilitate the servicing and reaper works conveniently. It is constructed for dependable, trouble free performance and ensuring smooth and safe operation. The post is made of high grade steel. The car hoists are specially designed for resistant to wear and damage during water wash. Single post type is suitable for vehicle up to 6 tones.

Fig 1



HYDRAULIC CAR HOIST

APN153031

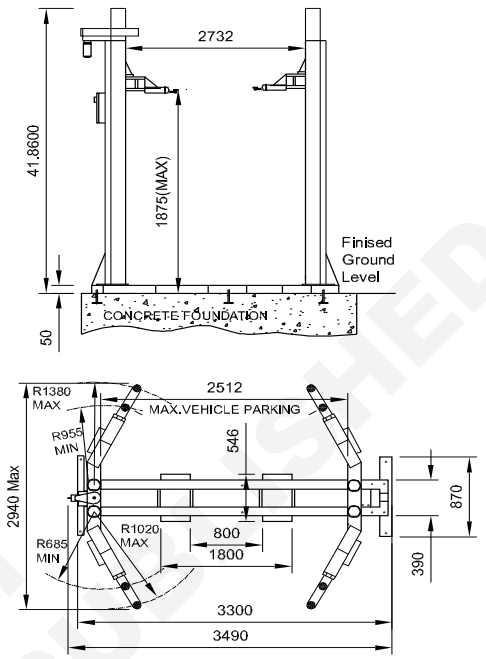
Two post hoist (Fig 2): It is operated by electro -hydraulic system. it is easy to operate and maintain the double post hoist and safety provision also provided to hold the vehicle. Double post type suitable for vehicle upto 4 tones.

Four post car hoist (Fig 3): It is operate by electro hydraulically and balancing the lifting vehicle. It is easy to operate and maintain the moving parts. Four post hoists is work as single and double post hoist it is suitable for lift the vehicle light and heavy vehicle.

Engine hoist (Fig 4): The engine hoist helps to lift an engine from a car/truck. The hydraulic pressure converts power to a mechanical advantage and lifts the engine from the car with less effort. When using a block and tackles for lifting an engine, use a lifting plate attached to the intake manifold or use a chain bolted at each end of the block.

Jacks: Jacks are operated by moving the handle up and down. The other type of portable floor jack is the pneumatic jack which uses compressed air to lift a car or truck. It is mostly used in production side.

Fig 2



TWO POST HOIST

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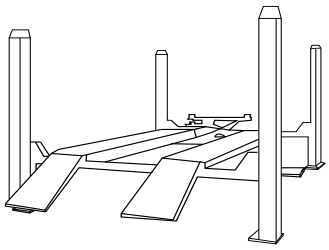
Fig 3



FOUR POST HOIST

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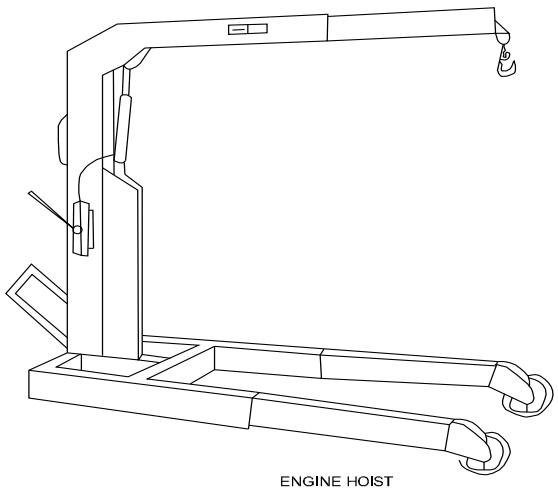
Fig 4



ENGINE HOIST

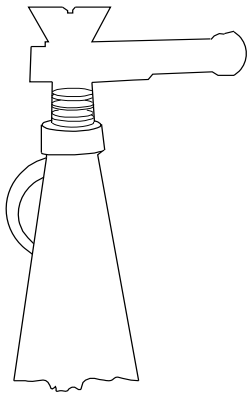
APN153034

Never work under a car without safety stands or jack stands: On roads mostly mechanical jacks are used to lift the car/vehicle for small jobs. These jacks work under the principle of screw and nut. Jacks are operated by mechanically and hydraulically, Jack is designed to lift the vehicle and hold the vehicle load during the repair works. Jack is a standard accessory with many vehicles.

Types of jacks

- Light weight screw jack (Fig 5)
- Heavy duty bottle type hydraulic jack (Fig 6)
- Trolley types hydraulic jack (Fig 7)

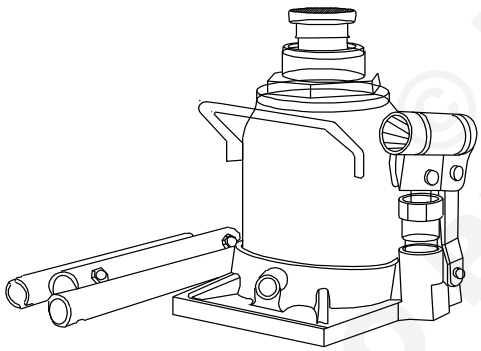
Fig 5



MANUAL TYPE LIFITING JACK

APN153035

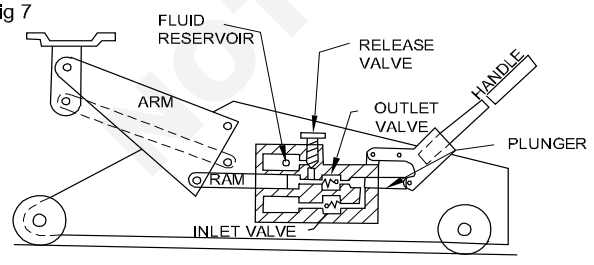
Fig 6



HEAVY DUTY BOTTEL TYPE LIFITING JACK

APN153036

Fig 7



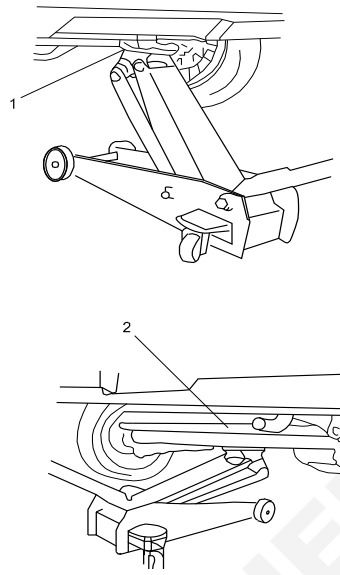
TROLLEY TYPE JACK

APN153037

n raising front vehicle end off the floor by jacking , be sure to apply jack against front jacking bracket(1) (Fig 8).

In raising rear vehicle end off the floor by jacking, be sure to apply jack against the center portion of rear axle (2) .

Fig 8



FLOOR JACK

APN153038

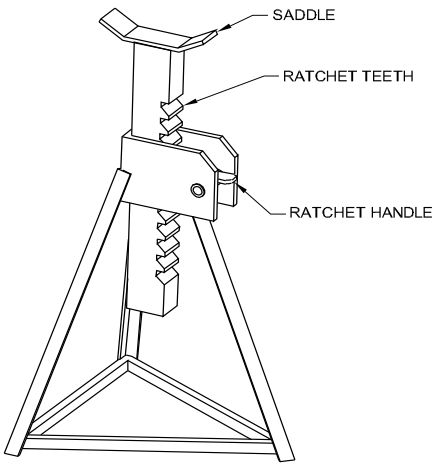
Caution: Never apply jack against suspension parts (i.e., stabilizer, etc.) front bumper or vehicle floor, Otherwise it may get deformed.

Warning: If the vehicle to be jacked up only at the front or rear end, be sure to block the wheels on ground in order to ensure safety.

After the vehicle is jacked up , be sure to support it on stands. It is extremely dangerous to do any work on the vehicle raised on jack alone.

Axle stand (Fig 9): It is always injure the safety before starting the work under the lifted vehicle, Jack report is not enough, it could be dangerous. Always use axle stands for safety work. Different size of stands are used depend upon the vehicle load.

Fig 9



TYPICAL ADJUSTABLE JACK STAND

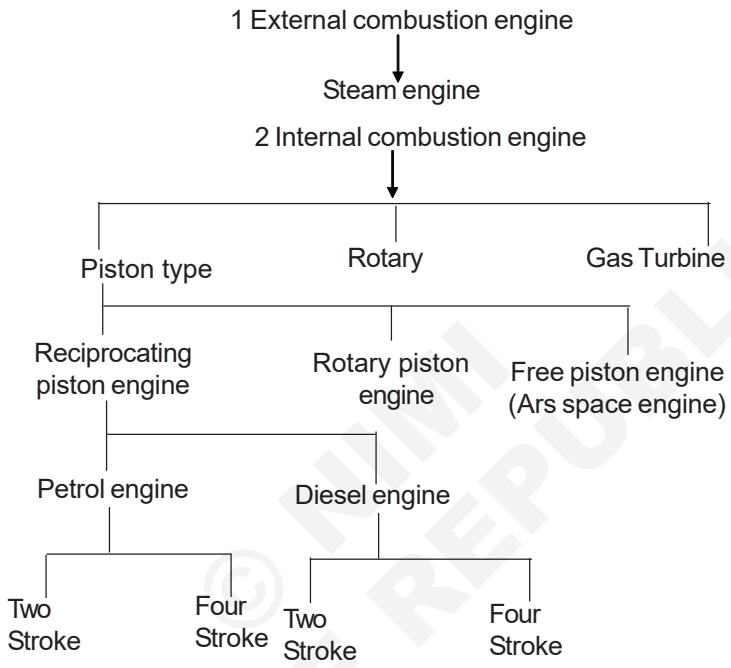
APN153039

To perform service with either front or rear vehicle end jacked up, be sure to place safety stands (1) under body so that body is securely supported. And the check to ensure that body does not slide on safety stands and the vehicle is held stable for safety's sake.

Internal and external combustion engine

Objectives: At the end of this lesson you shall be able to
- **type of heat engine**
- **state the internal and external combustion engine**
- **difference between an internal and external combustion engine.**

Types of heat engines



Internal combustion engine

Internal combustion engines are those heat engine, that burns their fuel and takes combustion inside the cylinder, this definition including the two stroke and four stroke engine, spark ignition and compression ignition engine, Austin and jet engines are also internal combustion engine. Ex: Wankle.

External combustion engine

The external combustion engines are those heat engine that burn their fuel outside the engine cylinder. The energy developed during the combustion of fuel is transmitted to steam. This steam acts on the piston inside cylinder example - railway steam engine.

Classification of I.C engines

Objective: At the end of this lesson you shall be able to
- **state the classification of engines.**

Engines are classified according to the following factors.

Number of cylinders

Single cylinder

Multi cylinder

Arrangements of cylinders

In-line engine (Fig 1)

`V' shape engine (Fig 2)

Opposed engine (Fig 3)

Fig 1

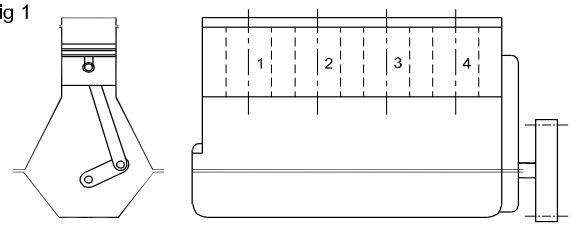


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Fig 2

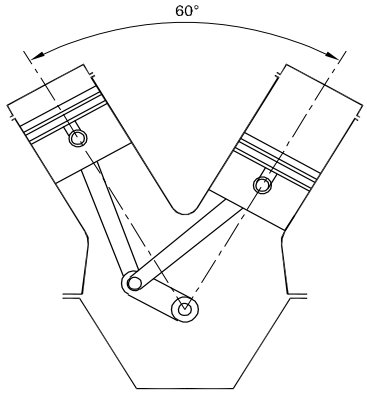

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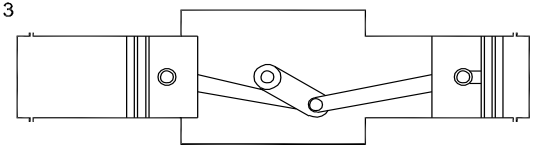
Fig 3



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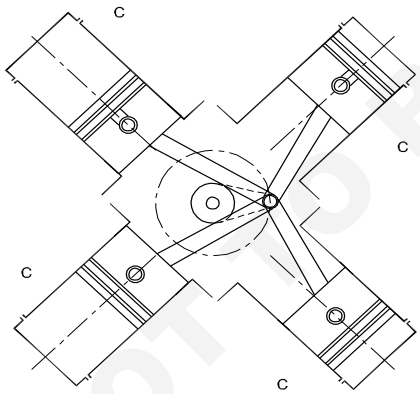
Horizontal engine

Radial engine (Fig 4)

Vertical engine

Fig 4



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Types of engines as per cylinder arrangement

In-line engines: In this type, the cylinders are arranged in one line. The length of the crankshaft is longer than that of the other types of engines, and hence a limited number of cylinders are used. Better balancing and more uniform torque is obtained in this type.

'V' shape engines: In this type, the cylinders are arranged in V shape at an angle, of usually 60°. This engine is more economical and compact. For multi-cylinder engines, the length of the crankshaft is much shorter than that of the in-line engine. In this type, the engine height is also lower than it is in the in-line engine.

Opposed engines

In this type the cylinders are arranged horizontally opposite to each other. This provides better mechanical balance. This type of engine can run smoothly even at a much higher speed. It also gives higher output. The length of the engine is too much, and therefore engine has to be placed in the transverse direction in the vehicle.

Radial engines

In this type, the cylinders are arranged radially. This type of engine is shorter, lighter and more rigid. Since it is rigid, a higher engine speed is possible and a higher combustion pressure can be obtained. This leads to high fuel efficiency. The radial type engines are used mostly in aeroplanes.

Types of engine as per number of cylinders

Single cylinder engines

An engine which has only one cylinder is called a single cylinder engine. Since it is a single cylinder engine it cannot develop more power. It is normally used only in two wheelers like scooters and motor cycles.

Multi cylinder engines

These engines have more than one cylinder. Two-cylinder engines are usually used in tractors. Three or four cylinder engines are used in cars, jeeps and other vehicles. In heavy vehicles six-cylinder engines are used. A greater number of cylinders gives smoother engine operation.

Types of fuel used

Petrol

Diesel

Gas

Types of valve arrangements

`I' head engine

`F' head engine

`L' head engine

`H' head engine

`T' head engine

Application of engine

Constant speed engine

Variable speed engine

Engine Cooling system

Air cooled engine

Water cooled engine

Strokes of engine

Four-stroke engine

Two-stroke engine

Working diesel engine

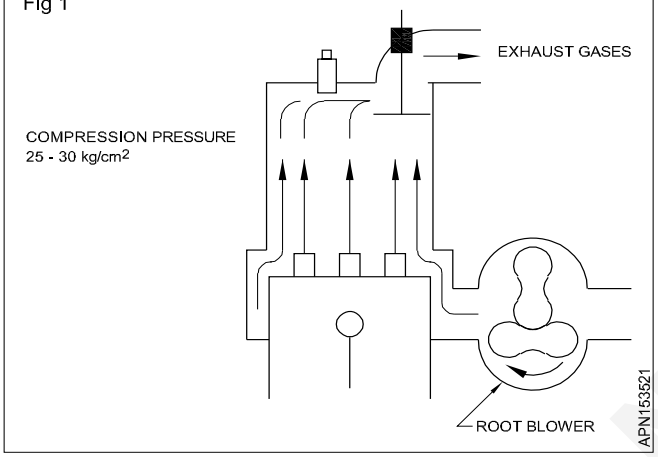
Objectives: At the end of this lesson you shall be able to
- **describe the function of a two-stroke diesel engine**
- **describe the function of a four-stroke diesel engine.**

Two stroke diesel engine

To produce power in a two stroke engine the following operation take place in the sequence given.

First stroke: Piston at BDC to TDC, the scavenging port and outlet valve open (Fig 1). A root blower sucks in pure air and presses it through the scavenging port into the cylinder. The tangential layout of the scavenging port brings the air into a turbulent motion. The cylinder is completely flushed out in the direct current and filled with fresh air. The exhaust gases flow out towards the outlet valve.

Fig 1



As the piston moves up from BDC to TDC the scavenging port and outlet valve closed. The piston compresses the fresh air to the compression chamber. The air temperature increases intensively.

Second stroke: Piston at TDC (Fig 2) scavenging port and outlet valve closed. The fuel is directly injected into the cylinder with the help of a fuel injection pump and an injector fitted in the cylinder head. The fuel gets vaporised into an ignitable fuel air mixture by the hot air. After attaining the ignition temperature the mixture gets automatically ignited and burns. The heat increases the pressure in the combustion chamber. The gases get expanded and push the piston towards the bottom dead centre.

Four-stroke engine: To produce power in a four-stroke engine the following operations take place in the sequence given.

Suction stroke: The piston moves from TDC to BDC (Fig 3). A vacuum is created inside the cylinder. The inlet valve opens while the exhaust valve remains closed. The charge air enters into the cylinder.

Compression stroke (Fig 4)

The inlet and exhaust valves are closed. The piston moves from BDC to TDC (Fig 4). The charged air is compressed in the cylinder. The compressed air pressure and temperature is increased upto 800°C.

Fig 2

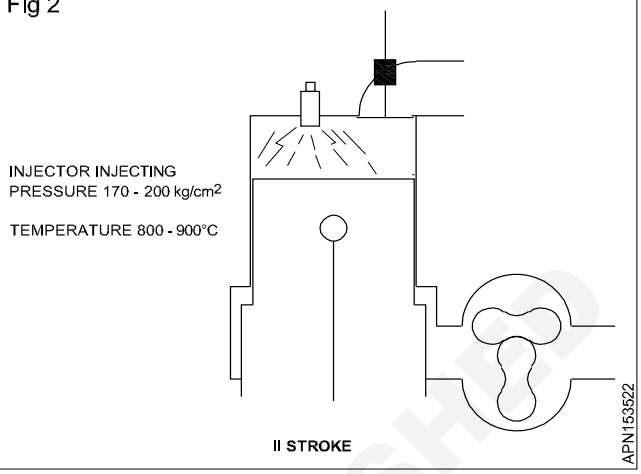
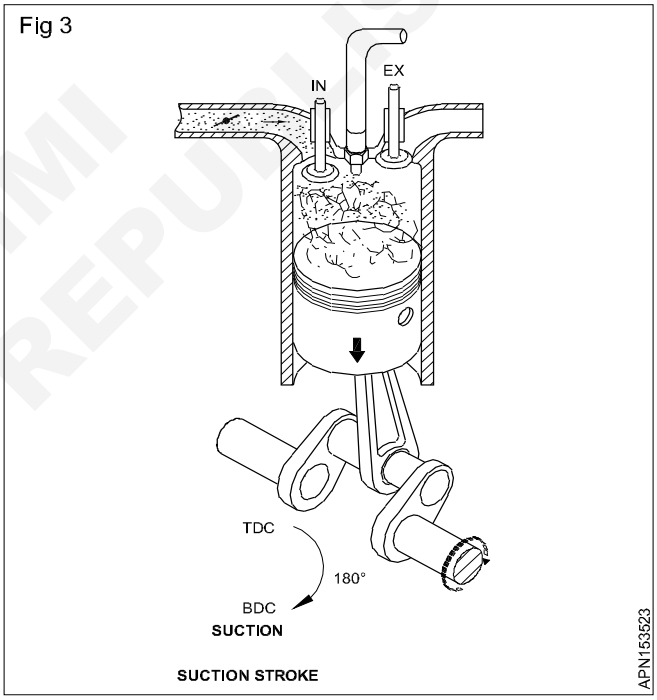


Fig 3



Power stroke

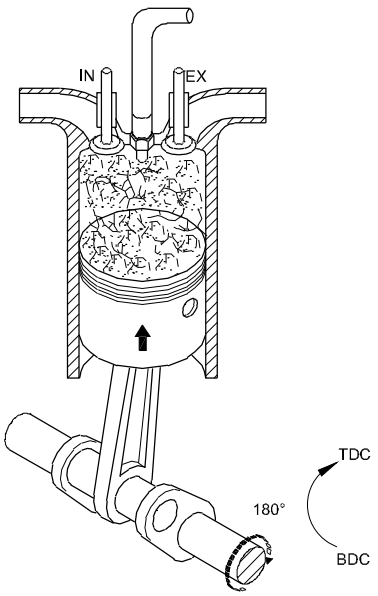
At the end of the compression stroke diesel fuel is injected into the hot compressed air in the combustion chamber; result burning of diesel with an explosion the gas expand and pressure develops inside the cylinder. The piston moves from TDC to BDC (Fig 5). Both the valves remain closed. Power is supplied to the fly wheel.

Exhaust stroke

The inlet valve remains in closed position. The exhaust valve opens, the piston moves from BDC to TDC (Fig 6) due to the energy stored in the flywheel. The burnt gases inside the cylinder go out through the exhaust valves.

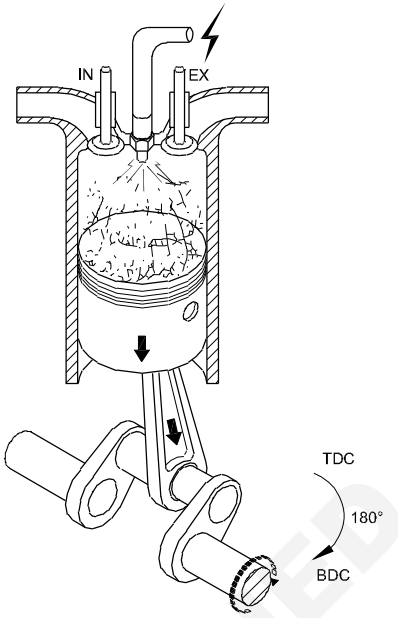
The cycle of suction, compression power and exhaust are repeated. In this type of engines one power stroke is obtained in two revolutions of the crankshaft.

Fig 4



COMPRESSION STROKE

Fig 5



POWER STROKE

Working of spark ignition engine

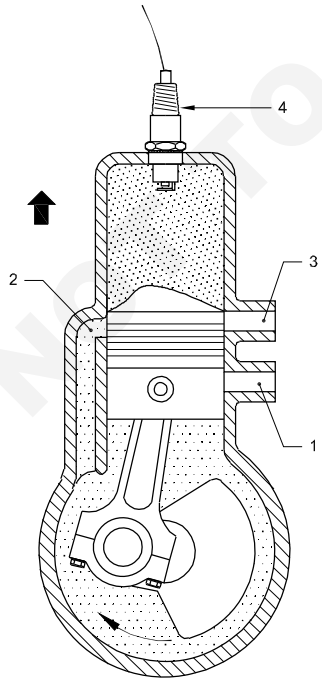
Objectives: At the end of this lesson you shall be able to
- **describe the function of a two-stroke engine**
- **describe the function of a four-stroke engine**
- **differentiate between a four-stroke and a two-stroke engine**
- **explain an OTTO cycle**
- **explain a diesel cycle.**

Two-Stroke spark ignition engine

To produce power in two stroke engine the following operations take place in the sequence given below.

First stroke (Suction and compression) (Fig 1)

Fig 1



FIRST STROKE

As the piston moves up from BDC,(Fig 1) it closes the inlet port (1), the exhaust port (3) and the transfer port (2). Further upward movement of the piston results in compressing the mixture in the cylinder and opening of the inlet port (1). The upward motion of the piston creates a partial vacuum inside the crank-case below the piston, and the air/fuel mixture is drawn into the crank-case through the inlet port (I). The exhaust and transfer ports remain closed during the operation of the upward stroke and the charge which reached above the piston during the previous stroke is compressed.

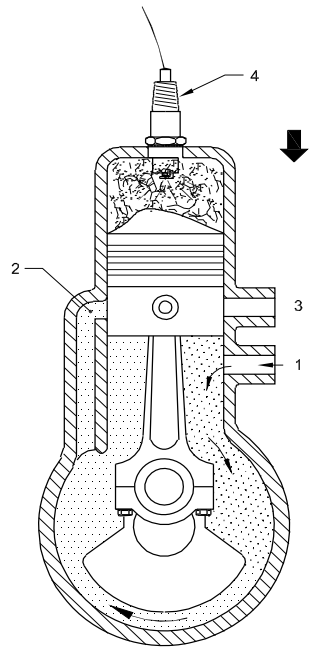
At the end of this stroke the mixture is ignited by an electric spark (4). This causes the pressure to rise.

Second stroke (power and exhaust): The piston is forced downward from the TDC (Fig 2). During this stroke the exhaust port opens and burnt gases escape into the atmosphere.

Further downward movement of the piston opens the transfer port and allows the partially compressed mixture, received during the previous stroke, to reach the combustion chamber from the crankcase.

The piston head has a special shape. It deflects a fresh change of fuel mixture up into the cylinder. The mixture flows down and pushes the burnt gas out. Through the exhaust port. This process is called scavenging. Once the flywheel has completed one revolution, the cycle is repeated. In this engine one power stroke is obtained in each revolution of the crankshaft.

Fig 2



FIRST STROKE

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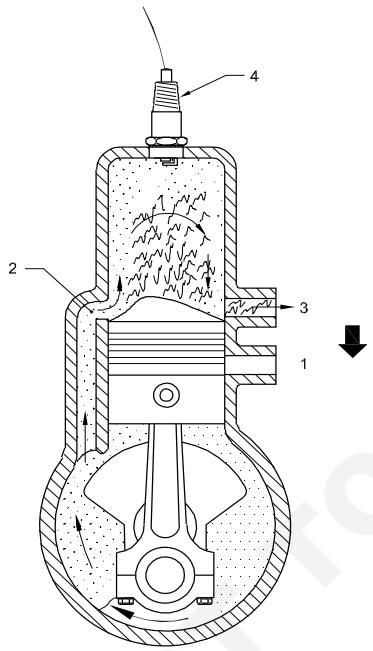
Spark ignition (Fig 3)

Fig 3



SECOND STROKE

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In a spark ignition (SI) engine, petrol is used as fuel. During the suction stroke the air and fuel mixture is sucked into the cylinder. The quantity of the mixture is metered by the carburetor according to the load and speed. The ratio of air/ fuel mixture is also metered by the carburetor. During the compression stroke, this air/fuel mixture is ignited by the spark and the mixture is burnt. It raises the pressure of the gas above the piston. The piston is forced down and this power is supplied to the flywheel. During the exhaust stroke burnt gases escape through the exhaust port/valve. In this type of engine the compression ratio is low.

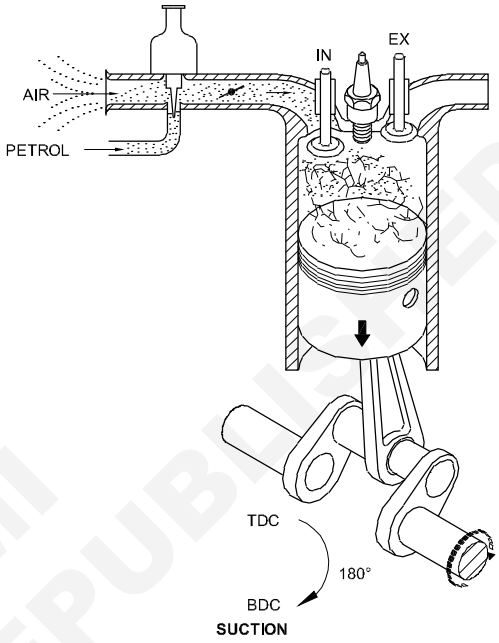
Four-stroke spark ignition engine

To produce power in a four-stroke engine the following operations take place in the sequence given below.

Suction stroke

The piston moves from TDC to BDC (Fig 4). A vacuum is created inside the cylinder. The inlet valve opens while the exhaust valve remains closed. The charge (air/air-fuel mixture) enters the cylinder.

Fig 4



SUCTION STROKE

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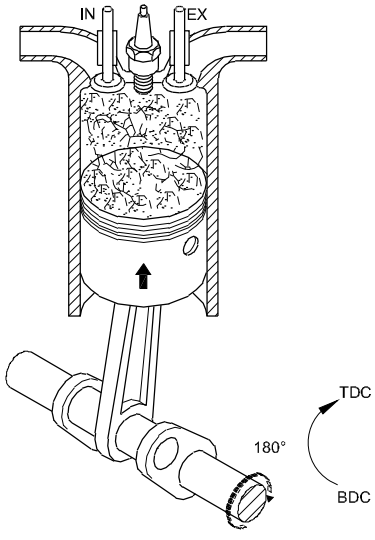
Compression stroke

The inlet valve closes. The exhaust valve remains closed. The piston moves from BDC to TDC (Fig 5). The charge (air/air-fuel mixture) is compressed. The pressure and temperature rise.

Fig 5



COMPRESSION STROKE

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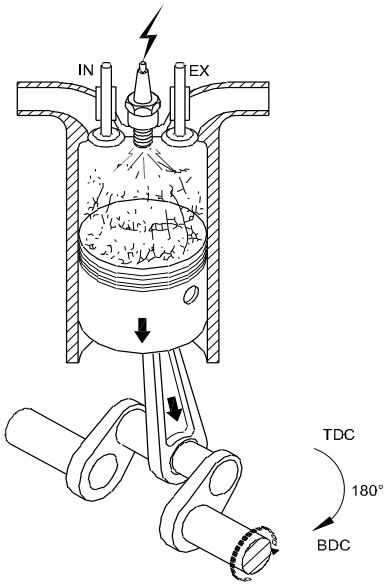
Power stroke

The compressed is ignited air fuel mixture and pressure develops inside the cylinder. The gas expands and the piston is forced down from TDC to BDC (Fig 6). Both the valves remain closed. Power is supplied to the flywheel.

Fig 6

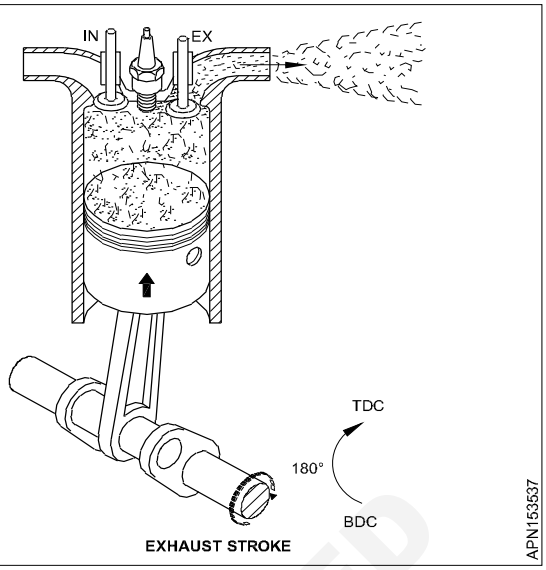


POWER STROKE

Exhaust stroke

The inlet valve remains in the closed position. The exhaust valve opens, the piston moves from BDC to TDC (Fig 7) due to the energy stored in the flywheel. The burnt gases inside the cylinder go out through the exhaust valves. At the end of the stroke the exhaust valve closes.

Fig 7



EXHAUST STROKE

The cycle of suction, compression power and exhaust are repeated. In this type of engines one power stroke is obtained in two revolutions of the crankshaft.

Otto Cycle

1 - 2 - Suction

2 - 3 - Compression

3 - 4 - Heat addition

4 - 5 - Power

5 - 2 - 1 - Exhaust

Comparison between four-stroke engine and two-stroke engine

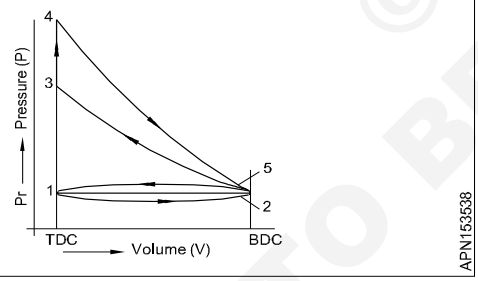
Four-stroke engine	Two-stroke engine
- Four operations (suction, compression, power and exhaust) take place in the four strokes of the piston.	- The four operations take place in two strokes of the piston.
- It gives one power stroke in two revolutions of the crankshaft. As such three strokes are idle strokes.	- The power stroke takes place in every two strokes i.e. one power stroke for one revolution of the crankshaft.
- Due to more idle strokes and non-uniform load on the crankshaft, a heavier flywheel is required.	- The engine has more uniform load as every time the piston comes down it is the power stroke. As such a lighter flywheel is used.
- The engine has more parts such as valves and its operating mechanism. Therefore, the engine is heavier.	- The engine has no valves and valve-operating mechanism therefore it is lighter in weight.
- The engine is costlier as it has more parts.	- The engine is less expensive as it has a lesser number of parts
- The engine efficiency is more as the charge gets completely burnt out. Consequently the fuel efficiency is more.	- The engine efficiency is less. A portion of the charge escapes through the exhaust port, and because of this, the fuel efficiency is less.

Comparison between S.I and C.I. Engine

SI engine	CI engine
Petrol is used as fuel.	Diesel is used as fuel.
During the suction stroke air and fuel mixture is sucked in the engine cylinder	During the suction stroke air alone is sucked in to the cylinder
Compression ratio is low. (Max. 10:1)	Compression ratio is high. (Max. 24:1)
Compression pressure is low. (90 to 150 PSI)	Compression pressure is high. (400 to 550 PSI)
Compression temperature is low.	Compression temperature is high.
It operates under constant volume cycle (otto cycle).	It operates under constant pressure cycle (diesel cycle).
Fuel is ignited by electric spark.	Fuel is ignited due to the heat of the highly compressed air. Combustion takes place at constant pressure.
Spark plug is used	Injector is used.
A carburetor is used to atomize, vaporize and meter the correct amount of fuel according to the requirement.	Fuel injection pumps and atomizers are used to inject metered quantities of fuel at high pressure according to the requirement.
Less vibration, and hence, smooth running.	More vibration, and hence, rough running and more noisy.
Engine weight is less.	Engine weight is more.
It emits carbon monoxide. (CO)	It emits carbon dioxide. (CO_2)

In otto cycle engine, (Fig 8) combustion takes place at constant volume.

Fig 8



Suction takes place at a pressure below atmospheric pressure when piston moves from TDC to BDC. (1-2)

Compression takes place when piston moves from BDC to TDC. (2-3)

Fuel mixture is ignited by introducing a spark at constant volume. (3-4)

The gas expands during the power stroke (4-5), reducing both pressure and temperature.

Heat is rejected at constant volume. (5-2)

Burnt gases exhaust when piston moves from BDC to TDC. (2-1)

Diesel Cycle

1 - 2 - Suction

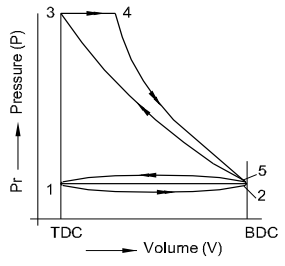
2 - 3 - Compression

3 - 4 - Heat addition

4 - 5 - Power

Suction takes place at (Fig 9) pressure below atmospheric pressure when piston moves from TDC to BDC. (1-2)

Fig 9



Compression takes place when piston moves BDC to TDC. (2-3) (Both the valves closed).

Fuel is sprayed at high pressure and ignited by hot compressed air (3-4), and this process takes place at constant pressure.

Fuel ignites, pressure of burnt gas increases, gas expands and piston is forced from TDC to BDC. (4-5)

Heat is rejected at constant volume. (5-2)

Burnt gases exhaust when piston moves from BDC to TDC. (2-1)

Basic technical terms used in relation to engines

T.D.C. (Top dead centre)

It is the position of the piston at the top of a cylinder, where the piston changes its direction of motion from the top to the bottom.

B.D.C. (Bottom dead centre)

It is the position of the piston at the bottom of the cylinder where the piston changes its direction of motion from the bottom to the top.

Stroke

The distance travelled by the piston from TDC to BDC or BDC to TDC.

Cycle

A set of operations performed in sequence by the motion of the piston in an engine to produce power.

Swept volume (VS)

Displacement volume of a piston.

Clearance volume (VC)

Volume of the space above the piston when it is at TDC.

Compression ratio (CR)

Ratio of compression volumes before the stroke and after.

$$CR = \frac{VS + VC}{VC}$$

where VS = Swept volume

VC = Clearance volume

VS+VC = Total volume at BDC.

Power

Power is the rate at which work is done in a specific time.

$$Power = \frac{(Force \times Distance\ moved)}{Time}$$

Horsepower (HP)

It is the measurement of power in SAE. One hp is the power required to lift a load of 33000 lbs, through one foot in one minute or 4500 kg through one meter in one minute (in metric system)

Thermal efficiency

It is the ratio of work output to the fuel energy burnt in the engine. This relationship is expressed in percentage.

Brake horsepower (BHP)

It is the power output of an engine, available at the flywheel,

$$BHP = \frac{2\pi NT}{4500}$$

where N is r.p.m of the crankshaft, and T is the torque produced.

Indicated horsepower (IHP)

It is the power developed in the engine cylinder.

$$IHP = \frac{PLAN}{4500} X K$$

Where Pm is the mean effective pressure in kg./cm².

L is length of stroke in metres

A is the area of the piston in cm²

N is the No. of power strokes per minute

K is the No. of cylinders.

Frictional horsepower

It is the horsepower lost in the engine due to friction.

FHP = IHP - BHP

Mechanical efficiency

It is the ratio of power delivered (BHP) and the power available in the engine (IHP). It is expressed in percentage

$$\text{Mechanical efficiency} = = \frac{BHP}{IHP} \times 100$$

Volumetric efficiency

It is the ratio between the air drawn in the cylinder during the suction stroke and the volume of the cylinder.

Throw

It is the distance between the centre of the crank pin to the centre of the main journal. The piston stroke is double the throw.

Firing order

The firing order is the sequence in which the power stroke takes place in each cylinder in a multi-cylinder engine.

Technical Specification of an engine

Engines are specified as per the following types.

Number of cylinders

Bore diameter

Stroke length

Capacity in cu.cm/cu.inch

Maximum engine output at specified r.p.m.

Maximum torque

Compression ratio

Firing order

Idling speed

Air cleaner (Type)

Oil filter (Type)

Fuel filter

Fuel injection pump

Weight of engine

Cooling system (type)

Type of fuel

Technical specifications of vehicles
LPT - 1210 D

Specifications

Engine	
Model	6692 D.I.
Number of cylinders	6
Bore	92 mm
Stroke	120mm
Capacity	4788 cc
Gross H.P. (S.A.E.)	125 at 2800 R.P.M.
Taxable H.P.	31.5
Maximum Torque	30 m kg at 2000 R.P.M
Compression Ratio	17 : 1
Compression pressure at 150-200 R.P.M.	Minimum 20 kg/cm^2
Fuel injection begins	23° before T.D.C.
Firing order	1-5-3-6-2-4
Opening pressure of the injection nozzles	200 + 10kg/cm^2 New nozzles Min. 180 kg/cm^2 Used nozzles
Maximum variation permissible in injection: nozzle pressure	5 kg/cm^2
Inlet valve clearance	0.20 mm
Exhaust valve clearance	0.30 mm
Air cleaner	oil bath
Total bearing area per bearing	55 sq.cm
No.of main bearings	7
Fuel injection pump	MICO BOSCH
Weight (Dry)	382 kg
Capacity of cooling system	20 litres
Crankcase oil capacity	Maximum - 14 litres Minimum - 10 litres
Cooling water temperature	75°C - 95°C

Depth max : 223 mm $\left(8\frac{3}{4}"\right)$

Body shop and paint shop safety procedures

– Disconnect the battery cable before performing work on the vehicle.

– Protect yourself by wearing goggles, ear plugs, respirators, gloves, safety shoes, caps etc., when working on a vehicle.

– Safety support the vehicle before work start, Block the front and rear wheels, if the vehicle is not lifted off the ground.

– When welding or performing other procedures that require the use of an open flame near the fuel tank, disconnect and remove the tank and fuel pipe and cap the pipe to prevent fuel leakage.

– Ensure proper ventilation of your working are. Some paint and sealant can generate toxic gases. When heated the painting metal surface.

– Use air chisel or saw to remove damaged panels instead of gas torch.

– Observe all local and national safety regulations when performing autobody repair or auto body refinishing work.

– Cover interior with heat-resistant cover to insure safety when welding with vehicle body panel.

– Take care when using gas or cutting torches so as not to burn body sealer or interior. Extinguish immediately if they should catch fire.

– Use safety stands, whenever a work required under the vehicle.

– Keep yourself and your clothing away from making parts.

– To prevent serious burns, avoid contact with hot metal parts.

– Don't smoke nubile working on a vehicle.

– To avoid injury, always remove rings, watches, loose hanging jewellery and loose clothing before beginning to work on a vehicle.

Vehicle construction technology

Vehicle constructed with engine, chases, body, steaming, brake, suspension, lighting and auto conditioning system.

Body shop

Automotive repair shops that specialize in body work repair are known as body shops. They offer paint work repairs to scratches scuffs and dents as well as repair to the bodies of vehicles damaged by collision.

Classification of atuo body shop

Any vehicle that has sustained damage an accident should be evaluated by a reputable collision repair shop to determine the type and extent of the damage. Reliable collision repair shop will complete a thorough assessment of vehicles, then assign it one of the following three classifications.

Fast track

A vehicle with a fast track classification has sustained maximal damage in an accident. This track require the least amount of time for repair and is often the most affordable to complete.

Quick track

When a collision repair shop classifies the vehicle as quick-track repair, the means that mild to moderate damage has taken place. Vehicle damage repair can be completed within a matter of days to get a quick-track vehicle back on the road.

Extensive track

The most serious type of classification that a vehicle involved in an accident can receive is extensive track. These vehicle will typically have visible structural damage that needs to be addressed during repair process. Major components will need to be replaced and new paint will need to be applied to repair a vehicle.

Paint service information, specifications and measurements

Study of service information

Painting is the practice of applying paint pigment, color or other medium to solid surface. The medium is commonly applied to the base with a brush, spray gun but other implements such as knives, sponges and air brushes can be used. The work also called a painting. Painting is an important form in the visual arts. Painting can be naturalistic and representational.

Painting media: Different type of paint are usually identification by the medium that the pigment is suspended in which determined the general working characters of paint such of viscosity, miscibility, solubility drying time etc.,

Type of paint

Oil paint, pastel, acrylic, water color, hot wax fresco, gouache, enamel, spray paint (Aerosol paint) Temper or egg tempera, water miscible oil paint, digital painting.

Painting styles

The painting style is used in seven senses.

1 Western

2 Modernism

3 Impressionism

4 Abstract styles

5 Outsider art

6 Photo realism

7 Surrealism

Type of painting

Allegory, Bodegon, Figure painting, illustration painting, Landscape painting, skill life vehicle.

Refinishing materials information

It will helps to allocate the right amount for refinishing materials and calculate their costs for each job. Modern refinishing information is based on the use of HVLP, high efficiency spray equipment that consumes less materials than older low efficiency spray equipment.

Vehicle paint code

Refinishing guide explain paint codes, type of paints and how to apply and buff paints and also describe other paint related information. Refinishing guides can be printed or in electronic form.

Refinishng software typically allows you to calculate painting cost for approximately 5000 paint codes from several panic manufactures including four types of paint. Refinishing guide and software will typically include information.

– Paint code locations

– Paint code explanations

– Body work materials

– Plastic and fiber glass materials

– Sanding and building materials

– Blending paints

– Low volatile organic compound (voc) information

There are several basic steps to use refinishing materials information effectively.

1 Look up the paint code log location. This will show you where the paint code tag is located on the vehicle and how to use the information on the vehicle paint code tag.

2 Look up the paint code/color page information in the reference material for the vehicle being repaired. The manual or program will give information on using the repair information.

3 Read the cost information for the specific vehicle being repaired. The information gives the typical costs for the type of paint being used, including single state colour, colour coat/clear coat and three stage finished.

4 Refer to any additional information for refinish time, two tone paint blending and so on.

Service symbols

Service symbols are small pictures that represents a location, part, procedure, safety warning, measurement point and other aspect of repair.

Symbol use varies from publisher to publisher. Normally the contents or front matter of service manual or computer software will explain its particular use of symbols.

Service charts

Repair charts give diagram that give you through logical steps for making repairs. Though they vary in content and design most use arrows and icons (graphic symbols) to represent repair steps.

Diagnosis charts

Trouble shooting charts give logical steps for finding the source of problems. Mechanical body electrical and other types of trouble shooting charts are provided in service manuals and computer based service information. These charts give the most common sources of problems for the symptoms.

Paint reference charts list comparable paints manufactured by different companies. This will help you to match the colour of paint to be used during refinishing units. The paint already on the vehicle. These charts are manufactured by different companies and have different application qualities.

Wiring diagram: Wiring diagram give wire colour codes wiring routing and other information for electrical repairs. Wiring circuit including

– Starting/charging system

– Air conditioning and cooling fan

– Anti-lock brake system (ABS)

– Cruise control

– Power window and door locks

– Interior and exterior lights

– Power and ground distribution

– Computer data lines

– Other electrical circuits

Compressor air system

Objective: At the end of this lesson you shall be able to
- **state the different type of air compressor.**

Basic requirement for compressed air systems: Air compressor is designed to compress air to higher pressured and harness this potential energy source. Compressed air power many different kinds of devices., it can be used to push a piston, as in a jack hammer, it can go through air turbine to a shaft, as in a dental drift or it can be expanded through compressed air provides torque and rotation power for pneumatic tools, such as drills, brushes, nut turners, riveting guns and screw driver. Such tools are generally powered by some form of rotary air motor such as the vane of tube type or by an air turbine.

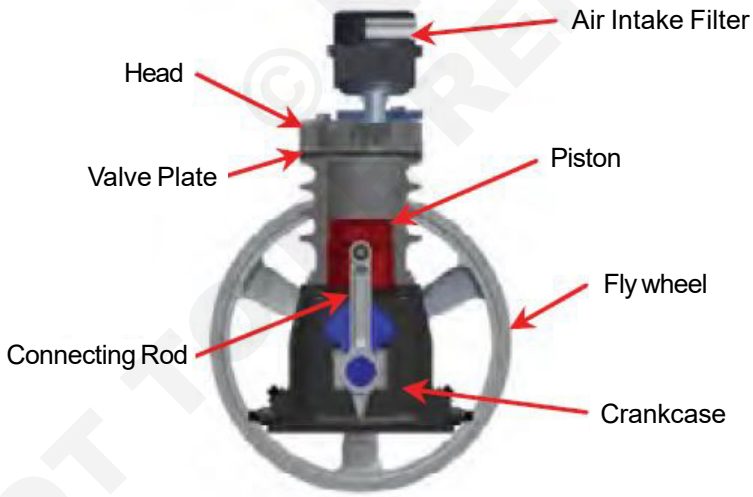
Common applications in industrial plants and on construction site are air powered nail guns, step hers, torque wrenches, screw drivers. Paint spraying and conveying of material. In paint spraying and in air conveying the dynamic pressure of the air imparts motion.

Types of compressors: Air compressors in sizes 30 horsepower and below include both reciprocating and rotary compressors, which compress air in different ways. Major types of reciprocating compressors include reciprocating single acting, reciprocating diaphgram and reciprocating rocking piston type. Major types of rotary air compressor include rotar sliding vane, rotary helical screw and rotary scroll air compressors.

Reciprocating single acting compressors: Reciprocating single acting compressors, are generally one-stage or two-stage. Compressors can be of a lubricant, non-lubricant or oil-less design.

In the single-stage compressor, air is drawn in from the atmosphere and compressed to final pressure in a single stroke. The single-stage reciprocating compressor is illustrated in Fig 1. Since-stage compressors are generally used for pressures of 70 psi (pounds per square inch) to 135 psi.

Fig 1



The two-stage compressor, air is drawn in from the atmosphere and compressed to an intermediate pressure in the first stage. Most of the heat of compression is removed as the second stage, where it is compressed to final pressure. Two-stage compressors can include two cylinder designs. The two-stage reciprocating compressor is illustrated in figs 2 & 3.

Single and two-stage reciprocating compressors are frequently used in auto and truck repair shops, body shops, service business and industrial plants. Although this type of compressor is usually oil lubricated, hospitals and laboratories can purchase oil-less versions of the compressors as illustrated in fig 4.

Rocking piston type: Rocking piston compressors are variations of reciprocating piston type compressors. (Fig 5). This type of compressor develops pressure through a reciprocating action of a one-piece connecting rod and piston. The piston head rocks as it reciprocates. These compressors utilize non-metallic low friction rings and do not require lubrication. The rocking piston type compressors are generally of a smaller size and lower pressure capability.

Fig 2

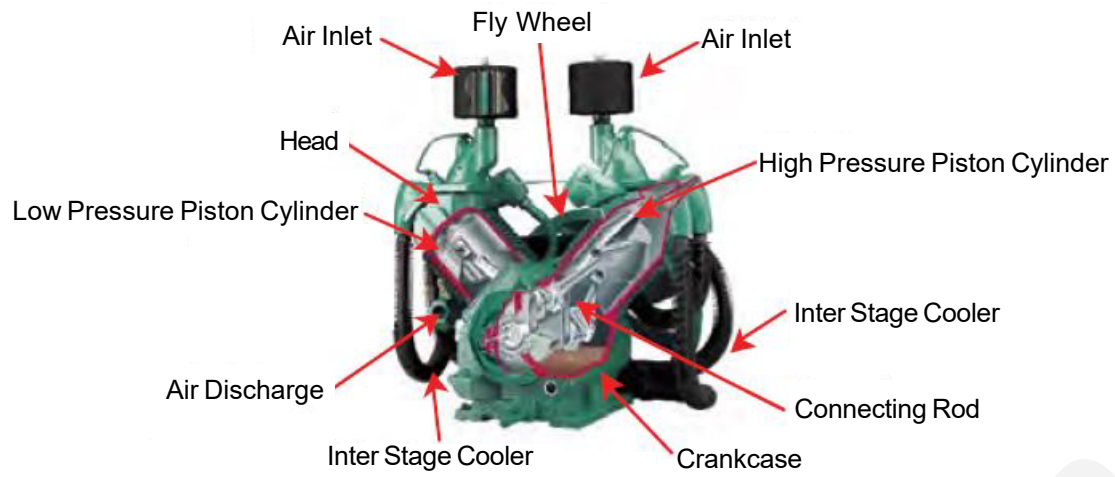


Fig 3

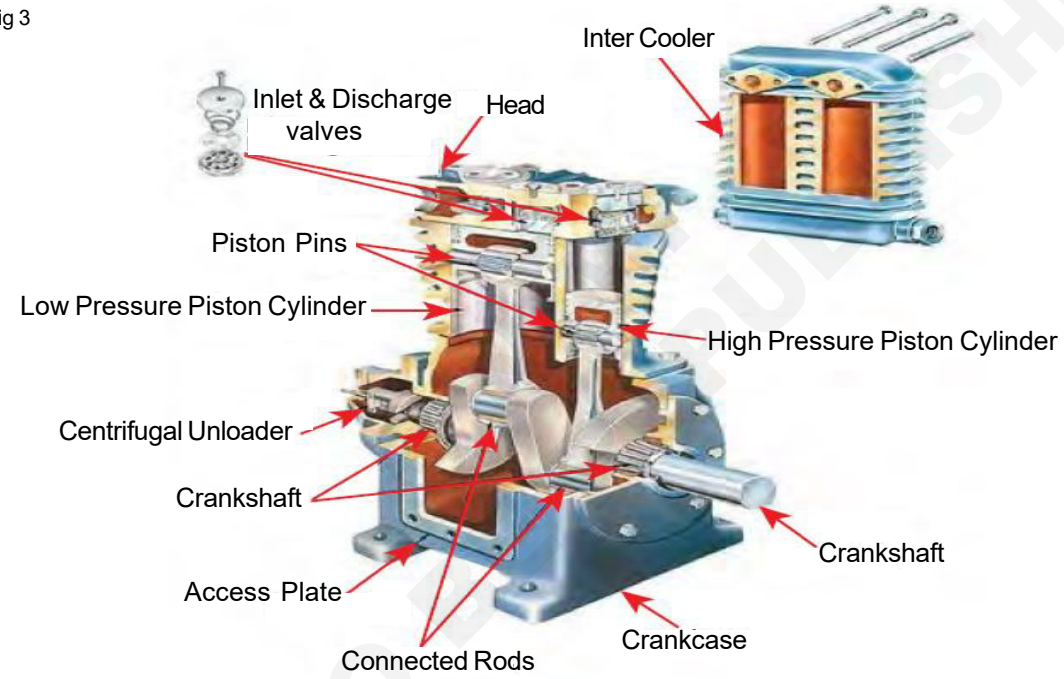


Fig 4

Reciprocating single stage, Oil-less

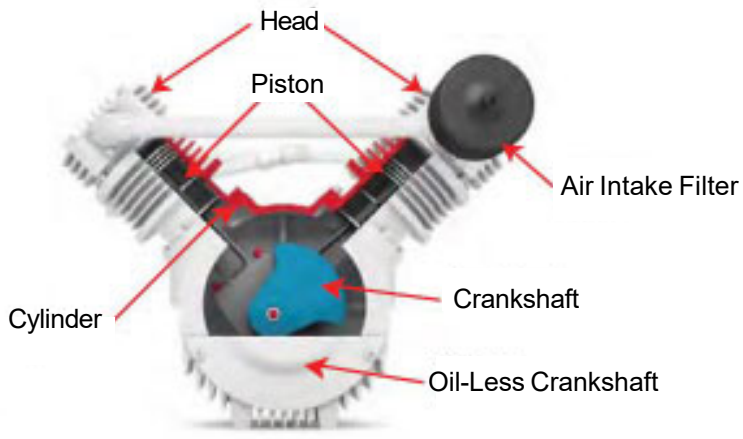
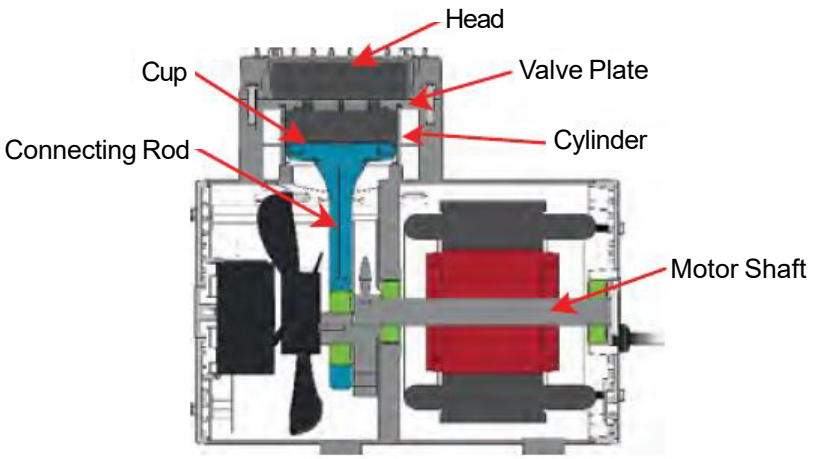


Fig 5

Rocking Piston Type

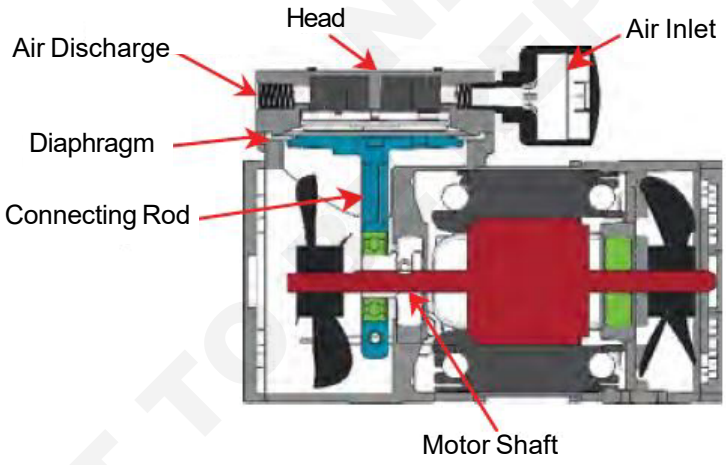


Diaphragm type

Diaphragm compressors (Fig 6) are a variation of reciprocating compressors. The diaphragm compressor develops pressure through a reciprocating of oscillating action of a flexible disc actuated by an eccentric. Since a sliding seal is not required between moving parts, this design is not lubricated. Diaphragm compressors are often selected when to contamination is allowed in the output air or atmosphere, such as hospital and laboratory applications. Diaphragm compressors are limited in output and pressure and they are used most often for light-duty applications.

Fig 6

Diaphragm Type



Rotary helical screw type: Rotary helical screw compressors (Fig 8) utilize two intermeshing helical rotors in a twin-bore case. In a single-stage design, the air inlet is usually located at the top of the cylinder near the drive shaft end. The discharge port is located at the opposite end of the cylinder. As the rotors unmesh at the air inlet end of the cylinder, air is drawn into the cavity between the main rotor lobes and the secondary rotor grooves. As rotation continues, the rotor tips pass the edges of the inlet posts, trapping air in a cell formed by the rotor cavities and the cylinder wall. Compression begin as further rotation causes the main rotor lobes to roll into the secondary rotor groove, reducing the volume and raising cell pressure.

Oil is injected after cell closing to seal clearance and remove heat of compression. Compression continues until the rotor tips pass the discharge porting and release of the compressed air and oil mixture is obtained. Single or multi-stage version are available. This type of compressor can be oil lubricated, water lubricated or oil-free. Some advantage of the rotary helical screw compressors are smooth and pulse-free air output, compact size, high output volume, low vibrations, prolonged service intervals and long life.

Fig 7

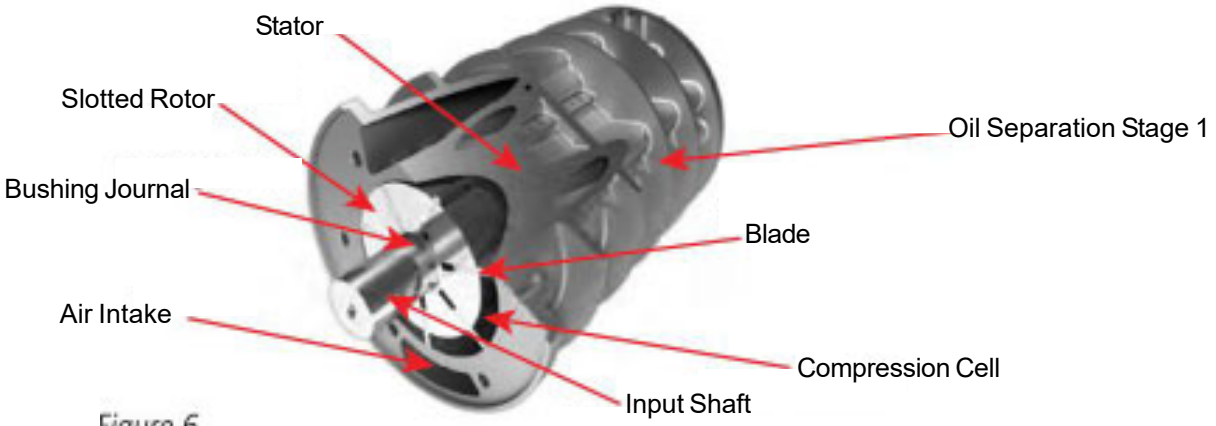
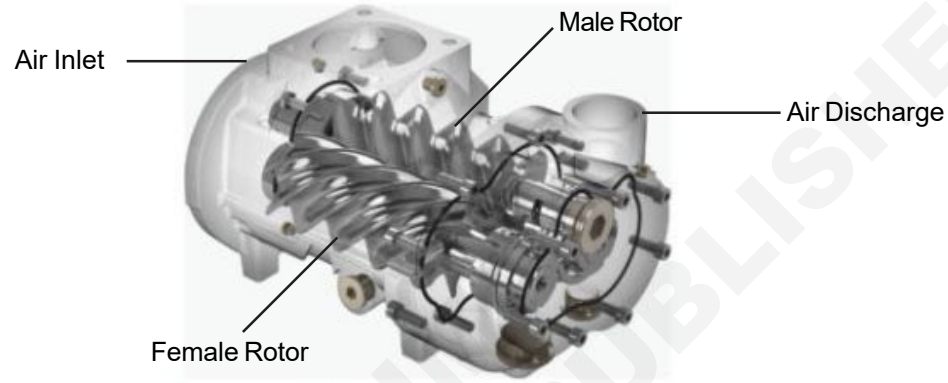


Figure 6

Fig 8



Types of controls: Controls are required for all compressors in order to regulate their operation. In accordance with compressed air demand. Different controls should be chosen for different type of compressor applications and requirements.

For continuous operation, when all or most of the requirements are of a steady nature, constant speed controls are required. Use **constant speed controls** whenever the air requirement is 5 percent or more of the free air delivery of the air compressor or when motor starts per hour exceed motor manufacturer recommendations. Constant speed controls include load/unload control for all types of compressors and inlet valve modulation for rotary compressors.

Start-stop controls are recommended for a compressor when adequate air storage is provided and air requirement is less than 75 percent of the compressor free air delivery.

Variable speed controls are utilized when energy efficiency is an important criteria in selecting an air compressor. This type of control is most commonly found in rotary screw and rotary vane compressor packages. A variable speed drive will control the speed of the motor and dynamically adjust the speed (increase or decrease) in order to meet the air demand required by the application.

Dual controls allow for switching between constant speed and start-stop operation by setting a switch. With dual controls, the operator can select a different type of control to suit his or her specific are requirements each time the compressor is used. Dual controls are helpful when a compressor is used for a variety of applications that vary between intermittent and continuous-duty.

Fig 9

Sequencing controls provide alternate operation of each compressor at each operating cycle and dual operation during peak demands. Sequencing controls are ideal for operating duplex air compressors or a group of compressors at peak efficiency levels or when 100 percent back-up air might be required for critical applications.

Types of drives

Most compressors are driven by electric motors, internal combustion engines or engine power takeoffs. Typically, power is transmitted by one of these sources with V-Belt, gear or direct drive configurations. Alternatively, a compressor can have an engine drive. However, an engine drive must use one of the traditional drive types to transmit power. Three common type of drives are used with these power sources.

V-Belt drives are most commonly used with electric motors and internal combustion engines. V-Belt drives provide great flexibility in matching compressor load to power source load and speed at minimum cost. Belts must be properly shielded for safety.

Gear drives are commonly used with electric motors and provide a reduction of the axial load on the compressed air producing element, extending the operational lifetime. More working points in the optimal working range provide a reduction in shear force.

Direct drives provide compactness and minimum drive maintenance. Compressors can be flange-mounted or direct-coupled to the power source. Couplings must be properly shielded for safety. Lower horsepower compressors also are built as integral assembles with electric motors.

Engine drives gasoline or diesel engine or power takeoff drives are used primarily for portability reasons. A gear box, V-belt or direct drive is used to transmit power from the source to the compressor.

Air compressor performance

Delivery (ACFM/SCFM)

The volume of compressed air delivered by an air compressor at its discharge pressure normally is stated in terms of prevailing atmospheric inlet conditions. (acfm) The corresponding flow rate in Standard cubit feet per minute (scfm) is measured at 14.5 psi (1 bar) 68°F (20°C) and 0% relative humidity.

Varying flow rates for more than one discharge pressure simply reflect the reduction in compressor volumetric, efficiency that occurs with increased system pressure (psig) for this reason, of a compressor the maximum operating pressure of a compressor should be chosen carefully.

Displacement

For a reciprocating (piston) compressor displacement (cfm) is defined as the volume of the first stage cylinder(s) of a compressor multiplied by the revolutions of the compressor in one minute. For a rotary screw compressor, displacement (cfm) is the volume at suction per thread times the number of lobes on the driving rotor.

Accessories

Standard accessories are available to help ensure reliable and trouble-free compressor operation. Some special purpose devices disc are available to meet unusual requirements. Below is a list of commonly used accessories.

Air receiver

A receiver tank is used as a storage reservoir for compressed air. The reservoir prevents the compressor from operating in a continuous run cycle. The receiver allows the compressed air an opportunity to cool. The receiver can be a separate item or can be integrated as part of the compressor package.

Air treatment products

Compressed air treatment products are designed to remove oil and water in a liquid or gaseous state from the compressed at stream. These products include but are not limited to moisture separators, air drivers, air filters and oil/water separators. The use and implementation of these products are highly dependent on the specific process and application. Further details can be found in the Air Compressor System section of this document.

A compressed air expert should be contacted or consulted when working through any compressed air system requirements.

Belt Guard

A belt guard's primary function is safety and it is only utilized on belt drive machines. The belt guard prevents access to fast moving and potentially dangerous components on the compression from both sides of the drive. The belt guard is a mandatory feature for all v-belt driven compressor units where flywheel, motor pulley and belts are used. Compressors 30 horse power and below are available as direct or gear drive and do not require belts or belt guards.

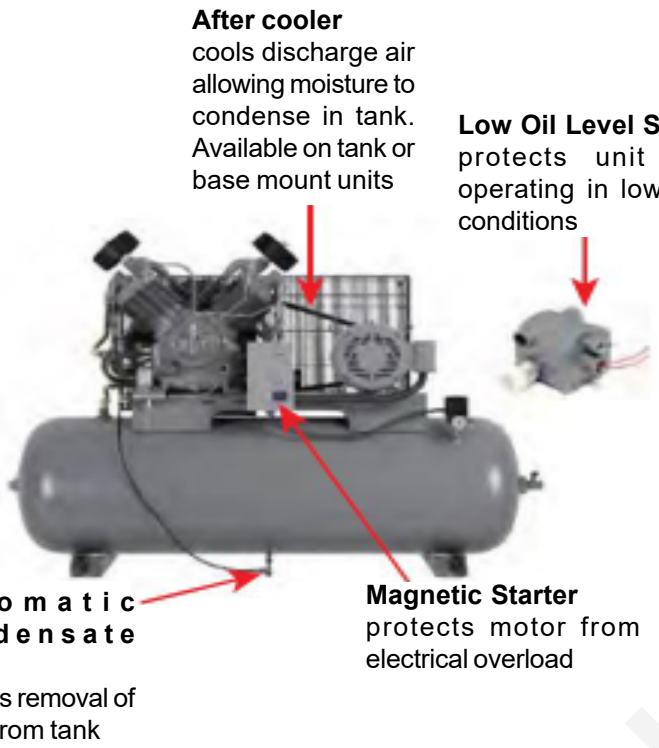
Diagnostic controls

Protective devices are designed to shut down a compressor in the event of malfunction. Devices may include high at temperature shut down, preventive maintenance shut down, etc. These protective devices may be individual sensors or may be monitored by a compressor controller depending on male and model of compressor. (Fig 10)

Intake filter

The intake filter eliminates foreign particulate matter from the ambient air at the intake suction of the air compressor system.

Fig 10



Magnetic motor starters: Magnetic starters provide thermal over-load protection for motors and are recommended for integral horsepower and all three-phase motors. Many compressors come standard with starters, however, when a starter is purchased separately from the compressor, local electrical codes should be checked prior to installation.

Duplex tank mounted compressor with alternator panel

Starters can be configured as full-voltage or reduced voltage. A common type of reduced voltage starter is a wye-delta. A wye-delta starter will reduce the amount of in-rush current to the motor upon initial turn on a compared to a full-voltage starter. A wye-delta starter is also commonly referred to a star-delta configuration. As a note, the motor must be wired to support a wye-delta starter, not all motors support this type of starter configuration.

Variable speed drives: This type of drive is most commonly found in rotary scew and rotary vane compressor packages. A variable speed drive will control the speed of the motor and dynamically adjust the speed (increase or decrease) in order to meet the air demand required by the application. In addition, this type of drive reduces in-rush currents upon initial start-up below that of full-voltage or wye-delta starters.

Air compressor installation

Location

The air compressor location should be a close as possible to the point when the compressed air is to be used. It is also important to locate the compressor in a dry clean, cool and well-ventilated area. Keep it away from dirt, vapour and volatile fumes that may dog the intake filter and valves. If a dry, clean space is unavailable a remote air intake is recommended.

On reciprocating type compressors the fly wheel side of the unit should be placed toward the wall and protected with a totally enclosed belt guard, but it no case should the fly wheel be closer than 12 inches to the wall. Allow space on all sides for air circulation and for ease of maintenance.

Rotary type compressor installations should follow the manufacture's installation requirements, which are typically supplied with the compressor in an installation drawing. Be sure to verify that there is enough space in the room or area where the compressor is to be installed to allow for air flow and compressor maintenance. The inlet grids in the room or area where the compressor maintenance. The inlet grids and ventilation fan should be installed in such a way that any recirculation of cooling air to the compressor is avoided. A proper condensate drain system is essential. Also be aware of the maximum air temperature at the compressor intake, as this can effect compressor operation and life.

Always refer to the manufacturer operational and user's manual for installation guidelines. Make sure that the unit is mounted level, on a solid foundation, so that there is no strain on the supporting or lagging down the unit, be careful not to over-tighten and impose strain.

Ambient temperature conditions can vary by manufacturer and should be reviewed prior to purchasing a compressor. Typical ambient conditions can range from 32°F ti 115°F. Special precautions are usually required when operating outside this range and manufacturer of the equipment should be consulted.

Operation at altitudes above 4000 feet may also require special consideration. Consult the manufacturer when operating a unit at a higher altitude to ensure proper operation can be achieved.

Air consumption chart for automotive service shops

Cubic feet per minute required to operate various pneumatic equipment at pressure range 70-90 psig

Equip. Air pressure range in psi	Portable tools	Compressor (cfm) required per unit
70-100	**Air filter cleaner	3.0
70-100	**Body polisher	20.0
70-100	**Body sander (Orbital)	10.0
70-100	Brake tester	4.0
70-100	**Carbon remover	3.0
90-100	Dusting gun (Blow gun)	2.5
70-100	Panel cutter	4.0
70-90	**Drill 1/16* to 3/8*	4.0
70-90	**Impact wrench 3/8* sq.dr.	3.0
70-90	**Impact wrench 1/2* sq.dr.	4.0
70-90	**Impact wrench 5/8* sq.dr.	5.0
70-90	**Impact wrench 3/4* sq.dr.	8.0
70-90	**Impact wrench 1* sq.dr.	12.0
70-90	Die grinder	5.0
90-100	*Vertical disc sanders	20.0
90-100	**Filing and sawing machine, (small)	3.0
90-100	**Filing and sawing machine, (Large)	5.0
90-100	**Burring tool	5.0
Tire tools		
125-150	Rim stripper	6.0
125-150	Tire changer	1.0
125-150	Tire inflation line	2.0
125-150	Tire spreader	1.0
125-150	“Vaccum cleaner”	7.0
Hammers		
90-100	**Air hammer	4.0
90-100	Tire hammer	12.0
125-150	Beak breaker	12.0
90-100	Spring dier	4.0
Spray guns		
90-100	**Engine cleaner	5.0
90-100	**Paint spray gun (production)	8.0
90-100	**Paint spray gun (touch up)	4.0
90-100	**Paint spray gun (undercoat)	19.0
Other equipment		
120-150	**Grease gun	3.0
145-175	Car LIft* (air compressed hydraulic)	6.0
120-150	Floor jacks (air compressed hydraulic)	6.0
120-150	Pneumatic garage door	3.0
90-100	Radiator tester	1.0
90-100	Spark plug cleaner	5.0
90-100	Spark plug tester	5
70-100	Transmission and differential flusher	3.0
70-100	**Fender hammer	9.0
70-100	**Car washer	9.0
70-100	**6* Medium duty sander	4.0

- This is for 8,000 ibs capacity. Add cfm for each 1,000 lbs, capacity over 2,000 lbs.
- These devices are rated based upon typical “on-load” performance characteristics.

Always check with tool manufactures for actual consumption of tools being used. The above is based on averages and should not be considered accurate for any particular make of tool.

Selecting the Proper Air Compressor to use with an Air Cylinder

Air Cylinders use compressed air to produce force. The Compressed air is directed into a cylinder chamber and it forces a piston to move in a linear direction. The distance the piston travels is called the length of stroke. A piston rod attached to the piston exerts a force in pounds to produce work or motion to a mechanism at a rate of so many strokes per minute.

In commercial and industrial uses, a piece of equipment using an air cylinder of a given diameter will be rated as to force (thrust load) in pounds, length of stroke and the number of strokes per minute.

Using the thrust load and cylinder diameter figures, make your choice of a compressor and determine the pressure needed from chart “A”.

Determine the cfm of free air needed by the air cylinder from chart “B” by using the factor shown opposite your cylinder diameter and pressure requirement (see example for explanation of how to determine factors not shown). Multiply this factor by the number of inches of stroke and the number of strokes per minute to determine the cfm requirement.

Air Flow Chart

Another industrial use for compressed air is using a blast of compressed air, released at the proper moment, to blow away small parts from a punch after forming and blanking.

An automatic valve allows air to flow from a properly positioned and aimed nozzle against the work pieces. The pressure employed and the diameter of the passage through the nozzle determine the volume of free air which will flow through the nozzle.

The chart below indicates the rate of flow (volume) per minute, through various sizes of orifices at definite pressures.

Chart A cylinder diameter required to develop power to overcome the load indicated

Thrust load in pounds	Pressure in cylinder-psi														
	70	80	90	100	110	120	125	130	140	150	160	170	175	180	190	200
500	3 1/8	2 7/8	2 3/4	2 1/2	2 1/2	2 3/8	2 3/8	2 1/4	2 1/4	2 1/8	2	2	2	2	1 7/8	1 7/8
1000	4 3/8	4	3 7/8	3 5/8	3 1/2	3 3/8	3 1/4	3 1/4	3 1/8	3	2 7/8	2 3/4	2 3/4	2 3/4	2 5/8	2 5/8
1500	5 1/4	5	4 5/8	4 3/8	4 1/4	4	4	3 7/8	3 3/4	3 5/8	3 1/2	3 3/8	3 3/8	3 3/8	3 1/4	3 1/8
2000	6 1/8	5 3/4	5 3/8	5 1/8	4 7/8	4 5/8	4 5/8	4 1/2	4 3/8	4 1/8	4	3 7/8	3 1/8	3 7/8	3 3/4	3 5/8
2500	6 7/8	6 3/8	6	5 3/4	5 1/2	5 1/8	5 1/8	5	4 7/8	4 5/8	4 1/2	4 3/8	4 3/8	4 1/4	4 1/8	4
3000	7 1/2	7	6 5/8	6 1/4	6	5 3/4	5 5/8	5 1/2	5 1/4	5 1/8	5	4 3/4	4 3/4	4 5/8	4 1/2	4 3/8

Chart B Cubic feet of air required for single acting air cylinder

Piston Dia. (in.)	90 psi	125 psi
1 3/4	.0102	.0131
1 7/8	.0115	.0149
2	.0133	.0172
2 1/8	.0150	.0194
2 1/4	.0168	.0127
2 3/8	.0187	.0242
2 1/2	.0207	.0268
2 5/8	.0228	.0268
2 3/4	0.250	.0324
2 7/8	.0275	.0355
3	.0299	.0386
3 1/8	.0323	.0418
3 1/4	.0350	.0454
3 3/8	.0378	.0489
3 1/2	.0405	.0524
3 5/8	.0434	.0562
3 3/4	.0467	.0605
3 7/8	.0496	.0642
4	.0530	.0685
4 1/8	.0564	.0730
4 1/4	.0599	.0775
4 3/8	.0635	.0822
4 1/2	.0672	.0870
4 5/8	.0708	.0915
4 3/4	.0748	.0970
4 7/8	.0789	.1020
5	.0832	.1076
5 1/8	.0872	.1127
5 1/4	.0913	.1180
5 3/8	.0957	.1237
5 1/2	.1004	.1299
5 5/8	.1050	.1361
5 3/4	.1096	.1416
5 7/8	.1146	.1482
6	.1200	.1550
6 1/8	.1250	.1623
6 1/4	.1300	.1681
6 3/8	.1346	.1742
6 1/2	.1402	.1813
6 5/8	.1460	.1888
6 3/4	.1510	.1955
6 7/8	.1570	.2080
7	.1630	.2105
7 1/8	.1684	.2181
7 1/4	.1746	.2257
7 3/8	.1802	.2332
7 1/2	.1870	.2419

Flow is expressed in cubic feet per minute (cfm) and is assumed to take place from a receiver or other vessel, in which air is contained under pressure, into the atmosphere at sea level. Temperature of air in receiver is assumed at 60 deg.F. This table is only correct for orifices with narrow edges; flow through even a short length of pipe would be less than that given below.

Gage pres. in receiver (ins)	Flow of Air (cfm) through orifices of various diameters							
	1/64"	1/32"	3/64"	1/16"	3/32"	1/8"	3/16"	1/4"
1	.027	.107	.242	.430	.97	1.72	3.86	6.85
2	.038	.153	.342	.607	1.36	2.43	5.42	9.74
3	.046	.188	.471	.750	1.68	2.98	6.71	11.9
5	.059	.242	.545	.965	2.18	3.86	8.71	15.4
10	.084	.342	.77	1.36	3.08	5.45	12.3	21.8
15	.103	.418	.94	1.67	3.75	6.65	15.0	26.7
20	.119	.485	1.07	1.93	4.25	7.7	17.1	30.8

Gage pres. in receiver (ins)	Flow of Air (cfm) through orifices of various diameters							
	1/64"	1/32"	3/64"	1/16"	3/32"	1/8"	3/16"	1/4"
25	.133	.54	1.21	2.16	4.75	8.6	19.4	34.5
30	.156	.632	1.40	2.52	5.6	10.	22.5	40.0
35	.173	.71	1.56	2.80	6.2	11.2	25.0	44.7
40	.19	.77	1.71	3.07	6.8	12.3	27.5	49.1
45	.208	.843	1.9	3.36	7.6	13.4	30.3	53.8
50	.225	.914	2.05	3.64	8.2	14.5	32.8	58.2
60	.26	1.05	2.35	4.2	9.4	16.8	37.5	67
70	.295	1.19	2.68	4.76	10.7	19.0	43.0	76
80	.33	1.33	2.97	5.32	11.9	21.2	47.5	85
90	.364	1.47	3.28	5.87	13.1	23.5	52.5	94
100	.40	1.61	3.66	6.45	14.5	25.8	58.3	103
110	.43	1.76	3.95	7.00	15.7	28.0	63	112
120	.47	1.90	4.27	7.58	17.0	30.2	68	121
130	.50	2.04	4.57	8.13	18.2	32.4	73	130
140	.54	2.17	4.87	8.68	19.5	34.5	78	138
150	.57	2.33	5.20	9.20	20.7	36.7	83	147
175	.66	2.65	5.94	10.6	23.8	42.1	95	169
200	.76	3.07	6.90	12.2	27.5	48.7	110	195

The capacity of an air compressor cannot be checked accurately by use of this table and a narrow edge orifice. Specialized equipment is necessary to check compressor capacity.

Example: An air ejector is being used on a punch press. It is connected to an air line with pressure at 120 - 150 psi. It has a nozzle orifice 3/32 in. in diameter and, through use of a stop watch, it delivers compressed air for a total of 30 seconds out of each one minute of operation.

Useful Formulae

1 Comp.RPM = $\frac{\text{motor pulley dia.} \times \text{motor rpm}}{\text{comp. pulley dia.}}$

2 Motor Pulley pd = $\frac{\text{comp. pulley dia.} \times \text{comp rpm}}{\text{motor rpm}}$

3 Comp. pulley pd = $\frac{\text{motor pulley dia.} \times \text{motor rpm}}{\text{comp. rpm}}$

4 Motor RPM = $\frac{\text{comp. pulley dia.} \times \text{comp rpm}}{\text{motor pulley pd}}$

5 Free Air = piston displacement x volumetric eff. (%)

6 Required Piston Displacement = $\frac{\text{free air}}{\text{vol.eff.}}$

7 Piston Displacement in Cu. Ft. per Min.* = $\frac{\text{Cyl. bore in In. x Cyl. bore x stroke in In. x rpm}}{2200}$

8 Cu. Ft. Compressed Air = $\frac{\text{cu.ft.free air x 14.7}}{(\text{psig} + 14.7)}$

9 Cu. Ft. Free Air = $\frac{\text{cu.ft.compressed air x (psig} + 14.7)}{14.7}$

10 Cu. Ft. Free Air Req'd to Raise Rec. From 0 Gage to final Pressure = $\frac{\text{vol.of rec.in cu.ft. x psig}}{\text{(atmospheric pressure) psia}}$

11 Cu. Ft. Free Air Req'd to Raise Rec. From Some Press. Greater Than 0 Gage To A Final High Higher Pressure =

vol. of rec.in cu.ft. x $\frac{\text{(final psig} - \text{initial psig)}}{\text{(atmospheric pressure) psia}}$

12 Piston Speed in Ft. Per Min. = $\frac{2 \times \text{stroke (in inches)} \times \text{rpm}}{12}$

13 Gallons = $\frac{\text{cu.ft.}}{0.134}$

14 Cu. Ft. = gallons x 0.134

15 Total Force in lbs. of Air Cylinder = (Area of the Cylinder Dia.in sq.inches) x (psig of air press.used)

16 CFM of Free Air req'd to Operate Air Cylinder (Single Acting) = (Vol. of Cyl. In cu.ft.) x (Cycles Per Min.) x $\frac{\text{(Gage Press psig} + 14.7)}{14.7}$

17 Pump Up Time (Min) = $\frac{\text{V (tank size in gal.)} \times \text{(final tank press.} - \text{initial tank press.)}}{7.48 \times \text{atmos.press.(psia)} \times \text{pump delivery (cfm.)}}$

* Piston displacement for multi – stage compressors – only the low pressure cylinders are considered.

Air Transformer A transformer (Fig 11) is a device that condenses air, oil, and moisture; regulates and strains the air; and provides outlets to which spray guns, dusters, and the like, can be connected. The transformer separates the oil and moisture by mechanical means and air expansion, allowing only clean, dry air to reach the spray gun. If any moisture or oil passes through the spray gun onto the freshly painted surface, it will ruin the paint finish. Therefore, a transformer is required in the refinishing field.

A transformer regulator controls pressure at the gun to give the desired atomization. The transformer regulator has a gauge that shows main line pressure and a gauge for working pressure. It also has outlets for main line pressure and outlets for working pressure, such as used when painting a vehicle. The regulator knob adjusts the working air pressure, and a drain is attached to the bottom of the cylinder. Transformers are usually hooked up off the main line at least 25 ft or 7.75 m from the compressor.

The workings of a transformer are relatively simple. The air enters at the back of the transformer main pressure line. By adjusting the pressure regulator knob until the desired pressure is reached, a diaphragm opens that allows air to pass through a metal filter. Water separators and baffle condensers clean the air of its impurities and then it passes out through the regulated side to the spray gun. Drain the transformer daily if necessary.

Fig 11

If the transformer cannot stop all the oil in the air line, it is necessary to install a filter such as in Fig 11, which uses a roll of double toilet paper as a medium to remove oil from the air. Filters must be checked regularly, and when a bit of oil is present on the intake side, the element should be changed.

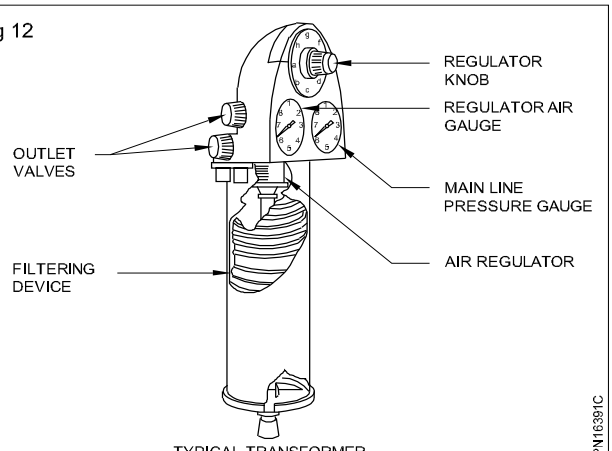
Coalescing oil removal filters are available to remove oil and water vapors and dirt particles from the compressed air. Some of these filters are available as submicron filters, which coalesce oil aerosols and remove them from the lines. The filtered air will contain less than 0.1 ppm of oil by weight. The life of the filter cartridge is exceptionally long when removing aerosols and is designed for 99.999% efficiency. A filter designed to remove any remaining oil vapour and its taste and odour must be used when the air is to be used for breathing purposes. To remove carbon monoxide from compressed air, there are units available on the market that will clean the air for breathing purposes.

Installation of Air Transformers (Fig 12)

The air transformer should be bolted securely to the spray booth or to some similar sturdy object near the operator for convenience in reading the gauges and operating the valves. It should be installed at least 25 ft or 7.75 m from the compressor and the take - off should always be from the top of the air line. Piping should slope toward the compressor air receiver or a drain leg installed at the end of the air line or at the end of each branch to provide for drainage of moisture from the air line. The reason the air line is sloped is to control the water in the air line. Humid air condenses to water when the air is compressed. If some of the water is allowed to get through the system and on a paint job, it will ruin it. Therefore, it is necessary

to drain the compressor, receiver, drain leg, and transformer as often as required. Use piping of sufficient size for the volume of air passed and the length of pipe used. The pipe must always be of the recommended size or larger. Otherwise, excessive pressure drop will occur.

Fig 12



TYPICAL TRANSFORMER

Different type of air purification methods:

The function of air quality management is checking of emission in the air and purified the with following systems:

— Sedimentation chamber (gravity separator)

— Cyclone separator

— Rotating scrubber

— Ventura scrubber

— Spray chamber

— Dry electro filter

— Wet electro filter

— Cloth filter

— Ceramic filter

— Absolute filter

— Demister

Gas Purification Techniques:

There are four commonly used technologies for gaseous pollutants, absorption adsorption, condensation and combustion. These systems are recovery techniques, where as combustion implies the destruction of the pollutant. The following techniques apply at purifying pollutants from the air flow.

- Condensation
- Cryo condensation
- Regenerative adsorption
- Dry and semi dry line absorption
- Gas scrubbing
- Thermic combustion
- Catalytic combustion
- Flaring
- Foliate-oxidation
- Ironization
- Selective non catalytic reduction
- Selective catalytic reduction

Compressor air hoses

There are two types of air hoses used in air compressor air layout system they are as follows:

- Durability and flexibly

Hose Size

The external diameter of air hoses will vary widely depending on the quality of the hose and the material, it is made from, common internal sizes of air hose are 6 mm, 8 mm and 10 mm internal diameter.

Weight

Very light and easy to transport

Application:

Medium duty usage in many situations

Cold Weather

Poor cold weather performance

Durability & Flexibility: Tends to coil and kink (materials used for durability is PVC, Rubber and Polyurethane)

Recommended hose size: Table 1 Table 2

TABLE 1

Minimum pipe size recommendations (English units)

Compressing outfit		Main air line	
Size (hp)	**Capacity (cfm)**	**Length (ft)**	**Size (in.)**
1 ½ and 2	6 - 9	Over 50	¾
3 and 5	12 - 20	Up to 200	¾
		Over 200	1
5 -10	20 - 40	Up to 100	¾
		Over 100 to 200	1
		Over 200	1 ¾
10 -15	40 - 60	Up to 100	1
		Over 100 to 200	1¾
		Over 200	1½

Source: Courtesy of DeVilbiss Canada Ltd.

TABLE 2

Minimum pipe size recommendations (Metric units)

Compressing unit		Main air line	
Size (watts)	**Capacity (litres/min)**	**Length (m)**	**Size (mn)**
1120 and 1492	170-255	Over 15	190.6
2238 and 3730	340-566	Upto 61 Over 61	190.6 254
3730-7460	566-1130	Upto 30.5	190.6
		Over 30.5 to 61	254
		Ovet 61	318
7460-11.190	1130-1700	Upto 30.5	254
		Over 30.5 to 61	318
		Ovet 61	382

Maintenance of compressor air hose

Air hoses mostly made by PVC, rubber and polyurethane materials. So it is need daily maintenance

- Daily dry clean the hoses
- Check hose connection
- Check the air leaks from the coupler connection
- Check crack on the hose
- Check weather damage in the air hose

Air hose connectors (Fig 13): Air hose connectors are used to connect the two pieces like air hose connect with adaptors and couplings.

Fig 13

Adaptors and coupling (Fig 14): Air hose adaptors and couplings are used to connect the paint spray gun, air blast sander, pneumatic tools.

Fig 14

Air system maintenance

Objectives: At the end of this lesson you shall be able to
- **state the typical piping arrangement in the in paint shop**
- **state the colour coding of air line, water line and fuel line.**

Typical piping arrangement of air compressor

A stationary air compressor is usually used in the paint shop therefore, the unit should be bolted at its proper location to prevent it from moving then the air line from the shop should connected to the receiver. The compressor should be installed in a cool, clean area that has access room for maintenance or repair. There are two type of piping and hoses are available in paint shop, an air hose and a fluid hose (Fig 1)

Colour code of the hoses (Fig 2)

A fluid hose is always black in colour with a special solvent resisting liner that is almost improvious to all common solvents in paints.

Fig 1

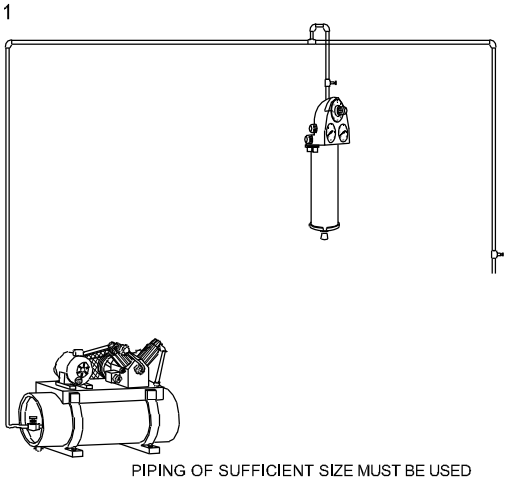
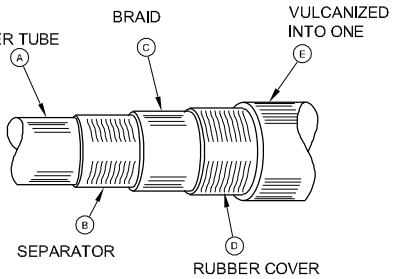


Fig 2



FLUID HOSE TWO - BRAID CONSTRUCTION

APN163922

Air hoses are constructed similarly to fluid hoses except inner liner is a different material such as nitrile rubber air hose outer cover is usually red and can be smooth corrugated. Some hoses are built with the special static wire between the outer cover and the braid. (Fig 3)

Colour code of water line

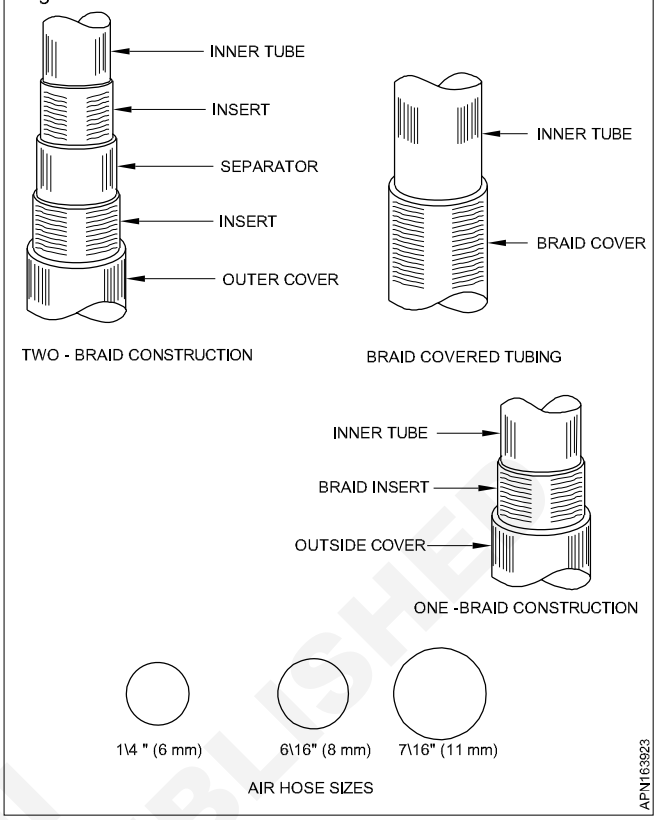
Fresh water line colour code is green and white

Fuel line colour code

Fuel gas line colour code is yellow/block and brown/white and fuel oil line colour code is also same as above mentioned colour.

Pipes are used in facilities to transport liquids and gasses from one place to another, both short and long distances. The pipe colour coding is very essential to track the correct pipe line during pipe line maintenance or repair.

Fig 3



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Refinishing materials

Objectives: At the end of this lesson you shall be able to
- **state the different type of refinishing material**
- **state the masking method.**

Paint material types

Lacquer based automotive paints due to fast drying process and thin body, these paints flow smoothly. The paint materials are as follows

- Acrylic lacquer
- Enamel paint
- Waterborne enamels

Paint Classification

- Urethane paints
- 2 - Pack paint

Automotive paint is made out of 5 components

- Pigments - Prime pigments to impart colour and opacity
- Binder (resin) - a polymer often referred to as resin forming a matrix to hold the pigment in place.
- Extender - Larger pigment particles added to improve adhesion strengthen the film and save binder.
- Solvent (Thinner) - Either an organic solvent or water is used to reduce the viscosity of the paint for better application water borne paints that use volatile organic compounds such as the hydrocarbons which are harmful to the atmosphere.
- Additives: Used to modify the properties of the liquid paint or dry film.

There are two types of car paint materials in the market, waterborne and solvent based.

Lacquer

At the automotive assembly plant, the lacquer is sprayed on the metal surface. To achieve the high gloss the lacquer finish must be rubbed out. This process is called compounding. After the lacquer has dried sufficiently.

Enamel

Enamel paint that air dries to a hard usually glossy, finish used for coating surface that are outdoors or otherwise subject to hard wear or variations in temperature. The term of enamel paint is used to describe oil - based covering products. However recently many latex or water based paints have adopted the term as well most enamel paints are alkyd resin based. Some enamel paints have been made by adding varnish to oil - based paint. Enamel paint also refers to nitro - cellulose based paints nitro cellulose enamels are also commonly known as modern lacquers.

Categories of enamel paint

- Floor enamel
- Fast dry enamel
- High temperature enamel
- Nail Enamel
- Epoxy enamel, Polyurethane enamel
- Wood and building enamel

Water Based Paints

It contains filter, pigments and binder all dissolved in water. Their low level of volatile organic compound (VOC) made it a go - to paint after the new voc regulation. This makes them environmental friendly paint with minimum to zero harmful effects on human health. Quality of water based paints have 100 percent acrylic binders that makes the paint especially durable and very flexible latex paint adheres well to a variety of interior and exterior surfaces.

Types of water based paints

There are two types of water based paints

1 Acrylic

2 Latex

Water is the ingredient that accounts for most of the benefits of latex paint as well as a few of the disadvantages. Water based paints becomes difficult to use when temperature fall below 50 degree Fahrenheit. The lower temperature also make it possible to see brush strokes in the final results.

Paint Pigments

A pigment is a colored material that is completely or nearly insoluble in water pigment is a material that changes the colour of reflected or transmitted light as the result of wave length - selective absorption. Pigment are used for edour paint ink, plastic fabric, cosmetic, food, and other materials.

Pigments are very fine powder that have their own colour and they are colour material for paint. Paints are mainly made of pigments and binders. Each pigments have their own chemical and physical properties.

Paint Binders

Paint is essentially composed of a binder pigment and solvent. The binder exis to hold the pigment to the surface. The binder is polymeric substance and is either dissolved in the paint or suspended it by emulsifiers.

Paint Solvents

Solvent is a material which dissolves another materials. For example when you add water to salt or sugar they dissolves in water forming solution. In other words, a solution contains a solvent in which the solute or the material is completely dissolved. This is a physical mixture, both the solvents and the solute can be separated by physical processes like distilling and evaporation.

Paint additives

Paint additives commonly used extenders include clay, silica, diatomaceous silica, calcium talc and zinc oxide additives can be used to speed up drying and improving gloss. Other additives slow drying. Additives that speed up curing and improve gloss are called hardeners. Additives that are slow drying are called retarders. Additives that are lower gloss are called flatteners.

Drying

As the paint dries a film is formed which adheres to the surface of the material to which it is being applied. On applying gloss paints the alkyd polymer cross links by an oxidation reaction with oxygen in the air once the solvent has largely evaporated.

The paint drying process corresponds to the evaporation of all solvents added to the paint in order to make it liquid or reduce its viscosity.

Hardening

The hardening of paint corresponds to the process by which main polymer of the paint it creates and hardens with all other pigments and additives which comprises the paint, creating a solid and adherent coating.

Curing

The Paint curing process corresponds both drying and hardening process curing = Drying + Hardening.

Physical curing paints correspond to the set of paintings where the main resin is already formed to cure the paint is only required to evaporate the solvent input into the painting itself chemical curing paints correspond to the set of paints where the main resin is created through chemical reactions between various compounds, in this type of cure is necessary both drying and hardening process.

Type of curing process

1 Hot air curing

2 Radiation curing

3 Curing by electrical process

Flash

Flash points are determined experimentally by heating the liquid in a container and then introducing a small flame just above the liquid surface the temperature at which there is a flash/ignition is recorded as flash point.

The lowest temperature at which a liquid gives off sufficient vapour to form an ignitable mixture with the air near the surface of the liquid or within a container. Painting material with flash point below 100°F (38°C), such as most solvents and solvent borne coating are considered dangerous. The standard method for flash point is defined in ASTMD3941.

Paints, linseed oil, mineral oil - flash point - 141 - 199°F (61 - 93°C)

Paints oil base, neats foot oil flash point (III - B) - 200°F (93°C above)

Retarder

In painting a retarder is a substance, usually added to water, used to slow the drying time of acrylic paints, giving more time for blending or layering highlights.

Accelerator

It is an liquid additive which is used in small quantities with 2k hibernate hardeners to achieve rapid through curing, it may be used with normal or medium solids (ms) or high solid (hs) system for air drying or storing and accelerates the through curing of 2k primers, top coats and clear lacquers, significantly reducing solving times - offering increased through put and energy - saving in the workshop.

Paint Catalyst

A catalyst is a chemical which makes a chemical reaction go faster but is not itself used up in the reaction in paints. Catalysts speed up the formation of polymers from the resin. Cobalt or manganese naphthenate are used in gloss paints to accelerate the polymerisation of the alkyd resin.

Paint adhesion

In the paint and coating industries, paint adhesion testing is often used to determine, if the paint or coating will adhere properly to the substrates to which they are applied. There are several different tests to measure the resistance of paints and coatings from substrates cross cut test, scrape adhesion, pull off test and other carried out.

Paint adhesion promoter

Rust-oleum adhesion promoter is fast drying clear primer that helps paints adhere to polyolefin surfaces such as

automotive plastics vinyl, trim bumbers, fibre glass and more adhesion promoter features an advanced spray system that allows you to spray at any angle.

Paint blending solvent

Blending solvent is a specially formulated solvent to assist in dissolving the dry edges of freshly sprayed 2k clear coat blending properties enable the job to be confined to a spot repair.

Paint toners

Pigments, colorants or toners, as they are called in the market, are actually finally ground particles, which produce a specific nuance. The paint can be toned individually, by hand or at a paint store, with the help of a machine, by adding a certain amount of pigment.

Paint primers and sealers

Sealer is designed to be used prior to or in place of a primer, sealers are special primers designed to perform some of these functions - provide good adhesion, recondition poor substrates such as crumbly old concrete tiles.

Sealers are not porous and what that means is that it will resist absorbing moisture, whereas primer can absorb moisture and get trapped in the primer. A good 2k sealer creates a moisture tight sealed barrier between the prepared surface and the top coat.

Self etching primer

Self etching primer is a rust preventive coating that etches and primes in one coat. Self etching primer features an advanced spray system that allows you to spray at any angle, even upside, down for those hard to reach areas.

UV Primer

UV primer is an innovative primer surfaces that uses UV radiation to cure, allowing painters to sand in as little as 2 minutes after application. This high build primer is suitable for a wide range of substrates and comes in a convenient aerosol package, making it easy to use and spray.

Primer Surfacer

When brushed or sprayed to metal or fiber glass surfaces this high build, rust resistant sand able formula will hide sanding scratches and quickly fills uneven surfaces improves top coat adhesion and appearance.

Epoxy Primer

Epoxy primer refers to sealer that is a non - porous finish. Epoxy primer not only offer excellent adhesion to metals, but also serve as a proper base for extra under coat products and top coats paint. Epoxy primer can be used over fibre glass, plastic or the black iron phosphate coating. This primer ability of an epoxy primer to ressis corrosion is related to its thickness. The thicker the epoxy primer layer, the better the protection. This primer can also be used on cracks and dents its banding capacity is excellent and produces a good surface finish.

Prep solvent: Paint Materials

The 3m prep solvent 70 is a low VOC water based solvent that works well for removing grease oil wax, and silicon from surfaces before coating. It can be used to clean metal painted surfaces and primed metal before applying paint or primer on them.

Paint Flattener

Flattener additive can be used to flatten any catalyzed cross/single stage colour. Achieve any of the established gloss levels flat satin and semi gloss or custom match for desired degree of gloss. It can be added to existing catalyzed ready to spray intermix colour, eliminating the need to formulate any additional cross/fire @ intermix colour qualities.

Flattener additives are versatile enough to be used in both national rule and VOC regulated areas.

Fish eye Eliminator

Fish eye eliminator is a special liquid additive that is formulated to allow epoxy systems to flow out on silicone or oil contaminated substrates, including existing epoxy and urethane floors.

The additive decreases fish eye or cratering by lowering the surface tension of the product to which it is added. This helps prevent beading of the liquid on the contaminated substrate.

Flex Agent

Flex additive has been recognized as an additional operation and or material necessary, when refinishing flexible parts such as bumper covers. Some paint manufactures have minimized or eliminated the need for flex additive in the clear coated portion of a base coat/ clear coat system.

Anti-chip coating

Anti - chip coating - water based is available in 2 colours it can be used for under body wheel arches, front and rear valences, body sills, new ports and repaired panels. This anti - chip coating is fast over paintable, has excellent rust prevention properties, excellent flexibility and non sag.

Features of water based Anti-chip coating:

- Water based under body coating.
- Fast over paintable 30 minutes up to at least 72hrs (without sanding) with all usual paint system, including water based.
- Excellent stone chip, weathering and corrosion resistant.
- High performance

- Fast drying
- Excellent sag resistance
- Sound deadening
- Temperature resistant - 25°C and + 130°C
- Available in black and gray colours

Metal Conditioner

It is a liquid phosphoric acid based product that effectively cleans the metal surface and removes rust. It is also used when only a simple metal treatment is required prior to painting. Rust removal is accomplished quickly due to the deep penetration and dissolving of the surface soils.

Paint Stripper

Chemical strippers are used to remove the paints by spreading on the surface of the metal sheet by using disposable brush. Generally not to brush in multiple directions and to apply thickly.

Best paint stripper

- Citri-strip paint and varnish striping gel
- Max strip paint of varnish stripper
- Eco-Friendly - Dumont chemicals smart strip advanced paint of varnish remover
- Excel blades K11 Paint remover
- Porter - Cable paint remover gun
- Foshan paint removers
- Sunny side ready strip paint and varnish remover
- Super remover - paint stripper
- Sunny side 2 - minute remover gel

Tack Cloth

Tack cloth work great for dust removal on auto body during painting process and galaxy tack cloth 12 patch works as perfect for wiping down items right before paint on the metal surface.

Masking Materials

Masking Paper

It is great for protecting panels, doors, glass and floors from paint spills, over - spray and splatters. It also great for a variety of surface protection jobs as well as many diy crafts. Paper masking is choice of professional painter.

Printer masking paper

Different type and sizes of primer masking papers are used by auto body painting professionals. Primer masking begin back mask primer application area using tape and paper. For individual product instructions and applicable precautions given on product labels and associated literature for the individual product.

Plastic masking tape

Masking with plastic has over paper is speed it eliminates dust better. The majority of painters use plastic mask for most of the car and then use paper around the edges. Plastic mask saves on tape too, plus dirt can't hide like it can in the folds created paper. When you stretch the plastic tight, you leave no place for dirt or specks of whatever to hides and pop out onto paint job.

Masking with plastic - steps

1 Prepare all the panels as normally would. Then cover the car with plastic, stretching it down to within 2 inches of the type bottoms. Then use 2 inch tape to stick the plastic to the types if the tape wouldn't stick because of type dressing, just pass the tape around to the back of the type where it will stick.

2 Using blade carefully cut out plastic around the area to be painted.

3 Usually put on two full wet coats of adhesion promoter using paint gun. The rattle cans just have too much orange peel for panels.

4 Let it go through the booth cycle, flash and then bake for five minutes. You are now ready to paint as used. After baking your clear or after air - dry, you can demask the car.

Paint masking paper

Paint masking paper is used around the panel surface to be painted.

Tips and tricks for proper masking

- Prepare the surface for masking make sure to prepare properly the mask. It should be smooth and clean dry and free from dust.
- Apply masking tape under the edges around the masking area.
- Use masking paper or film to cover nearby areas
- Use specific products for high precision application.

Masking tape

Masking tape also known as painters tape. It is a type of pressure sensitive tape made of a thin and easy to - tear paper and an easily released pressure sensitive adhesive. It is available in a variety of width. It is used mainly in painting to mask off areas that should not be painted. Masking tapes tend to leave residue behind, if left for the duration of paint project.

Fire line masks

N.95 particulate filtering respirators do a great job of filtering out particulate matter. But they don't absorb toxic chemical vapors. To do that you need activated carbon.

Fine line masking tape

Fine line tape is vinyl or nylon paint masking tape for fascia, rocker panels, two - tone and other multiple colours application, where critical paint break lines are required. The confirmable backing is designed for uniform stretching to help create better paint lines.

Wheel masks

Wheel masks simply hook over back of type and whole front of wheel is masked when dipping the car, takes second to do.

Abrasives

Abrasive materials

Abrasive is a material, often a mineral, that is used to shape of finish a work piece through rubbing which leads to part of the workpiece being worn away by friction. In short the ceramics which are used to cut, grind and polish other softer materials are known as abrasives.

There are two types of abrasives.

1 Natural

2 **Manufactured:** Important natural abrasives such as emery corundum and diamond are used only in special types of grinding wheels and honing stones.

Abrasive grit

The grit size indicates the abrasive grade on the abrasive side of the paper. A higher grit number indicates a smaller abrasive grain and firer abrasive product. A 'p' in front of the grit size indicates that product is graded in accordance with the European standard. The grit of sand paper refers to the size of the abrasive particles bonded to the paper. The higher the grit the smaller particles and the finer the scratches left behind.

Grit ratings

The grit of sandpapers is a ratings of the size of abrasive materials on the sandpaper. The higher the grit number is equivalent to a finer. Which creates smoother surface finishes. Lower grit numbers coarser abrasives that scrape off materials much quicker.

Open and closed coat grit

Open - coated sand paper has abrasive material covering approximately 70 percent of its surface. Leaving room for saw dust to build up. Which helps prevent clogging. Closed coated sand paper is completely covered by abrasive material.

Grinding disc

Grinding disc is used to grind and remove the rust and dust particle on the surface of panel. There are many types of grinding disc.

- Straight grinding wheel
- Large diameter grinding wheel
- Grinding cup wheel
- Grinding disc wheel
- Segmented grinding wheel
- Cutting face grinding wheel

Dry and wet type sand paper

The difference between dry sanding and wet sanding is the movement used. Dry sanding requires small circles. Wet sanding uses straight lines, alternating direction between passes. Wet sanding is a process that's often used on car paint jobs, guitars and even 3D prints to give them a mirror smooth look.

Wet sanding is typically done after dry sanding to get an even finish. Unlike dry sanding wet sanding is done, not to shape a surface, but to remove the large scratches left by dry sanding.

Scuff pad

It is designed for scuffing base primed or painted surfaces prior to applying primer or paint excellent for removing light surface rust can be used wet or dry rinses clean for repeat use. Scuffing pad is designed to prepare the surface prior to painting.

Rubbing compound

Rubbing compound is a material used to restore old paint work and it acts as a new top coat of the vehicle. It also helps conceal scratches in vehicle paint. First wash the vehicle thoroughly with soap and water. Then use sand paper and an orbital polisher to smooth down existing scratches.

Polishing compound

It is used for the finishing of painting surfaces to a high luster mirror like finish and it is giving mirror finishing and removal of more products than other ordinary polishing compound. The scratches varnish quicker with this polishing compound.

Adhesives

Adhesive also known as glue cement mucilage or paste is any non metallic substance applied to one or both surfaces of two separate items that blinds them together and resists their separation.

Epoxies

Epoxy resin are characterised by their very good electrical properties and chemical resistance, good strength and low absorption of moisture.

Expoxies operates as formulator of expoxies, urethanes, and silicons. The company produces adhesives, potting, encapsulating and casting, electrically conductive resins, thermally conductive resins, UV curable illuma bond epoxy doming resins trigger bond, and non - hazardous products.

Composition of paint

All paints generally have four main ingredients - pigments, blinders, solvents (liquid) and additives. Pigments provide colour and hide while blinders work to bind the pigment together and create the paint film.

Types of paint

Paint manufactures manufacture in various types of paint for various work (painting jobs). They are as follows

- Oil paints
- Enamel paint
- Emulsion paint
- Cement paint
- Bituminous paint
- Aluminium paint
- Anti corrosive paint
- Synthetic rubber paint

Impact of paint

The impact of paint diverse. Traditional painting materials and processes can have harmful effects on the environment including those from the use of lead and other additives. Measures can be taken to reduce environmental impact including accurately, estimating paint quantities. So waste is minimized and use of environmentally preferred paints coating painting accessories and techniques.

Paint components on plastic and rubber parts

Although plastic and rubber can now be produced in all colours and with a matt or a glossy surface, in many cases they still have to be painted. On the one hand, plastics must be painted for aesthetic reasons.

The solvents absorbed by the plastic material, when it is cleaned must be removed completely before the coating is applied otherwise they will cause a build up of vapour pressure between the plastic and the coating, ultimately reducing the adhesion. The risk of solvent popping and pin holing is also increased.

Top coats and undercoats must contain the right amount of plasticiser. Too little and coatings usually crack under mechanical strain. A perfect refinish on plastic components is the result of skillful workmanship, correct preparation and the exact choice of colour. Standox offers refinishers many useful aids for precise colour matching. Always refer the technical data sheet and other latest information on the paint component on the plastic and rubber parts.

Paint techniques

Auto body painting is usually done by a professional auto body shop, the test requires all kinds of special equipments and safety precautions.

Materials required for refinishing work

- Plenty of 1200 & 2000 grit wet and dry sand paper
- Electric or air powered sander
- Masking tape
- News paper (For masking off)
- Air compressor
- Paint spray gun
- Buffer
- Paint thinners
- Face masks
- Safety glasses
- Under coat
- Top - coat
- Clear coat lacquer
- Dust extractor
- Wash the car and hose down the surrounding area. If you plan to paint something with detail on specific areas of the car, block off those areas with masking tape and masking paper.
- Use the power sander to strip away the old paint using circular motion you may have to manually sand the corners and other tricky areas. Go from front to back and make the surface as smooth as possible, the smoother it is the better the paint finish. After sanding, wipe down the whole vehicle completely. Dust sand paper remnants, and other debris will cause imperfections in the vehicle.
- Mix the primer with the thinners. Apply the primer, working from the roof down it might take 2 - 3 coats to cover the car surface completely.
- Assume 10 minutes per application and 20 minutes of drying time.
- When dry, the primer will be powdery on the surface, so use 2000 grit sand paper to smooth and wipe it down.
- Clean the spray gun and wipe down the primed surface with a rag slightly dampened with thinners (Note: If you apply too much thinner to the rag the thinner will strip the primer you just applied)
- Apply 3 - 4 coats of the paint with the same sweeping strokes.
- Again, each coat will take about 10 minutes to apply and 20 minutes to dry. Before applying the final coat, go over the car one last time with sand paper followed by a clean rag to get rid of any final residue.
- Apply the clear coat lacquer.
- Remove the masking tape with the lacquer is still wet

Note: if you find any problem areas, sand them with the 2000 grit wet and dry sand paper and re-spray

Once everything is dry, buff the whole thing with a soft buffer, using a circular motion. Be careful not stay in on spot too long, it could ruin the finish.

Body fillers

Objectives: At the end of this lesson you shall be able to
- **state the different type of body fillers**
- **state the body filler hardener**
- **state the polyester glazing putty**
- **state the rust repair procedure.**

Body plastic filler: Filler materials are particles added to resin or binders (plastics, composites, concrete) that can improve specific properties, make the product cheaper, or a mixture of both. Most of the filler materials used in plastics are mineral or glass based filler materials. The curable polyester resin compositions of the invention are use full as plastic body filler for repairing metal surfaces. Metal surfaces of the parts to be used in automotive bodies.

Body filler ingredients: The majority of body fillers that were used the five main components, polyester resin talc, styrene, titanium dioxide and glass silica bubbles. The polyester resin is a proprietary formulation determined specifically by the manufacturer.

Body filler hardener: A special additive designed to promote a faster cure of the body filler and faster cure of the enamel paint film.

Putties: A stiff paste made of whiting and linseed oil that is used to fix glass panes into frames and to fill cracks or holes in wood or metal surfaces.

The name of putty is also applied to substances resembling putty, such as iron putty, a mixture of ferric oxide and linseed oil, and red - led putty, a mixture of red and white lead and linseed oil, certain dough like plastics are also called putty. Putty powder tin oxide is used in polishing glass, granite and metal.

Light weight body fillers: Light weight body fillers are used to repairs car body dents, dings and cosmetic imperfections on bare metals and fiber glass reinforced polyester. This body filler comes in a creamy formula that is easy to mix, spread and sand. The filler cures tack free in 20 minutes with good handling characteristics. It resists loading sand paper, so sanding is easier and can use less abrasive. This is a two component product that includes both filler and cream hardener.

Premium fillers: Premium body filler is high - build with excellent filling capabilities and excellent adhesion to metal fibre glass and superior coverage and feather edging ability. Premium fillers process no glazing putty required. This custom blended premium body filler helps to finish body work faster and more effectively. Always wear eye, skin and respiratory protection when using this product apply in a well ventilated area.

Spot putties: Bando glazing of spot putty is easy to use, dries fast and stays durable ideal for filling pinholes in body filler and covering the panel scratches, paint chips and minor dings.

Polyester glazing putty: Polyester glazing putty is elastic and very easy to sand. Polyester putty is re - spray able with all lacquer systems and resistant to chemicals and water influences. Mo tip polyester putty can be applied in layers with a thickness upto 2 centimeters.

Applying body filler

— Clean the body surface to be fill the body filler

— Rough up the surface without removing a significant amount of primer

— Clean the sanding dust so the surface would be nice and clean for the filler to adhere to

— Before applying body filler, see the gap between the body panel and the piece of spring steel.

— Prepare the body filler with mixing hardeners and apply the right amount of hardener and make sure mix it through with the filler.

— Apply the mixed filler to the area needing it.

— After applying the filler use the spring steel again to even out the surface and remove the excess filler.

— Lets the panel sit outside in the sun for the filler to cure or use the heat lamp to curing process. Usually this takes about 10 -15 minutes.

— After filler was ready lightly sanded over the area to get an idea.

— If the two spots in the surface still exist requiring more filler.

— Apply a little more filler than sand off a large amount to get a surface even.

— Apply guide coat to the filler so can see the high and low spots and then sand and check the surface

— Final check how the finished area looked.

Surface preparation for filler

— Inspect, remove, store and replace exterior trim and moulding.

— Soap and water wash entire vehicle, use appropriate cleaner to remove contaminants

— Inspect and identify substrate, type of finish and surface condition, develop a plan for refinishing a total product system.

— Remove paint finish

— Dry or wet sand areas to be refinished

— Feather edge broken areas to be refinished

— Apply suitable metal treatment or primer

— Mask trim and protect other areas that will not be refinished

— Mix primer, primer - surfacer or primer sealer

— Apply primer onto surface of repaired area

— Apply two - component finishing filler to minor surface imperfections.

— Dry or wet sand area to which primer - surfacer has been applied

— Dry sand area to which two - component finishing filler has been applied.

— Remove the dust from area to be refinished, including cracks or mouldings of adjacent areas.

— Clean area to be refinished using a final cleaning solution.

— Remove with a tack rag, any dust or link particles from the area to be refinished.

— Apply suitable sealer to the area being refinished, when sealing is needed or desirable.

— Scuff sand to remove ribs or imperfection scalar.

— Use the personal safety devices during surface preparation.

Ingredient: An ingredient is a substance that forms part of a mixture and it is used to prepare a specific paint materials. Ingredients are purported to make them better than competing products.

Characteristics and application of body filler and putties: Putty and body fillers are filling material that is used to provide a right and perfect level to the surface and also filler hollows, craters, cracks, dents and imperfections that may contain the surface.

Characteristics of polyester body putty

— Soft is a 2 component polyester quick filler

— High degree of fireness

— Pore free surface and fire featheredging capabilities

— Thixotopically adjusted

— Homogeneous and smooth surface spreading

— Surface dry hardening and great dimensional stability

— Easy sanding properties

— For use on steel surfaces only

— Not for use on zinc and aluminium surfaces.

Application: Putty is used for filling in deep uneven areas and dents on motor vehicle body work in the area of cars, lorries and buses and railway vehicles, and for covering filling and fiber putty.

Characteristics of body filler

— High degree of finishing

— Excellent adhesion

— Quick drying

— Reduce the repair time

— Durable coverage

— Multi substrate

— Universal application

— Deep filling properties

— Ideal for large repairs

Application: Body filler are used for filling in deep uneven areas and dents, dings on automotive body surface.

Mixing and spreading body filler

- Clean the body surface to be body filler spreading.
- Sanding the surface and clean the sanding dust from the body surface.
- Ensure the body surface is ready for apply body filler.
- Select the suitable contour premium body filler.
- Place the body filler mixing board on the table and wipe it with clean cloth.
- Open the body filler container tin cover.

Rust repair procedure: Identify the rust area on the panel. Remove the rusts by hand cleaning and sanding process. Clean the bare metal with metal conditioner. Metal conditioner is an acid compound that neutralizes microscopic rust particles. The acid also etches the metal surface to improve the bond between the metal and the primer surfacer. Metal conditioner is bolted in concentrated form and must be diluted with water before use. Always

wear rubber gloves and safety glasses when handling conditioners. Follow the manufacturer's instructions carefully when diluting the conditioners. Remove the rusted metal and weld patch on the rust metal remove place and neutralizing remaining surface rust. Prepare the fibre glass filler and apply the filler on the prepared surface. Ensure fibre glass filler is properly lulled on the rust removal surface use sanding tool to smoothness of surface as study earlier.

Corrosion protection

Objectives: At the end of this lesson you shall be able to
- **state the causes for corrosion**
- **state the anti corrosion materials**
- **state basic surface preparation**
- **state the corrosion protection primers**
- **state exposed joints and interior surfaces.**

Corrosion: Corrosion is when a refined metal is naturally converted to more stable from such as its oxide, hydroxide, or sulphide state this leads to deterioration of the material. Corrosion also happen when metals like steel are placed too much stress causing the material to crack.

Cause for corrosion: Obviously, the most common type of corrosion is the formation of rust or iron oxide on the surface of metals containing iron, when acidic substances come in contact with metals such as iron and steel. Rust begins to form.

There are two types of corrosion

Chemical corrosion

Atmospheric corrosion

And other types of corrosion

1 Uni for attack
2 Two metal corrosion
3 Crevice corrosion
4 Pitting
5 Inter granular corrosion
6 Selective leaching
7 Erosion corrosion
8 Stress corrosion cracking

Anti corrosion materials: Anti corrosion refers to the protection of metal surfaces from corroding in high risk environments. When metallic materials are put into corrosive environments, they tend to have chemical reactions with the air or water. The effects of corrosion become evident on the surfaces of these materials.

— Epoxy resins
— Painting material
— Adhesives
— Laminates
— Nickel or chrome, electroplate
— Composites
— Potting
— Encapsulate for semiconductors
— Insulating material for electrical
— Silicones and phosphorus based compound
— Aluminium and zinc coating

Basic surface preparation: Surface preparation is the first stage treatment of critical parts and equipment against corrosion. It is the essential first step before anti corrosion coating is applied. Surface preparation is most often used for steel, aluminium and concrete materials. There are many types of surface preparation methods used in the paint shop. They are as follows.

- Hydro blasting/water felting
- Sweep blasting
- Spot blasting
- Blast profile
- Abrasive blasting
- Solvent cleaning

The choice of preparation method will depend upon the repair areas to be prepared and the equipment available.

Steps in surface preparation

- Straightened and filled the damaged metal surface
- Blow the dust off including the dust between joints
- Wash the car with clean water and dry it completely
- Clean the area to be corrosion treatment areas. Using a wax and silicone remover to remove all traces of wax, tar and polish.
- Examine the type of damage and condition of paint.
- Grind off the paint and feather edge out to good paint surrounding the damage.
- Re-clean the area to be repainted with wax and silicone remover
- Clean the metal with a metal conditioner. This dissolves any rust or corrosion and also slightly etches the metal.
- Apply a suitable metal treatment or conversion coating to the surface to help prevent rust and to provide maximum adhesion of the primer.

Corrosion - protection primer: Primers is a under coat material it prevent rusting and corrosion. Primer also helps to bond the topcoat to bare metal.

Corrosion treatment areas: In an automobile vehicle body is used the metals and plastics but this metals are affected by rust and cracks due to various reasons as study earlier. Rusted area to be treated by corrosion treatment.

Exposed joints: Car body made by plastics and metals. The metals are not in single piece. But it is assembled by many pieces. The different metal body part like door, mudguard, bonnet, wind shields and tool box. Where metal pieces are joined together there is a joint gap between two pieces. The metal joint gap to be cleaned for rust and dust removing and then apply metal conditioner to protect from rust. There after fill the gap by seam sealer.

— Final the top-coat and clear coat are applied on the interior of exterior surface.

Estimating repair cost

Objectives: At the end of this lesson you shall be able to
- **estimate direct repair program**
- **estimate the time factor**
- **estimate the work orders**
- **using the estimate guides.**

Description of Estimate: Auto body repair estimates are called different names, including damage report, damage estimate and auto estimate but they all are basically the same thing. A damage estimate however is more than gust a sheet of paper listing the total cost of repair. An auto body repair estimate is a an agreement between the repair shop and customer and the customer should sign the agreement to authorize the repair shop to repair the vehicle.

Repair estimates do not guarantee the exact amount of the final invoice. There may be hidden damage, parts price, adjustments or many other factors that may change before the vehicle is completed.

The sequence of an estimate: Mask estimator starting with front between and ending with the rear bumber. Follow the steps to prepare the estimate of auto body repair.

— Park the vehicle on work spot

— Inspect the vehicle front bumber to rear bumber inch by inch

— Inspect the interior and bottom of the vehicle damage by direct & indirect force

— Note down the parts damaged in the estimate form

— Refer the estimate guide for parts price, labour cost, labour (work) time, paint material cost and labour time and labour cost.

Insurance company also need the assistance of estimator. Insurance appraisers may generate their own estimates or they may inspect the damage and agree to the body shop's estimate.

Measurement may need to be made during the inspection process tools used to measure include tape measure, tram gauge ruler and possibly a computerized measuring system to fully analyze the damage.

A seam tool may be needed to check error codes that may have been caused from the accident. This can be check engine, light, air bag etc.

The estimator will need estimating guides or an estimating computer system for labour times and prices for parts and other materials. Most repair shops are using estimating computer systems.

Calculate shop labour rate: The labour times fall into different categories which are body labour, refinish labour frame labour and structural labour. It is important to record the type of labour and labour rates. For each categories separately to calculate the labour cost.

Per hour rate x Total work hour = Total labour cost

Calculate the part price: Original and other parts price which part is used to replace the damaged parts as original company parts and other manufacturer part

Original parts price x Number of parts used = Total cost

Other parts price x Number of item used = Total cost

Parts other repair cost x Number of items repaired = Total cost

Total cost of parts + repair cost = Total cost

Add refinishing material total cost with labour cost + spare parts cost + shop profit + GST = Estimate cost

Estimate cost = Body shop material cost + Spare part cost + Electrical, frame work, mechanical, structural, refinishing estimator and other total labour cost + refinishing material cost + shop profit + GST

This estimate cost is covered approximately to bring the vehicle into original condition.

Paint spray gun and paint mixing method

Objectives: At the end of this lesson you shall be able to
- **state the painting environment variable**
- **state the function of spray gun**
- **state the types of spray gun**
- **state importance of spraying material viscosity**
- **state the paint mixing methods**
- **state the spray gun adjustment and maintenance**
- **state the different type of paint spray booths**
- **state the sanding and masking method.**

Painting Environment Variable: Painting environment variables are text strings that contain information to dynamatically configure a software application when it is launched for example to specify a particular drink, director path preference setting or filename.

Environment variables can be set locally for a single user account by the user or more globally for an entire system of users by a system administrator.

Steps to keep dirty from finish during body repairs

Tips for safety

1 A well-ventilated, safe, and clean shop will keep the skilled personnel healthy; they are the most precision assets.

2 Well-lighted and neat working areas encourage and improve the performance of employees.

3 When spray painting, always wear a respirator of the appropriate type for the materials used, especially when using isocyanates.

4 The shop should be kept free from debris, rags, and old parts as a fire could be a calamity.

5 All paint and solvents should be stored in approved cabinets or in storage rooms that have explosion-proof lights and adequate ventilation.

6 Never more than a day's supply of paint materials should be outside of an approved storage area.

7 All solvent drums must be grounded and bonded to containers while being used.

8 High-flash paint solvents should always be used when possible.

9 No smoking signs should always be posted in spray areas or any other critical area. Any spray area should be 20 feet or 7 meters from flames, electric motors, sparks, or any other ignition source. All spray areas should be free of hot surfaces and any lamps in the spray area should be enclosed and guarded. Any electrical drying apparatus must be properly grounded and vented.

10 Adequate ventilation must be provided to remove any solvent fumes.

11 The right type of fire extinguishers must be placed in strategic locations, and they should be checked periodically to be sure they work.

12 Care should be used to prevent spilling of solvents or liquids.

13 Hands should always be washed before eating or smoking.

14 Always read directions on labels to find the safe way of using products and for first aid instructions.

15 Aisles and walkways should be kept free of tools, creepers, or any other objects that might cause somebody to trip or stumble.

16 All floors should be kept clean; any paint, oil, or other materials should be cleaned up immediately, and any holes in the floor should be repaired.

17 Used cloth or paper towels should be stored in a covered container and then removed from the shop at day's end and stored in a proper garbage bin or tank.

18 Always wear safety goggles to protect the eyes from flying objects, particles, and splashing liquids.

19 Always wear the appropriate respirator or dust filter masks when painting, machine sanding, or sandblasting. These respirators or dust filters protect your lungs from the harmful effects of solvents, dust, and fine silica sand dust.

20 If at all possible, wear safety shoes; they have a metal insert that prevents injuries to the toes from falling objects.

21 Always place safety stands under the axles of a vehicle that is jacked up and block the wheels.

Steps in painting a car body

The panel must be straightened and repaired, filled with plastic filler, and sanded. Then it is given additional treatment. Here are the various steps:

1 Sheet metal and frame are repaired and straightened by the methods learned.

2 Sheet metal is filled with plastic filler and sanded down to contour.

3 Dust is wiped off. The car is washed and dried. All crevices where dust might collect are blown out with compressed air.

4 Repaired area is smoothed with fine sandpaper and blown clean.

5 Car is masked as explained in previous lesson.

6 Repaired area is wiped down with clean paper towels and tack rag.

7 Bare metal is treated with metal conditioner and conversion coating to prevent rust and provide a slightly etched surface for good undercoat adhesion.

8 Primer coats are sprayed on.

9 Guide coat is sprayed on and wet-sanded to remove any trace of sand scratches.

10 Repaired area is washed clean with water and remarked if necessary.

11 Chip-resistant plastisol material (if used) is sprayed on to specific lower areas of the body.

12 Final colour coats are sprayed on.

13 Clear coat (if used) is sprayed over colour coats.

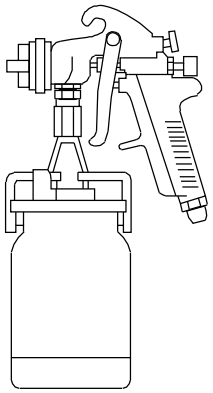
Description of spray gun and its parts: Spray application is perhaps the simplest method of coating. Where a sizeable area or volume of material is involved or when intricate shapes and irregular surfaces require painting. Spray will give the most uniform film thickness making it easy to obtain a smooth finish.

The air spray gun is a tool which uses compressed air to atomize paint or other spray able material and to apply it to a surface. Air and material enter the gun through separate passages and are mixed at the air cap in a controlled pattern. Air spray guns may be classified various ways.

Basic stages of atomization: There are two ways of classifying guns are by the location of the material container and the material feed system.

Figure 1 shows a gun with a cup attached below. This is called suction feed which draws material to the gun by suction. Figure 3 is a gun with a cup attached above. This is called Gravity Feed - the material travels down, carried by gravity. Figure 4 shows a material container some distance away from the spray gun. This is pressure feed - the material is feed by positive pressure. Suction feed is easily identified by the fluid tip extending slightly beyond the face of the air cap, as shown in Figure 2. Suction feed guns are suited to many colour changes and to small amounts of material, such as in touch up or lower production operations.

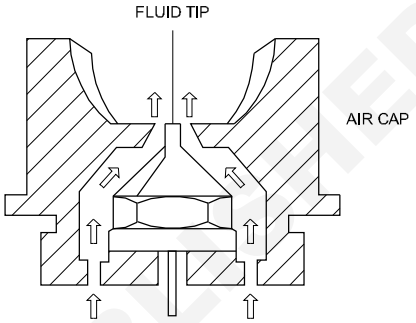
Fig 1



SUCTION FEED GUN WITH ATTACHED CUP

APN186811

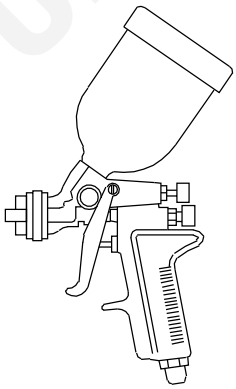
Fig 2



SUCTION FEED AIR CAP

APN186812

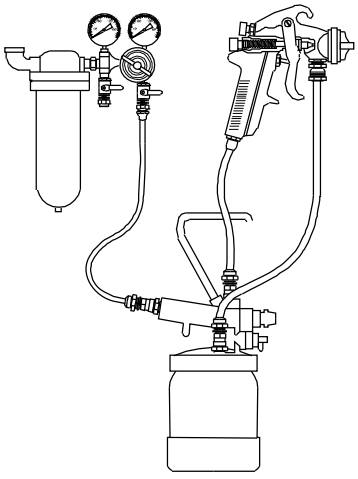
Fig 3



GRAVITY FEED GUN WITH CUP ON TOP

APN186813

Fig 4



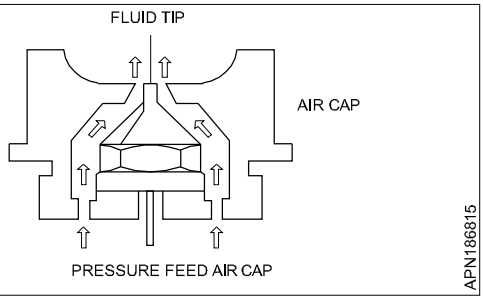
TYPICAL PRESSURE FEED GUN WITH REMOTE CUP

APN186814

Gravity feed guns are ideal for small applications such as spot repair, detail finishing or for finishing in a limited space. They require less air than a suction feed gun and usually have less overspray.

Pressure feed air cap (Fig 5): A pressure feed system is normally used when large quantities of material are to be applied, when the material is too heavy to be siphoned from a container or when fast application is required.

Fig 5



Internal and External Mix Guns (Figs 6 & 7): An external mix gun mixes and atomizes air and fluid outside the air cap. It can be used for applying all types of materials, and it is particularly desirable when spraying fast-drying paints such as lacquer. It is also used when a high quality finish is desired.

Fig 6

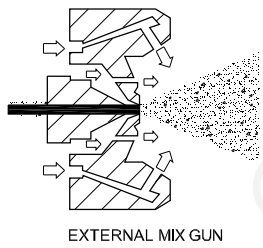
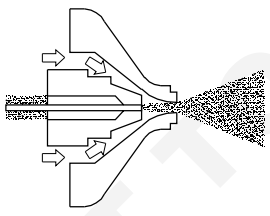


Fig 7



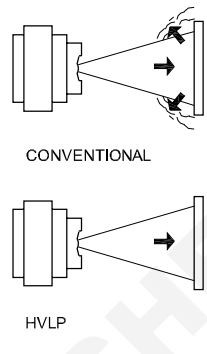
This gun mixes air and material inside the air cap, before expelling them. It is normally used where low air pressures and volumes are available, or where slow-drying materials are being sprayed. A typical example is spraying flat wall paint, or outside house paint, with a small compressor. Internal mix guns are rarely used for finishing when a fast-drying material is being sprayed, or when a high quality finish is required.

HVLP (High-Volume/Low-Pressure): HVLP uses a high volume of air (typically between 15-22 CFM) delivered at low pressure (10 psi or less) to atomize paint into a soft, low-velocity spray pattern.

As a result, far less material is lost in overspray, bounce-back than with conventional air spray. This is why HVLP delivers a dramatically higher transfer efficiency (the amount of material that is actually applied to the part) than higher pressure spray systems.

Air cap overspray conventional/HVLP (Fig 8): The HVLP spray gun resembles a standard spray gun in shape and operation.

Fig 8



HVLP is growing in popularity and it has also been judged environmentally acceptable due to its high transfer efficiency.

HVLP can be used with low to-medium solid materials, including two-component paints, urethanes, acrylics, epoxies, enamels, lacquers, stains, primers, etc. More recently developed HVLP air caps can also satisfactorily atomize even high solid coatings.

Operation

Suction and Gravity Feed Equipment Hook-Up

Connect the air supply from the compressor outlet to the air filter regulator inlet. Connect the air supply hose from the regulator outlet to the air inlet on the spray gun. After the material has been reduced to proper consistency, thoroughly mixed and strained into the cup, attach the gun to the cup.

Suction feed and gravity feed system components (Fig 9)

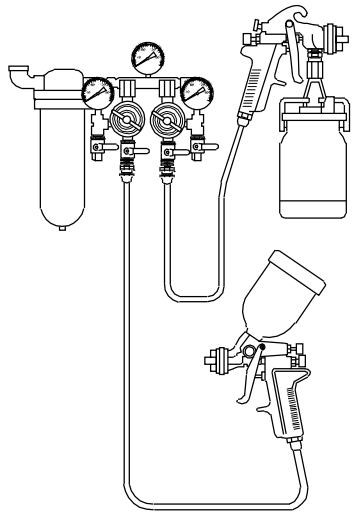
Spray a horizontal test pattern (air cap horns in a vertical position). Hold the trigger open until the paint begins to run. There should be even distribution of the paint across the full width of the pattern (see figure 10). Adjust with fan pattern adjustment. If distribution is not even, there is a problem with either he air cap or the fluid tip.

Horizontal test pattern with even material distribution (Fig 10)

If the pattern produced by the above test appears normal, rotate the air cap back to a normal spraying position and begin spraying (Example - a normal pattern with a #9000 air cap will be about 9" long when the gun is held 8"from the surface) with the fluid adjusting screw open to the first thread and the air pressure set at approximately 30

psi, make a few test passes with the gun on some clean paper. Move the gun faster than usual when spraying the test passes. If there are variations in particle size-specks and/or large globs, the paint is not atomizing properly, increase the air pressure slightly and make another test pass. Continue this sequence until the paint particle size is uniform.

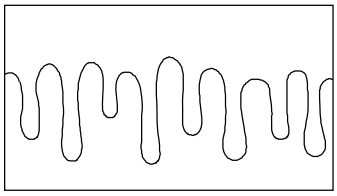
Fig 9



SUCTION FEED & GRAVITY FEED SYSTEM COMPONENTS

APN186819

Fig 10



HORIZONTAL TEST PATTERN WITH EVEN MATERIAL DISTRIBUTION

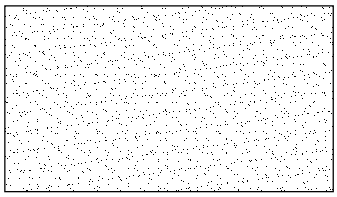
APN18681A

If the pattern seems starved for material and the fluid adjusting screw is open wide (to the first thread), the atomization air pressure may be too high, or the material may be too heavy. Recheck the viscosity or reduce the air pressure.

If the material is spraying too heavily and sagging, reduce the material flow by turning in the fluid adjusting screw (clockwise).

Pattern with uneven particle size (Fig 11)

Fig 11



PATTERN WITH UNEVEN PARTICE SIZE

APN18681B

Pressure Feed Components: A pressure feed system consists of a pressure feed spray gun, pressure feed tank, cup or pump, an air filter/regulator, appropriate air and fluid hoses and an air compressor.

Connect the air hose from the air regulator to the air inlet on the gun. Connect the mainline air hose to the air inlet on the tank, cup or pump.

Warning: To avoid hazardous bursting or equipment damage, do not exceed the container's maximum working pressure.

Connect the fluid hose from the fluid outlet on the tank or pump to the fluid inlet on the gun.

Open spreader adjustment valve for maximum pattern size. Open fluid adjustment screw until the first thread is visible.

Shut off atomization air to the gun. Set the fluid flow rate by adjusting the air pressure in the material container. Use about 6 psi for a remote cup and about 15 psi for a 2- gallon, or larger, container. Adjust the fluid flow in the following ways:

Remove the air cap. With atomization air off, pull the trigger, flowing material into a clean, graduated container for 10 seconds. Measure the amount of material which flowed in that time and multiply times 6 (or flow for 30 seconds and multiply time 2). This is the fluid flow rate in ounces per minute. For standard finishing, it should be about 14 to 16 ounces per minute. If the flow rate is less than this, increases the air pressure in the container and repeat.

When the flow rate is correct, reinstall the air cap. If fluid pressure at the tank, cup or pump exceeds 20 psi, the next larger fluid tip size should be used.

Turn the atomization air to about 30 psi at the gun. Spray a fast test pattern on a clean sheet of paper and check the consistency of the particle size. Increase or decrease the air pressure until even particle size is achieved.

Spray a horizontal test pattern holding the trigger open until the material begins to run. Paint distribution across the full width of the pattern should be the same (adjust with fan pattern adjustment). If it cannot be adjusted, there may be a problem with either the air cap or the fluid tip which must be corrected.

Hints for good spray technique

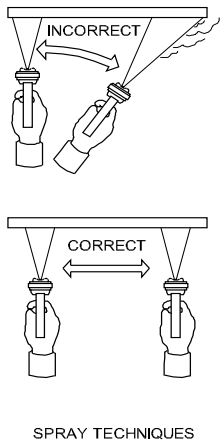
Hold the gun perpendicular 6" to 8" (HVLP guns) or 8"-10" (suction, gravity or pressure conventional feed guns) to surface being sprayed.

Don't tilt the gun in any direction. This will result in uneven paint build causing runs and sags (See figure 12).

Trigger gun just before the edge of the surface to be sprayed. The trigger should be held fully depressed and

the gun moved in one continuous motion, until the other edge of the object is reached. Release the trigger but continue the motion for a few inches until it is reversed for the return stroke.

Fig 12



SPRAY TECHNIQUES

APN18681C

Overlap each stroke 50%. Less than 50% will result in streaks on the finished surface. Move the gun at a constant speed while triggering since the material flows at a constant rate.

Another technique of triggering is referred to as “feathering”. Feathering allows the operator to limit fluid flow by applying only partial trigger travel.

Spray edges and corners reduces overspray yet provides good coverage on corners.

Replacement of Parts: Follow specific gun service bulletin exploded view for replacing parts.

The fan adjustment assembly should only be installed after turning the knob out. If left in, the stem or needle could jam against the seat.

Pull trigger or remove fluid adjusting screw prior to tip tightening. Tip and needle damage can occur.

Spray guns have some combination of plastic, copper, leather and soft packings and gaskets. It is recommended that these be replaced if the assembly is removed or when doing an overall repair. The fluid needle packing must be replaced when the packing nut bottoms out.

It is recommended to oil a new packing or needle before assembly. Packing nuts should be tightened just enough to seal (fluid leakage on pressure feed, suction of air on suction feed). Too tight will bind the needle as well as shorten life of packing. When replacing the fluid tip or fluid needle, it is recommended to replace both at the same time. Matched sets are available for most guns on pressure feed combinations.

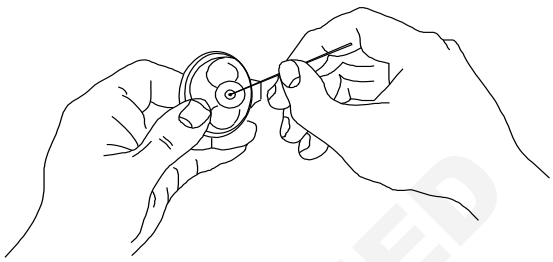
Maintenance: Air cap: Remove the air cap from the gun and immerse it in clean solvent. Blow it dry with compressed air.

If the small holes become clogged, soak the cap in clean solvent. If reaming the holes is necessary, use a toothpick, a broom straw or some other soft implement.

Do not clean holes with a wire, a nail or a similar hard object. Doing so could permanently damage the cap by enlarging the jets, resulting in a defective spray pattern.

Cleaning Air cap (Fig 13)

Fig 13



CLEANING AIR CAP

APN18681D

Suction or Pressure Feed Cleaning: A suction or pressure feed gun with attached cup should be cleaned as follows:

Turn off the air to the gun, loosen the cup cover and remove the fluid tube from the paint. Holding the tube over the cup, pull the trigger to allow the paint to drain back into the cup.

Don’t tilt the gun in any direction. This will result in uneven paint build causing runs and sags.

Empty the cup and wash it with clean solvent and a clean cloth. Clean off the outside of the tube. Fill halfway with clean solvent and spray it through the gun to flush out the fluid passages. Be sure to comply with local codes regarding solvent disposal.

Then remove the air cap, clean it as previously explained and replace it on the gun.

Wipe off the gun with a solvent soaked cloth, or if necessary, brush the air cap and gun with a fiber brush using clean-up liquid or thinner.

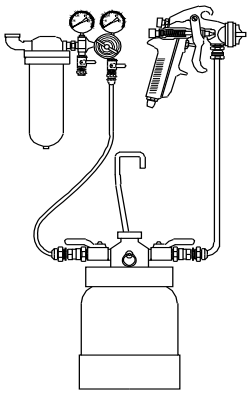
Cleaning a pressure feed gun with remote cup or tank: Turn off air supply to cup or tank. Release material pressure from the system by opening relief valve. Material in hoses may be blown back. Lid must be loose and all air pressure off, Keep gun higher than container, loosen air cap approximately 2-3 turns, hold rag over air cap, and trigger gun until atomizing air forces all material back into the pressure vessel.

A gun cleaner may be used for either type of gun. This is an enclosed boxlike structure (vented) with an array of cleaning nozzles inside.

Guns and cups are placed over the nozzles, the lid is closed, the valve is energized, and the pneumatically controlled solvent sprays through the nozzles to clean the equipment. The solvent is contained, and must be disposed of properly.

Some states codes require the use of a gun cleaner and it is unlawful to discharge solvent into the atmosphere. Another efficient method of cleaning the hose and gun passages is with a “Gun & Hose Cleaner” device, such as the “Solvent Saver”. (Fig 14)

Fig 14



USING A HOSE CLEANER

APN18681E

This device incorporates a highly efficient fluid header, which meters a precise solvent/air mixture. The cleaner operates with compressed air and sends a finely atomized blast of solvent through the fluid passages of the hose, and spray gun.

This simple, easy to use cleaner speeds up equipment cleaning and saves solvent. It also reduces VOC emissions. Be sure that both the hose cleaner and gun are properly grounded.

Where local codes prohibit the use of a hose cleaner, manually back flush the hose into the cup or tank with solvent and dry with compressed air.

Clean the container and add clean solvent. Pressurize the system and run the solvent through until clean. Atomization air should be turned off during this procedure. Be sure to comply with local codes regarding solvent dispersion and disposal.

Clean the air cap, fluid tip and tank. Reassemble for future use.

Note: Never soak the entire gun in cleaning solvent. This will dry out the packings and remove lubrication.

Lubrication: Lubricate the fluid needle packing (A), the air valve packing (B), the trigger bearing screw (C), and the adjusting screw threads (D) with spray gun lube daily.

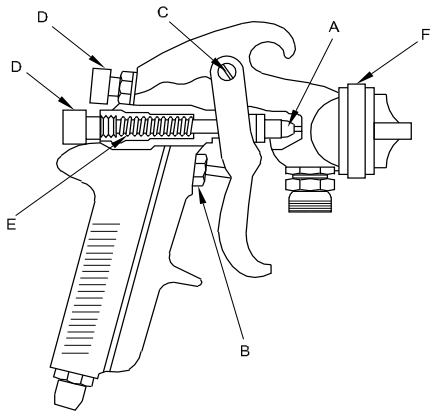
The fluid needle spring (E) should be lightly coated with petroleum jelly.

Thoroughly clean the air cap and baffle threads (F), and lubricate with spray gun lube daily.

Lubricate each of these points after every cleaning in a gun washer.

Lubrication points (Fig 15)

Fig 15



LUBRICATIONS POINTS

APN18681F

Pressure - Feed Spray Gun: The pressure-feed spray gun fig is not often found in the typical auto paint shop, because it is less convenient for small jobs. This type of gun is more useful for big jobs, such as trucks, or for fleets where all vehicles are painted the same colour. The pressure-feed spray gun uses a pressure tank, partly filled with paint and pressurized by the compressed-air system. This pressure forces the paint through a tube to the gun and out the fluid tip. A second tube sends compressed air into the gun and out the air openings in the fluid tip and air cap.

The advantages and disadvantages of the two types of spray guns are listed below:

Suction - Feed Spray Gun

Advantaged	Disadvantages
Can handle small jobs	Gun, which includes cup, is heavier and harder to handle
Easy to change from one colour or material to another	Limited control of spray pattern and rate of paint flow; harder to use around curves
Easy to clean	
Simple to operate and adjust	

Checking Paint Viscosity (Figs 16 & 17): When using the spray gun, temperature is important both the temperature of the paint and the temperature of the surface to be sprayed. If the temperature is too low, the paint will go on sluggishly, dry slowly, and run. If the temperature is too high, the solvent may evaporate too fast. Then the paint will not smooth out, or flow, to provide a good job. The ideal temperature for spray painting is about 75°F (24°C).

Temperature also affects the paint viscosity. This is the resistance to flow, or thickness, of a liquid. The paint should be at room temperature. After mixing the paint,

check the label for the recommended viscosity that the mixture should have when it is ready to spray. Paint viscosity is checked with a viscosity cup (Fig 17). The cup holds a standard amount of paint, primer, or other material applied with the spray gun. A small hole in the bottom of the cup allows the liquid to run out. The length of time (in seconds) required for the cup to empty is the viscosity reading of the paint. Specifications are given by the paint manufactures.

To use the cup, dip it into the paint until the cup is full (Fig 17a). Raise the full cup out of the paint. As the cup clears the surface of the paint, begin timing the flow from the small hole in the bottom of the cup. (Fig 17b) Measure the time with a watch (preferably a stopwatch). Stop the watch when the stream of paint first breaks (as shown in Fig 17c) and not when it stops completely. This will give you an accurate viscosity reading.

Table 1 shows the ranges of recommended viscosities for spraying various kinds of finishes (as measured with a viscosity cup). If the viscosity is within the recommended range, the paint is ready to spray. The paint can now be strained into the spray-gun cup. If the viscosity is not correct, the paint mixture must be further thinned, or thickened by adding un-thinned paint.

Fig 16

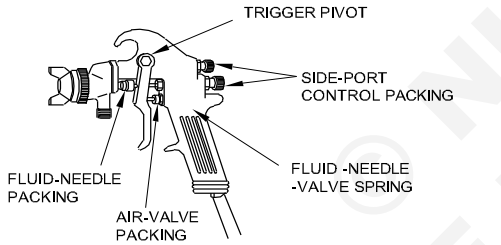
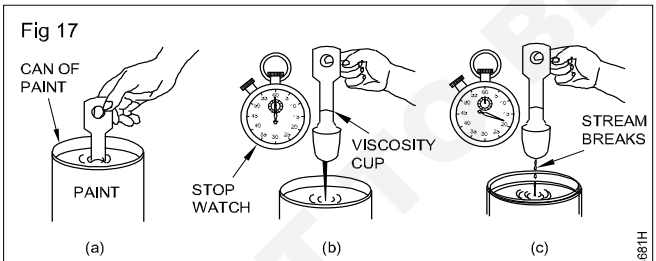


Fig 17



CHECKING PAINT VISCOSITY WITH A VISCOSITY CUP

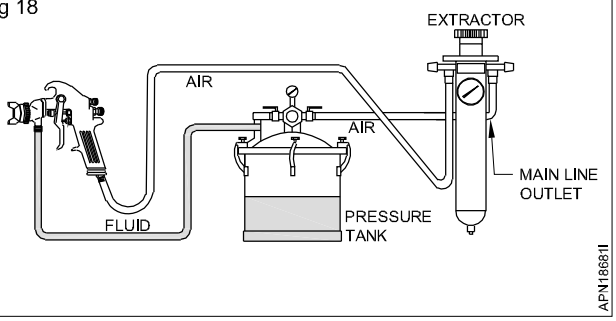
Ranges of recommended viscosities for spraying various kinds of finishes

Table 1

Kind of Paint	Recommended Viscosity, Seconds
Acrylic lacquer	18 - 22
Acrylic enamel	18 - 21
Alkyd enamel	20 - 23
Polyurethane enamel	18 - 22
Flexible Finish	16 - 20

Pressure-Feed Spray Gun (Fig 18)

Fig 18



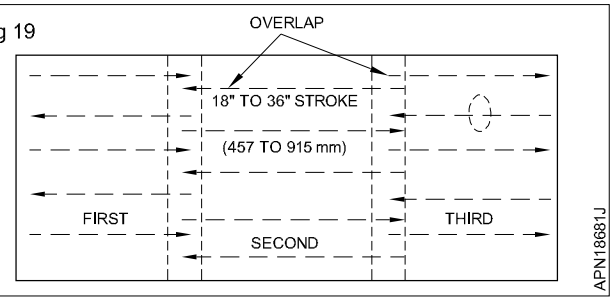
Advantages and disadvantages of pressure-feed spray gun

Advantaged	Disadvantages
Can handle large amounts of paint and big jobs	Not suitable for small jobs requiring small amounts of paint
Provides constant flow of paint at uniform pressure	Frequent changes of color and material not practical
Will handle heavy materials such as spray-on vinyl	Difficult to clean
Light weight and easy to handle	
Working angles of nozzle are unlimited	

Overlapping, Banding, and Arcing

When spraying, always overlap the area 50%. Overlapping is accomplished by aiming the air horns directly at the bottom or top of the last spray stroke; otherwise, streaks will appear on the sprayed surface. This is particularly true when metallic paint is sprayed (Fig 19).

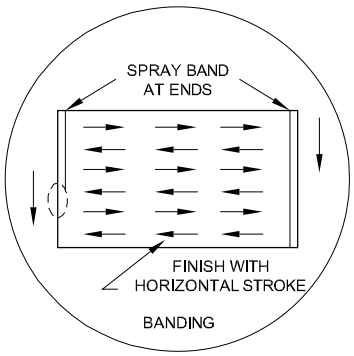
Fig 19



If the painter has only one panel to paint on an automobile, it should be banded at the edges (Fig 20). This method reduces the amount of overspray that reaches the surface to be painted. Either this over spray is exhausted through the exhaust fan or it falls on the spray booth floor. The painter sprays a band at each end of the panel vertically; then the panel is sprayed with horizontal strokes. The

painter triggers the gun at the appropriate time in the stroke. The bands help over-come any arcing that could be present in the stroke. This method will give a good flow out of the painted surface and cut the waste of material. It is well known that approximately 30% of the material is wasted, especially if proper triggering and gun stroking are not applied to the job by the painter. The stroke must always be a smooth and steady movement by the painter at all times.

Fig 20



Arcing means that the gun is swung in a stroke in which the gun may be 6 to 8 in. (152 to 203 mm) from the surface in the center of the swing, but at the end of the stroke it could be perhaps 16 in. (406 mm) away from the surface. The results are an excessive overspray and poor flowing out of the painted surface. When spraying a radius or curved surface, the gun must follow a path that has the same radius as the surface being coated, maintaining the correct gun distance. For spender work, adjust the spray pattern to fit the job avoid excessive overspray. Spray technique is the most important phase of spray painting, and the various rules and methods just outlined should be practiced until they become fixed working habits.

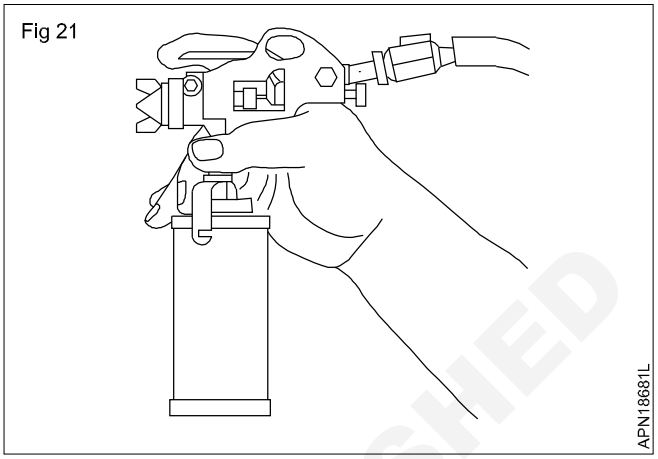
Feathering

Feathering is a control used by painters during blending and spot repairs. To feather a spray gun means that, when the spray gun is approaching the area requiring paint, the trigger is pulled back gradually. This allows paint to come gradually out of the gun. The trigger is pulled back more where more paint is required in the blend or spot area, and then the trigger on the gun is feathered again to cut off the paint volume. Depending on the area to be painted, such as from a door edge to the middle of the panel, the spray gun is feathered at the end of the stroke. If the repair is from the center toward the edge, the spray gun is feathered at the start. If the repair is done in the middle of a wheel opening, hood edge, or trunk lid, this situation could require that the spray gun be feathered at the start and end of the stroke.

When spraying a level surface, the spraying should always be started on the near side and gradually worked out to the far side. This is essential when lacquer is sprayed, since lacquer over-spray landing on wet paint will dry sandy or rough. The gun is sometimes tilted a certain amount for some level surfaces, but where practical the spray gun can and should be held at as near a right angle to the surface as possible.

Touch-up Gun (Fig 21)

Fig 21



The spray guns described as “production” guns. They are used by the automotive painter for production work in the shop. These jobs range from spraying a spot repair to complete vehicle refinishing. However, there are many jobs that are too small to be handled easily by the production gun. These jobs are ideal for the touch-up gun. This is a small spray gun that is often used for touch-up, spotting, shading, and custom painting.

The touch-up gun has the same general construction as the production gun, and operates in the same way. However, the paint cup is smaller, holding a pint or less of paint. The trigger is usually “overhead, “and operated by the index finger. The smaller size and lighter weight make the touch-up gun very handy for small jobs.

Air brush: In operation, the airbrush is similar to the standard spray gun. However, the airbrush is much smaller. It can be adjusted to produce a varying spray width, from 1½ inch down to a fine line. The typical airbrush has three interchangeable tips. The tip with the smallest opening can be used for extra-fine detailing. Its spray width can vary from a pencil-line thick-ness up to 1 inch. The medium tip sprays 1/16 to 1 ¼ inch patterns. The tip with the largest opening sprays a pattern from 1/8 to 1 ½ inches.

The airbrush has a cup or jar to contain the paint, ink, dye, or watercolor to be applied. The airbrush can be adjusted to provide varying amounts of the liquid being applied. Depressing the trigger admits air to the airbrush. As the air flows through, it picks up the liquid from the jar or cup. The air and liquid mix to form the spray.

Air less paint spray gun (Fig 22)

The air less spray gun is the physical connection between you and a quality finish. Graco airless spray guns are recognized as the industry standard for quality, durability

and performance delivering a comfortable spraying experience and a perfect finish. On every job. Air less paint gun is designed to be the longest lasting, most reliable air less spray guns on the market. Air less paint spray high pressure is 3600 PSI

Fig 22

Electrostatic spraying gun system (Fig 23)

Fig 23

The electrostatic gun represents one device that uses electrostatic technology for the use of spraying disinfectants, sanitizers and even odor counteractants. This particular device is powered by a rechargeable lithium iron battery. A cartridge holds 1 quart of diluted ready to use disinfectant or sanitizer.

The paint is atomised in a static field which is formed at the end of the electrostatic spray gun. Just before the fog of paint leaves the nozzle. It is given a positive charge. The charged paint droplets are sprayed through a strong electric field which is a term used to describe patterns of forces.

During the paint application process electrostatic paints give off high amounts of toxic fumes, therefore the painting environment for the electrostatic paint process must be highly monitored and have a high rate of air exchange.

Paint spray booth

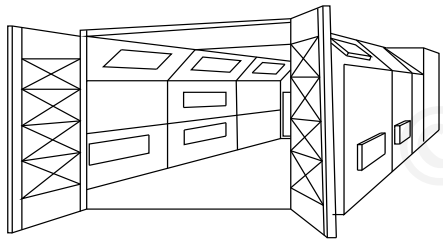
Objectives: At the end of this lesson you shall be able to

- **state the paint spray booth**
- **state the different types of spray booth**
- **state the spray booth maintenance**
- **state the drying equipment**
- **state the air supplied respirators.**

Paint spray booth: Paint spray booth is an enclosed or semi-closed area used for the spray painting of fabricated items it may be equipped with a source of filtered air to keep the atmosphere dust-free, a water fall back drop to trap overspray and an exhaust system to vent the fumes of evaporating solvents.

One and two room spray booth: Basically, the booths used are the water-wash and the paint arrestor type (Figs1 and 2). Water-wash booths use a type of air washing action to trap the paint particles. A water-wash booth delivers cleaner air to the atmosphere, and thus less pollution, as well as a constant air velocity that results in a better ventilation system.

Fig 1



PAINT BOOTH

APN187311

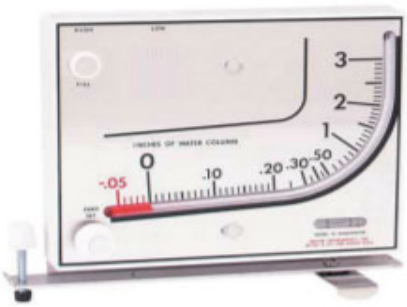
Fig 2

A booth that uses disposable paint-arrestor filters is usually suited for limited or interrupted spray operations, such as a refinish shop where paint use is moderate. Moderate consumption would include minimal overspray, and the amount of paint being sprayed would not exceed 2 gallons per hour. These booths work best when the coating used does not dry too rapidly. If the materials sprayed can react chemically with each other, a water-wash system must be used.

The paint-arrestor type of booth removes airborne paint particles from the spray booth exhaust air by using a disposable paint-arrestor filter. These filters must be of a good quality and must be changed as required; otherwise they choke off the air to the exhaust fan, In a booth with inter-locks, a pressure differential switch shuts of the compressed air when insufficient air is going up the stack. The OSHA code requires that filters be examined after each period of use, and if any clogged filters are present, they must be discarded and replaced immediately.

Down draft spray booth: The OSHA code also requires that the clogged filters must be removed and placed in a water-filled container or a safe detached location and disposed of at the end of the day's work. In some areas a draft gauge must be installed to meet code requirements (Fig 3). This draft gauge or manometer should be installed on the side of the booth; the pilot tube is placed on the intake side and the other tube on the exhaust side of the filter stack to indicate there is a pressure differential or drop across the filter bank. After new filters are installed, a reading should be taken on the manometer and noted. The filter media will need replacement when a ½ in. or 0.635 mm increase is indicated on the manometer. This is caused by the air movement through the filters diminishing due to restricted passages in the filter media.

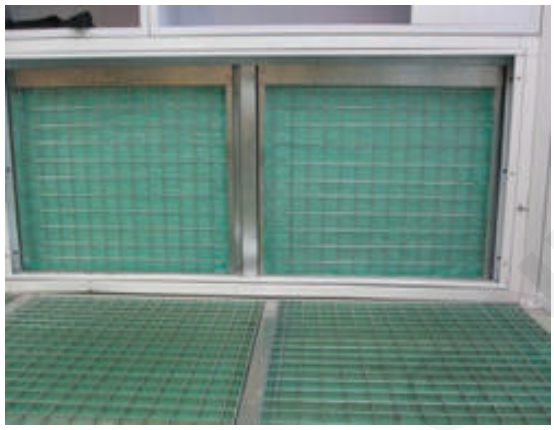
Fig 3



The paint-arrestor filters are made from a fire retardant treated paper, and the holes are formed into a diamond-shaped configuration. Several thickness of paper are sewed together; therefore, as air flows through the filter media it is forced to move back and forth and sheds the paint particles on the filter media through centrifugal force. The size of the holes in the first sheet of paper on the filter are the largest, and they get progressively smaller toward the back of the filter.

Usually two filters are used in each frame present in the filter bank exhaust; they are usually placed one against the other with the small holes toward the inside of the exhaust filter bank (Fig 4). A grid is used on the inside to help hold and prevent the filter from collapsing, and one grid is on the outside to hold the filters in place. The two most common sizes are 1 x 20 x 25 in. (2.5 x 51 x 63 cm) or 1 x 20 x 20 in (2.5 x 51 x 51 cm).

Fig 4



When the filters need to be changed (Fig 5), the grid is removed, the filters are removed, a new filter is inserted at the back, the filter that was on the back is installed on the front, and the grid is replaced. The reason that they are changed in this fashion is that the greater portion of the paint is on the side facing the inside of the booth.

Fig 5

This method of changing the filters cuts the cost in half and is still very effective in cleaning the air. The filter bank area must be cleaned of all residue dried paint before completing the filter change. An accumulation of dried paint inside the filter bank could cause spontaneous combustion if the right conditions were present. The old filters must be disposed of according to code in a safe and appropriate manner.

The paint-arrestor-type spray booth is less expensive to buy, is lighter, and is easier to install. In many states, provinces, and cities, it is required by code that the booths be equipped with a sprinkler system of sufficient capacity and with proper location of sprinkler heads. The electric and building codes must also be followed, and consulting the local authorities can save a purchaser or contractor many headaches as well as money. These authorities can help advise as to what equipment is necessary, what electrical and fire prevention codes to follow, and the location of the spray booth in the paint shop. These regulations are usually in line with the National Fire Protection Association (NEPA).

Dual draft gauge used in down-draft spray booths.

Filter media shown with opposite sides, showing the different size holes in the material.

Cross draft paint spray booth: The cross-draft booths (Fig 6) are lately have changes been made to this design. One change is the semi-down draft (Fig 7) in which the air is drawn from the upper levels of the shop. This air is usually cleaner and is pulled through filters located in a plenum is equipped with a baffle so that the air is distributed evenly and smoothly over the vehicle.

Fig 6

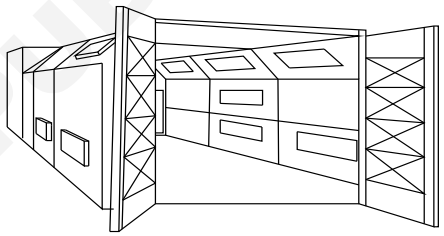
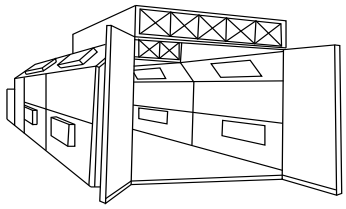


Fig 7



In the cross-draft spray booth the air is drawn through filters installed in the doors. The air travels horizontally along the vehicle and is exhausted by an exhaust fan.

These booths leave a lot to be desired, especially since the air velocity must be adequate to remove paint fumes and provide a safe working environment, but yet low enough to allow for a good paint job. OSHA and NFPA require a design velocity of 100 feet per minute (FPM) or 30.48 meters per minute (MPM).

The speed at which this air moves makes it difficult for the intake air filters to remove all the dust that is pulled into the booth by the exhaust fan in a negative pressure booth. The intake air filters are a self-sealing type and are designed to be efficient at an air velocity of 125 FPM (38 MPM) at 75°F or 21.1°C. They are made from a soft,

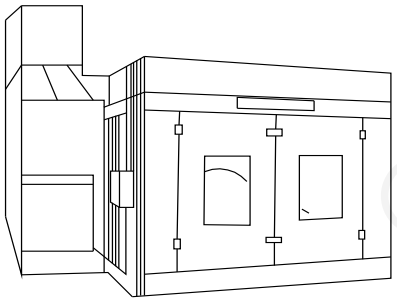
pliable polyester fabric coated with a special adhesive material to provide superior dust-trapping capabilities. They are held in a built-in reinforcing frame without a perforated metal facing, which would reduce air flow.

The life expectancy of the intake filters varies according to the amount of air going through them and the temperature of the air. The higher the velocity and temperature, the quicker the filter material will break down and start shedding fibers. Therefore, a program suited to the particular shop conditions must be followed as to when these filters have to be replaced.

The filters are provided to give a smooth, even flow of clean air, which in turn envelopes the vehicle being painted and carries away spray fumes and evaporating solvents. These filters are available in different sizes, but the most popular sizes are 2 x 20 x 20 in. (5 x 51 x 51 cm) or 2 x 20 x 48 in. (5 x 51 x 122 cm)

Air filtration system in paint booth: Down-draft spray booth (Fig 8) and was developed in Europe. The down-draft spray booth is designed on the same principle as automotive production line down-draft booths. The replacement air passes through filters in the ceiling and flows around the vehicle and through gratings in the floor.

Fig 8



This varies from conventional spray booths where the air flow is from one end to the other across the vehicle. The air flow pulls the overspray down and away from the painter into the pit instead of along the length of the vehicle being sprayed. This minimizes the chance of overspray and contaminants collecting on a freshly painted vehicle and spoiling the finish. This type of spray booth gives superior quality to the painted vehicle and draws the overspray away from the painter; it gives a finish comparable to an original factory finish. Due to the better filtration system and different air flow, it helps to eliminate the two major causes of unsatisfactory refinish jobs: airborne dirt and a bad painting environment.

A variation of the down-draft booth is the cure spray booth. This booth operates the same as a down-draft spray booth in the paint application phase. But after the spraying operation is completed, the painter does not have to move the vehicle for the curing stage. The curing stage is initiated by the painter by flipping a lever and then selecting the temperature and time.

The purging of the solvents from the booth atmosphere and changing the cycle to a high temperature air flow is automatically carried out by pre-programmed controls. The curing time varies from 20 to 30 minutes, which depends on the type of paint used and the size of the vehicle. The booth controls are preset for each temperature and curing time to ensure consistent results.

The fresh air used is about 10% and is heated and mixed with recirculated air, maintaining a steady temperature without using an excessive amount of fuel. The air is filtered at all times; therefore, the car is not exposed to any dust-laden air. Air flows through the spray booth in the same direction except that much less air flows when the booth is in the curing phase.

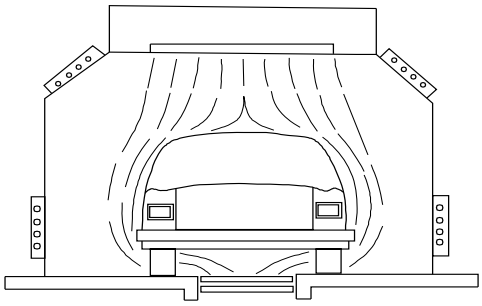
A spray booth should have walls that are smooth; this will eliminate dust clinging to them. The booth should be fireproof and should have an unobstructed working area as well as an access door so that the painter can go to and from the spray booth without opening large doors. The spray booth must have a lighting system that provides enough intensity and uniformity to produce good working conditions. Fluorescent light fixtures are usually used as they provide more uniform illumination.

Booths installed in the United States are equipped with vaportight fluorescent lights. Explosion-proof lighting, switches, and inter-lock must also be provided to meet electrical codes as required. (Figs 9, 10 & 11)

Fig 9

Fig 10

Fig 11



AIR FLOW IN A DOWN-DRAFT BOOTH.

APN18731B

Maintenance of paint spray booth

- Keep the spray booth is good operating shape
- After painting swept and wash the paint booth floor
- Floor can be dampened to help keep dust problems to a minimum
- The booth should be kept free of un required materials such as parts, water bucket, brooms, squeegees, dust pans, and trash cans.
- Air hoses should be hung on hose hangers and not laid on the spray booth floor.
- All filters should be changed as required.
- All door seals should be kept in good repair, so that dust will not come through open gaps.
- The glass lenses, fluorescent fixtures, and spray booth walls should be kept in a clean condition.

Reverse flow paint booth: The exhaust is located in the front near the drive in doors to be pulled directly into the exhaust. The paint booth provides great air filtration at the entrance of the booth limiting shop dust from entering the booth.

Regular flow paint booth: During spray jobs in paint booth the exhaust system must draw substantial of air out of the shop in order to operate. These volumes must be replaced with equal volumes of air coming into the booth.

The air being pushed in and pulled out are alone with two types of fans. The exhaust fan that pulls the air out of the standard tools paint booths is a tube axial exhaust fan. It is a propeller blade type fan. Tuber axial is the best fan to be used on the exhaust of the booth because they are designed to pull the air. Aluminium blades are used because they will not spark, causing a fire, which is important when working with flammable paint coating.

The fan that pushes the air into the booth through the sure-cure is a blower fan, designed to force the air into the booth. Controlling the air flow and pressure is a delicate balance between input air and exhausted air.

Wet filtration System: Water wash booths trap paint overspray with curtains of water and deposit then into a collection tank. Which must be cleaned of sludge periodically.

Water wash systems are ideal for operations with very high production rates while dry filtration systems are better fit for most other operations. Wet filtration require a high initial investment, but are ideal for operations using very high paint volumes that need a uniform and constant air flow.

Dry filter system: Dry filter booths use layered filters to separate the paint particulate from constant air stream passing through the exhaust filter. There are many types of materials and designs available for dry filter media. Dry exhaust filters and even reclaim systems available. The dry filtration system require dry filter replacement and the periodic maintenance needed.

Types of infrared drying equipments: Infrared dryers belong to family of generate heat at targeted material type of due this utilization of infrared dryers for heating help the dryer to provide various advantages. Variable speed AC motor with imported variable.

A diverse range of equipment is used industrially for drying operations including tray, screen conveyor, screw conveyor rotary drum, tunnel, bin, tower, spray, flourished bed, and flash driers. Some driers have a direct mode of heating. Where by air entering the drier is brought into contact with the wet solid.

Near infrared drying equipment: Near infrared drying technology is that it is designed to minimize maintenance equipment. The radiation emitter which generates high filament temperature and heat intensities from 1000 to 1500 kw/m^2. The emitters are designed for an average operational life of 5000 to 6000 hrs. The emitters performance could be extended to as much as 8000 hours.

The Infrared panel heaters are used to ensure a properly cured and blaster free surface. Normally it involves a 10-20 minute curring process. This method interrupts the continuous car production process, as the damaged vehicles must be removed from the line and placed into special spot repair booths.

Far infrared drying equipments: Adopted the technology of far-infrared radiation heating, heating speed of this infrared lamp cure time is 60% to 80% faster, and it only heats objects within its infrared range efficiently utilizes the energy its aluminium alloy frame and 304 bright stainless reflector are sturdy and durable.

The large drying area, the electric paint dryer lamp is used. This lamp working temperature is adjustable and this lamp is fitted with the powerful 2000W short wave infrared lamps to let heat pass back through the coating via conduction.

Description of air supplied respirators: The different materials present in the workplace and the many airborne chemicals, dust and elements that are inhaled can damage the lungs severely. Some chemicals also irritate the skin and eyes and some absorbed by the skin into the body.

Some possibly harmful elements found in paint are, antimony, barium, cadmium, nickel and selenium, when paint hardeners and gloss improvers are used, isocyanates are introduced into the air that a painter breathes. Therefore, it is of great importance that breathing protection be wear as required.

When working is dusty conditions or when power/dry sanding is done, a dust mask, such as this mechanical type respirator that removes dust and solid particles from the air a person breathes. This respirator covers the nose and mouth and when covered with dust is thrown away with vacuuming or light brushing, masks can be cleaned so that they last longer. When the respirator is clogged with dust from filing plastic or fiber glass, it should be discarded. Masks should be stored in a clean box or cupboard for proper hygiene. (Fig 12)

Fig 12

The respirators most generally used for painting are made to protect against the general types of paints such as lacquerer, and enamel mists and organic vapors. A poor-fitting respirator must never be used as it endangers the painters health.

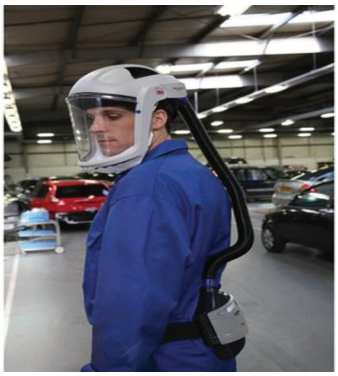
Hood types of respirator: This type of respirator used at all times when spraying paints that have polyurethane additives in them. This respirator can be used when spraying in areas that are closed as they are supplied with clean, pure air at all times. All the components must meat the code such as the regulator, waist belt assembly, air supply hoses (25 foot or 7.6 meter) and air regulator. The air line used by the hood or respirator cannot use the same source as the spray gun. The air used for the respirator must meet the standards set by OSHA or CSA as per table given below these guide line set rigid purity standards for compressed air. (Fig 13)

Breathing Air Standards

(Maximum allowable contaminant level)

Contaminant	OSHA	CSA
Carbon monoxide (ppm)	20	5
Carbon dioxide (ppm)	1000	500 ± 25
Oil (Condensed) Hydrocarbons (mg/m^3)	5	1
Odors and tastes	Slight	Slight

Fig 13



Half-face piece pressure respirator: The half mask respirator is used where eye protection is not required. This respirator protects the lower part of the face and the lungs from hazardous vapors, dust and chemicals. The same air system must be used for hood air respirator and full face shield type air respirator and half face shield respirator. The half mask is held securely enough to prevent leakage. (Fig 14)

Fig 14

Full face respirator: The full face respirator air hose is attached to the regulator on the wrist belt and the regulator is plugged into the hose line. The respirator is ready to use, when the regulator pressure is adjusted as required. The air supplied respirator must be inspected for defects after each use. If defective, it must be repaired immediately. The regulator should be connected to the breathing air source at 30 to 125 PSI. (Fig 15)

Fig 15

Air supply unit for hood and half, full face mask: Many paint shops are used a small oil-less compressor that is vary from a diaphragm type oil-less piston to an oilless turbine type driven by an electric motor. (Fig 16)

The compressor air intake must be located so that only clean fresh air is drawn into the compressor. Great care must be taken to place the intake away from engine exhaust. Chemical processes and dust sources. The air should be checked often to assure its purity.

Fig 16

Paint shop equipments and tools

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

- **state the wet sanding stand and paint hangers**
- **state the sanding and masking method.**

Wet sanding standard: The wet part of wet sanding refers to use of water or some other liquid as lubrication to help carry away grit particles that are removed without the liquid, material can build up in the sand paper and leave behind scratches that are larger than the particle size running finish.

Paint hangers: 36 mm is a perfect storage solution for those who do not have any room to spare on their work benches it can be mounted on a wall and it can be combined vertically and horizontally with other paint hangers. Painting stand that is quick, easy and convenient to use. Adjustable frame that extends from 50-70 inches in height is 70 inch long and six hooks to hold parts for painting or drying it is great for hoods, doors, fenders and tail gates.

Panel Drying Ovens: The function of panel drying oven is to remove moisture from a product, depending upon the process and production requirement, a batch or conveyor configuration is available. To meet both process and safety requirements, the exhaust system is engineered to accommodate specific moisture release rates.

A drying oven is designed to remove moisture from the oven chamber so to dry the samples as quickly as possible. The drying oven process introduces fresh dry air to the chamber and expels the warm moist air simultaneously allowing to rapidly dry the samples. A drying oven provides high performance drying and heating.

Paint shakers: The paint shaker is formed by a housing mounting a vertical mainshaft, which supports a container clamp assembly at one end is engaged through a simple crank arm at its other end to a double acting air cylinder motor.

Paint blade agitator: Strong and economical paint mixing agitator blades that are shaft mounted. Thoroughly mix paint at 200 - 900 rpm. Stirrer blade easily mixes high viscosity materials.

Churning Knives: Product churning is similar to the razor and blades business model. This involves selling a basic product at a loss, but receiving very high profit margins on associated products that are necessary for the basic products continued usage.

Knife is cutting instrument consisting of a sharp blade fastened to a handle or knife is a sharp cutting blade or tool in a paint mixing machine.

Paint scale: Paint mixing scales bring a new level of comfort and functionality into the automotive body shop, and for this reason the scales are often referred to as an automotive scale or automotive paint scale. Even though they can cover a larger range of applications including being used as an ink mixing scale.

Paint cabinet: Semi gloss, gloss, the harder the finish the better matte paint on kitchen cabinet is impractical. Would not even use eggshell finish.

Painting costs a lot less than buying new cabinets and having them installed. If you need to make an economical choice. Painting is the way to go even if you are not forced into making the most economical decision, painting is still an attractive option.

Tack Cloth: Tack cloth is a specified specialized type of wiping cloth that is treated with a tacky material. It is designed to remove loose particles of dust, dirt and link that would contaminate a surface that is to be coated, laminated, photo-etched or otherwise finished.

Purpose of the strainer: Strainers are important components of piping systems to protect equipment from potential damage due to dirt and other particles that may be carried by the process fluid.

A line strainer is a device to filter out grit and debris from a water line to protect appliances from being damaged by contamination. Sometimes line strainers are integrated into other fittings to provide a combined function such as safety systems fitted to unvented hot water cylinders.

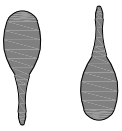
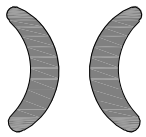
Masking tape: Masking tape also known as painters tape, it is a type of pressure-sensitive tape made of a thin and easy-to-tear paper, and an easily released pressure-sensitive adhesive. It is available in a variety of widths. It is used mainly in painting to mask off areas that should not be painted.

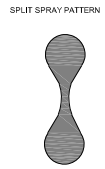
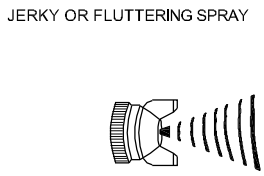
Spray gun trouble shooting

Objectives: At the end of this lesson you shall be able to
- **rectify the trouble of spray pattern**
- **adjust the spray gun valves**
- **rectify spray gun leaks**
- **handle the spray gun**
- **control the fluid flow through the gun.**

Probable Causes and remedies

Troubleshooting

Trouble	Cause	Correction/Remedies
Heavy top or bottom pattern HEAVY TOP OR BOTTOM PATTERN 	Horn holes plugged Obstruction on top or bottom of fluid tip. Cap and/or tip seat dirty	Clean. Ream with non-metallic point .Clean Clean.
Heavy right or left side pattern HEAVY TOP OR BOTTOM PATTERN 	Left or right side horn holes plugged Dirt on left or right side of fluid tip.	Clean. Ream with non-metallic point .Clean.
	Remedies for the top-heavy, bottom-heavy, right-heavy and left-heavy patterns: 1 Determine if the obstruction is on the air cap or the fluid tip. Do this by making a test spray pattern. Then, rotate the cap one-half turn and spray another pattern. If the defect is inverted, obstruction is on the air cap. Clean the air cap as previously instructed. 2 If the defect is not inverted, it is on the fluid tip. Check for a fine burr on the edge of the fluid tip. Remove with #600 wet or dry sand paper. 3 Check for dried paint just inside the opening. Remove paint by washing with solvent.	
Heavy center pattern HEAVY RIGHT OR LEFT SIDE PATTERN 	Fluid pressure too high for atomization air (pressure feed). Material flow exceeds air cap's capacity. Atomizing pressure too low. Material too thick.	Balance air and fluid pressure. Increase spray pattern width with spreader adjustment valve. Thin or lower fluid flow. Increase pressure. Thin to proper consistency.

Trouble	Cause	Correction/Remedies
Split spray pattern 	Fluid adjusting knob turned in too far. Atomization air pressure too high. Fluid pressure too low (pressure feed only). Spreader adjusting valve set too high.	Back out counterclockwise to achieve proper pattern. Reduce at air regulator. Increase fluid pressure. Adjust by turning in clockwise.
Jerky or fluttering spray 	Loose or damaged fluid tip/ seat. Material level too low. Container tipped too far. Obstruction in fluid passage. Loose or broken fluid tube or fluid inlet nipple (suction or pressure feed). Dry or loose fluid needle packing nut. Damaged fluid needle packing	Tighten or replace. Refill. Hold more upright. Back flush with solvent. Tighten or replace. Lubricate or tighten. Replace.
Suction Feed Only	Material too heavy. Air vent in cup lid clogged. Loose, damaged or dirty lid. Fluid tube resting on cup bottom. Damaged gasket behind fluid tip.	Thin or replace. Clear vent passage. Tighten, replace or clean coupling nut. Tighten or shorten. Replace gasket.
Unable to get round spray	Fan adjustment screw not seating properly. Air cap retaining ring loose.	Clean or replace. Tighten.
Will not spray	No air pressure at gun. Internal mix or pressure feed air cap and tip used with suction feed. Fluid pressure too low with internal mix cap and pressure tank. Fluid needle adjusting screw not open enough. Fluid too heavy for suction or gravity feed	Check air supply and air lines. Change to proper suction feed air cap and tip. Increase fluid pressure at tank. Open fluid needle adjusting screw. Thin material or change to pressure feed.
Uneven spray pattern	Inadequate material flow. Low atomization air pressure (Suction and gravity feed).	Back fluid adjusting screw out to first thread, or increase fluid pressure at tank. Clear cup vent. Increase air pressure and rebalance gun.

Trouble	Cause	Correction/Remedies
Excessive overspray	Too much atomization air pressure.	Reduce pressure.
	Gun too far from work surface.	Adjust to proper distance.
	Improper stroking (arcing, gun motion too fast).	Move at moderate pace, parallel to work surface.
Excessive fog	Too much, or too fast-drying thinner.	Remix properly.
	Too much atomization air pressure	Reduce pressure.
Paint bubbles in cup	Fluid tip not tight	Tighten
Fluid leaking or dripping from cup lid	Cup lid loose.	Push in or replace.
	Dirty cup or lid.	Clean.
	Cracked cup or lid	Replace cup and lid.
Dry spray	Insufficient material flow.	Increase fluid pressure or change to larger tip.
	Air pressure too high.	Decrease air pressure.
	Material not properly reduced (suction feed).	Reduce to proper consistency.
	Gun tip too far from work surface.	Adjust to proper distance.
	Gun motion too fast.	Slow down.
	Gun out of adjustment.	Adjust.
Fluid leaking from packing nut	Packing nut loose.	Tighten, do not bind needle.
	Packing worn or dry.	Replace or lubricate.
Fluid leaking or dripping from front of gun	Packing nut too tight.	Adjust.
	Dry packing.	Lubricate.
	Fluid tip or needle worn or damaged.	Replace tip & needle with matched sets.
	Foreign matter in tip.	Clean.
	Fluid needle spring missing or broken.	Replace.
	Wrong size needle or tip.	Replace.
	Needle bound by misaligned spray head (MBC guns only).	Tap spray head perimeter with a wooden mallet. Retighten lock bolt.
Runs and sags	Too much material flow.	Adjust gun or reduce fluid pressure, or change to smaller tip.
	Material too thin.	Mix properly or apply light coats.
	Gun tilted on an angle.	Hold gun at right angle to work and adapt to proper gun technique.
Thin, sandy coarse finish drying before it flows out	Gun too far from surface.	Check distance. Normally 6-8" (HVLP), 8-10" (conventional).
	Fluid tip too small.	Change to larger tip.
	Too much air pressure.	Reduce air pressure and check spray pattern.
	Improper thinner being used.	Follow paint manufacturer's mixing instructions.

Trouble	Cause	Correction/Remedies
Thick, dimpled finish "orange peel". Too much material coarsely atomized	Gun too close to surface.	Check distance. Normally 6-8" (HVLP), 8-10" (conventional).
	Fluid tip too large.	Change to smaller tip.
	Air pressure too low.	Increase air pressure or reduce fluid pressure.
	Improper thinner being used.	Follow paint manufacturer's mixing instructions.
	Material not properly mixed.	Follow paint manufacturer's mixing instructions.
	Surface rough, oily, dirty.	Properly clean and prepare.
Fluid dripping	Cup loose on gun.	Tighten.
	Cup threads dirty.	Clean.
	Cup gasket damaged or dirty.	Replace.
Pin holes	Oil or moisture in equipment/material	Remove oil or moisture.
Blushing coat	Moisture droplets trapped in the wet paint film.	In hot humid weather try to paint early in the morning.
	Excessive air pressure at the gun.	Reduce air pressure to minimize cooling effect of the spray.
	Too fast a thinner.	Use a slow-evaporating thinner, that is suitable for the temperature and humidity.
Fluid will not come from fluid tank or canister	No air pressure.	Check air pressure line.
	No fluid in tank.	Fill fluid.
	Air leak from canister top gasket.	Tighten the canister top or replace the gasket.
	Improper air pressure adjusting.	Adjust the air pressure.
	Fluid tip blocked.	Clean.
	Air valve closed.	Replace or clean or adjusted.
Fluid leaks through fluid tip when trigger is released	Fluid tip damaged.	Replace.
	Air cap loose fitting.	Tighten the air cap.
	Fluid needle damaged or improper setting.	Replace or set properly.
	Trigger not properly released.	Adjust the air valve.
Spray coat short of liquid material	No liquid material in canister.	Fill the material.
Uneven spray pattern	Dirty fluid tip	Clean and adjust.
	Damaged fluid tip	Replace.
	Improper air valve setting	Set properly.
	Fluid suction pipe leak	Replace.
	Air cap loose fitting.	Tighten the cap nut.

Trouble	Cause	Correction/Remedies
Slow to build	Low air pressure. Material Viscosity too heavy. Fluid suction pipe blocked. Air leak from canister top.	Adjust the air controlled valve. Replace the fluid. Clean or replace Replace the gasket or tighten the cap.
Air continues to flow . through gun when trigger has been released	Air valve seat damaged. Air valve damaged. Trigger not properly released	Replace Replace Check and repair
Air leaks at canister gasket	Canister top gasket damaged Canister top loose fitting	Replace Tighten
Air Leak at set screw in canister top	Damaged set screw Improper set screw adjustment.	Replace Adjust
Leak between top of canister cover and gun body	Canister top loose fitting. Canister top gasket damaged.	Tighten Replace
Spotty	Air cap center orfice or horn hole dirty. Needle valve improperly adjusted. Air controlled valve damaged	Clean Adjust Replace
Streaks gun sputters constantly	Check valve not operating properly Material too thick Loose or damaged packing	Clean or replace valve assembly Thin material Adjust or replace packing.

Vehicle surface preparation and masking

Objectives: At the end of this lesson you shall be able to
- **state the importance of surface preparation**
- **state the checking paint thickness**
- **state the prime coat selection**
- **state the sanding and masking method.**

Importance of surface preparation

Most important thing to get right when painting a vehicle is prepare proper auto body surface preparation is crucial for a good result. Whether painting a touch-up in small spot or respraying an entire vehicle. Follow the steps for proper surface preparation.

Steps

— Assessing the situation of vehicle body condition

— Puling dents of panel

— Cutting rust on the vehicle panels and joints

— Welding patches of damaged metal and plastic parts

— Using filler on panel joints and sanding scratches

— Sanding the filler applied surface for smoothening

— Cleaning the sanding area by clean cloth

— Masking the unpainting area

— Cleaning again the metal surface

— Applying primer on the panel surface

— Cleaning your work place before start painting to avoid dust particular mix paint material

— Under coat spray on the surface

— Smooth sanding again on the undercoat surface for smoothening and carry out the deep scratches.

— Top coat on the metal/plastic surface

— Clear coat on the top if needed

— Polishing the painted area for shinning

Evaluate the surface condition

The surface of the vehicle must be evaluated properly so as to determine which the areas where cracks and reregulates are present. These areas require fixing before the final refinishing process has to take place.

The vehicle surface evaluation is the step that decides what steps to be taken to prepare the surface for the find painting process. If the condition of the paint is good, the surface is only scuffed, and then painted. The scuffing of the surface reduces the old paint thickness if the condition of paint is bad, the paint is fully removed to provide firm base for new paint coat.

Checking paint thickness

When preparing a surface in a poor condition, one of the first steps to take to measure the thickness of paint film. The thickness of paint is very important because the application of excessively thick top-coats, a practice that is prevalent in many areas, may result in the paint film wrinkling or cracking. Low gloss, water spolting, poor dry, and many other film defects that spoil what could be a first-quality refinish job. A thick top coat could cause the vehicle to be restore, which will be very costly due to difficulties in removing the excessively thick top coat by stripping or sandings. (Fig 1)

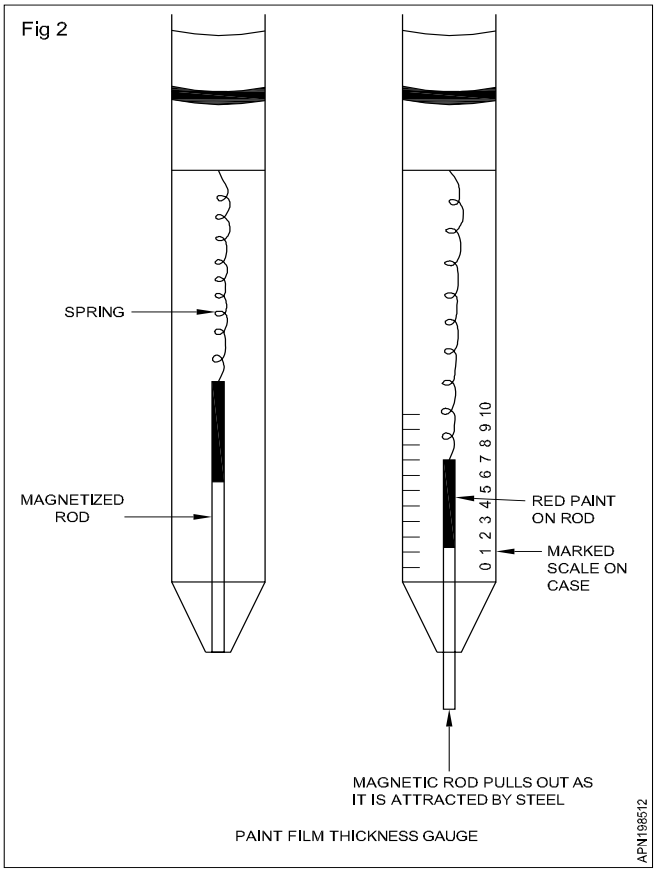
Fig 1

Paint Thickness Gauge

Paint thickness gauges are important tools in a paint shop because they are used to measure the thickness of the paint film on a vehicle. How else can an estimate be properly done but by measuring the film thickness. If the film is too thick, extra funds will be required to cover the cost of stripping the vehicle before repainting.

Many different types of gauges are sold by industry, but very common and inexpensive is the gauge with a magnetic rod that is attracted to ferrous metals. To use, the protective cover is removed; a window on each side of a housing is exposed in which a magnetic rod is attached at the end to the housing by a spring (Fig 2) . One side of the rod is marked in thousandths of an inch (or mils); the other side is marked in the SI equivalent.

Fig 2



PAINT FILM THICKNESS GAUGE

The gauge is held at right angle to the surface as in Fig 3. The area to be tested must be free of dirt, grease, oil, or ferrous metal chips. The magnet end of the rod in the gauge is touched to the surface, and the gauge is then lifted smoothly and slowly away from the surface. The rod marking must be watched as the gauge is pulled up. When the magnet end releases from the surface, its location shows how thick the paint film application is on the metal underneath the paint film. On heavily coated metal, the magnetic attraction is less and the rod will let go sooner. On bare or very thinly covered metal, the magnetic strength is greater; therefore, the housing will have to be pulled higher before it releases and registers the mil thickness. The paint should be measured in several areas.

Fig 3

Paint film thickness gauges are available from some paint jobbers and for different prices depending on their construction.

Paint Removal Method

Chemical stripping: Old paint can be removed by using a liquid chemical paint remover which strips off the paint. The paint stripper is brushed on and allowed to stand for a short time. The paint bubbles and then it is scraped off with a putty knife (Fig 4) or washed off with water.

Fig 4

Painters prefer to remove paint by sanding and grinding. Instead of using paint stripper. Sanding and grinding is usually more convenient and less messy for example, paint stripper will soften any plastic body filler. Which will then have to be replaced. Also, the use of paint stripper requires protective clothing. Including safety goggles, respirator, cap, coveralls and industrial rubber gloves.

Caution

Always wear full-body protective clothing when using paint stripper. You must keep paint stripper and its fumes off your skin, out of your eyes, and out of your lungs.

When using paint stripper, you must know the type of surface you are stripping. Paint stripper may attack plastic, glass, previous repairs, and adhesives. Therefore, always follow the safety cautions and directions on the label of the container.

Media Blasting

Procedure for operating a blaster: Sand blast is also known as abrasive blasting. Basically it is the operation of forcibly propelling a stream of abrasive material against a surface. The sand blasting operation is done under high pressure to smooth a rough surface roughen a smooth shape the surface to remove its contaminants.

Sand blast can remove paint, rust and residue from oxidation from metal quickly and efficiently. The different type of sand blaster such as, suction feed, pressure feed and pressure feed with vacuum recovery of sand blasting sand. (Figs 5 & 6)

Fig 5

Fig 6

Types of grit and numbering system: The sand paper numbers such as to grit, 100 grit, 200 grit on stamped on rear side of the sand paper. The higher number of grit the smaller the grains and the finer the sand paper grit and conversely, lower numbers indicate larger grains and overall coarser sandpaper. The grit size of sandpaper is usually stated as a number that is inversely related to the size of particle pasted on the sand paper.

Sanding or grinding: With the rust removed sand the entire surface to smooth out uneven areas and dull the surface so the primer and paint can adhere. Start with 120 grit sand paper and work to finer grade sand papers ending with 320 grit. For large flat surface use sanding block to get even pressure. For uneven surface use sanding disc to prepare the panel surface.

Importance of prepare bare metal: When preparing metal for paint, checking for rust is important to make sure that the paint will adhere properly to the surface. It also known as rust converters rust inhibitive primers can be used to cover rusted spots and turn them into non rusting paintable surface. Repairs small holes and dents.

Five Important steps for preparing metal for paint

1 Clean the bare metal surface

2 Remove the loose and peeling paint

3 Remove the rust

4 Repair small holes and dents

5 Prime the surface.

Priming immediately after cleaning the surface is imperative to prevent dust or dirt from accumulating flash rust (rust occurs within hours) from forming.

Metal Conditioner: It is a liquid phosphoric acid based product that effectively cleans the metal surface and removes rust. It also used when only a simple metal treatment is required prior to painting. Rust removal is accomplished quickly due to the deep penetration and dissolving of the surface soil.

Preparing hard chrome surface

The following steps to be used to preparing the hard chrome surface

1 Mix 1/3 part hydrochloric acid to one part water in a wet used for chemical mixtures (like a heavy duty plastic bucket) to produce a 30% acid solution.

2 Submerge the chrome-plated object in the solution until chrome strips off.

3 Wash the object thoroughly in soap and water, and rinse before dry.

Removing chrome with specialized machinery

- Use an abrasive blaster
- Use an ultrasonic cleaner
- Removing chrome with chemical solutions
- Use over cleaner
- Use a homemade abrasive to remove especially thin or weak chrome
- Chock the chromed item in house hold bleach
- Use broke fluid to remove chrome plating.

Preparing metal replacement parts: Properly prepare new metal surfaces, use mineral sprits to remove grease and apply a rust-inhibitive primer before painting for painted surfaces that are in sound condition. Remove dust with a clean dry cloth-de-gloss the metal part surface with light sanding and wipe with mineral sprits to ensure good adhesion.

Self - etch primer: Rust-locum self etching primer is designed to prepare bare metal, aluminium, fiberglass surfaces to promote maximum adhesion and smoothness of the top coat finish. Self etching primer is a rust preventive coating that etches and primer in one coat.

Seam Sealer: Seam sealer is made to cover and seal areas where panels may have been welded or overlapped. It will keep the seam from getting moisture in between panels and rusting out. As long as you use the correct scan sealer and prepared the panel correctly. It will last the lifetime of the vehicle.

Prime coat selection: There are four primary purposes for the application of a prime coat on an aggregate base course coat and bond loose material particles on the surface of the base. Harden or toughen the base surface to provide a work platform for metal surface. The major purpose of prime coat is to protect the under lying layers

from wet weather by providing a temporary waterproofing layer. Additional benefits of prime coat are stabilizing or binding the surface fines together and promoting bond to HMA (Hazardous Material Adequate) layer. Prime coat must adequate penetrate the base to function properly.

Prime coat apply: The prime coat is applied above the aggregate base coarse or granular bases that will receive the asphalt layer. While the tack coat is applied between two layers of asphalt. Tack coat is a very light application of bituminous materials to ensure proper bonding between two binder layers.

Applying spot or glaze putty: The spot and glazing putty is ideal for spot repairs and other small repairs to autobody panels. Use it 60 filling pin holes in body filler as well as for covering minor sand scratches and dent, digs on metal surface, fiber glass and wood as well as sanded and primer or sanded and painted surfaces.

Final Sanding: A good sanding block is approximately 12 inches long and the flat side of the block is covered with sand paper. To use sanding block properly hold it with both hands and slowly sand the flat surfaces of a panel and sand in slow, deliberate and even, strokes. This will allow to slowly sand away the paint and primer.

Using the right grit: For heavy sanding and stripping you need coarse sand paper measuring 40 to 60 grit, for smoothing surfaces and removing small imperfections, choose 80 to 120 grit sandpaper. For finishing surfaces smoothly, use a super fine sandpaper with 360 to 600 grit.

Masking: Whatever kind of painting you have to carry out on the vehicle, the masking process is always the same. The most effective techniques to mask a car body for painting.

- Provide yourself with the right tools for masking tape for the automotive painting sector. Masking paper and masking film are most used to mask the upper part of the vehicles, as they are easier to deal with them masking paper.
- Prepare the surface for masking surface should be smooth and clean, dry and free from dust.
- Apply masking tape under the edges around the masking area. Apply it under the edges of the area you need to paint.
- Use masking paper or film to cover near by areas - apply masking tape around the edges of the paper and letting half of the tape stick out, then fit the paper on the car. The best masking tapes for painting car give their best performance tape on tape.
- Use specific products for high precision application use foam masking tape and trim masking tape.

Surface sanding method

1 Sand old paint and primer off a car using a dual action sander and 80 grit sand paper.

2 Use 120 - grit sand paper to sand down any body filler used on the cars surface.

3 Cover the sanding block in 220 grit sandpaper to sand the primer coat after it has dried.

Power Sanding: An electric sander is a power tool used to smooth and finish surfaces. To remove material from the surface. The sander moves a piece of sandpaper or another abrasive rapidly, often in a circular motion. You can use an electric sander for a variety of tasks in many industries including autobody repair and finishing works.

Hand Sanding: The flat surface hand sanding purpose is to remove any marks or imperfections on the panel surface. Hand sanding blocks are increase the speed and efficiency of your work as well as providing a more even finish due to weight being distributed evenly across the block.

The flex pads shaped block will provide great comfort and comes in either a light weight soft foam version.

The mirka murlon sanding blocks are not only ergonomic but coupled with an abranet abrasive and an extractor will provide with dust free sanding solution. When using a hand sanding block replace the abrasive as often as possible. Otherwise the finish will be poorer due to reduced efficiency of the paper.

Wet Sanding: The wet part of wet sanding refers to the use of water or some other liquid as lubrication to help carry away grit particles that are removed. Without the liquid, material can build up in the sand paper and leave behind scratches that are larger than the particle size running surface finish.

Dry Sanding: Dry sanding is requires small circles to get an even finish no need any liquid lubricant during dry sanding process.

Comparison between wet and dry sanding: One big difference between dry sanding and wet sanding is the movement used. Dry sanding requires small circles. Wet sanding uses straight lines, alternating direction between passes. This way each successive pass works to remove the scratches from the previous one.

Surface Scuffing: Scuffing is a particularly damaging form of wear in highly loaded lubricated contacts. Scuff sanding is the process of lightly sanding a surface in preparation for primer, paint or varnish. You can scuff sand surfaces or even ones that have been already painted. It helps smooth out imperfections as well as given paint and varnish to grip on the surface.

Surface Cleaning: Clean the metal surface using the ordinary detergent or soap oil. Remove loose paint or rust with a wire brush, sand paper, steel wool, sand glossy surfaces with fine grain sand paper and wipe with a tack cloth or clean towel.

Masking

Objectives: At the end of this lesson you shall be able to
- **state the basic ways to mask the parts of the vehicle**
- **state the different type of masking procedure**

Basic ways to mask the parts of a vehicle

Prior to any vehicle repair or any painting need to be protected from unwanted damage, soiling or paint overspray working thoroughly from the very beginning reduces or even eliminates any clean up or rectification after-wards. Time consuming masking activity can be minimized by using high quality material and good application techniques. The following materials should be used and ready at hand.

- Interior protection covers for seat and foot area.
- Masking tapes
- Masking film
- Possibly masking paper
- Special masking tapes such as soft edge foam masking tape plus for apertures or fine line tapes for sharp clear lines.

Step by step guide for masking a vehicle repair

- Cleaning of the repair surface
- Apply masking film
- Prepare the repair area surroundings
- Cut and fix the film
- Attach the film to contours before base/clear coat
- Aftermath - correct demasking
- Removal of the masking tapes and film are best done, when the vehicle has just left the oven and is still warm.
- Always remove masking tape by pulling is an right angle to the surface. A flatter or sharper angle has a higher risk of leaving adhesive residue on the surface.
- Using premium masking tapes will pay-off as they have a lower tendency to leave adhesive or slice-saving you the most valuable thing work time.
- Avoid to stretch the tape particularly, when applying in cavities or dips.
- Firm press the edge of the tape to assure correct adhesion and prevent unclean edges.

Liquid Masking Materials

Masking liquid is latex-based product that is very effective at keeping small areas and thin lines white when painting on water colour paper. The rubber prevents the paint from reaching the paper and is peeled off to expose the white paper left untouched.

Liquid Masking System

It is a outstanding overspray protection and easy to apply and remove, durable protective film, economical to use, safe for operators and protected surface.

Methods liquid masking as follows

1 Outline the area to be painted with masking paper

2 Fold masking paper on to the area to be painted

3 Spray “Liquid-Mask” liberally on all other surfaces of the vehicle to be protected as textured “chip guard” coating 4 - 6 mil.thick. Apply to bumpers, grills, doors, windshields, body panels, wheels, wheel wells, doorjambs, and engine compartment.

4 Fold the masking paper back over the “Liquid-Masks” using a damp sponge, wipe away any compound from area to be painted.

5 Prepare surface to painted and apply primer, paint and any clear, including urethanes, according to manufactures direction.

6 Allow paint clear to dry. “Liquid-Mask” performs well under both air dry and bake condition.

7 After paint is cured and surface cods to room temperature rinse off “Liquid-Mask” with water spray or pressure.

8 Clean up: Flush and disposing equipment with hot water after use.

Plastic sheet masking

The majority of painters are use plastic mask for most of the vehicle any way, then use paper around the edges. They typically don’t mask the outer edge fully, which leaves a place for specks of dirt to hide. Plastic saves on tape too, plus dirt can’t hide like it can in the folds created by paper. When you stretch the plastic tight, you leave no place for dirt or specks of whatever to hide and pop out on to paint job.

Steps to use masking with plastic

1 Prepare all panels as normally would. Then cover the car with plastic, stretching it down to within 2 inches of the type bottoms. Then use 2 inches tape to stick the plastic to the tires.

2 Using a new razor blade, carefully cut out the plastic around the area to be painted. Use the plastic to mask the windows.

3 Painter's biggest fear when using plastic is that the paint will flake off the plastic and get into the job. To avoid this first spray all the panels plus two feet around them with adhesion promoter just as far as the overspray might land. Should not put adhesion promoter on the primer area and use sealer on and put on two wet coats of adhesion promoter using paint gun. The rattle cans just have too much orange peel for panels.

4 Let it go through the booth cycle, flash and then bake for five minutes. Now it is ready for paint as usual. After baking clear or after air dry you can demask the vehicle without any worry of the paint products flaking off the plastic.

Masking paper

Masking paper material used to mask or protect areas not to paint low acquisition cost and easy of placement on flat surfaces make the paper a suitable material for masking. The main characteristic to provide the paper used in the masking process is to resist the solvents and-diluents containing in the paint and the possible manipulation efforts on the other hand the paper selected must resist drying temperatures to which shall be submitted once painted the work piece in order to accelerate the drying process.

Masking tape

All masking tapes have as common features that have at least one adhesive size and also available in the market or double sided tapes with adhesive on both sides as occurs with the films and papers, the masking tapes have to be resistant to solvents from paints, to handling and drying temperature on the other hand once the work is end the tape must be remove easily and quickly without trace of adhesive.

Trim masking tapes especially useful for masking of frames and windows.

Masking rope

Masking rope are self-adhesive foam strips used in holes and openings the purpose of masking rope is to prevent the penetration of the spray paint into the hole and stain the interior paint is not desired. This type of masking material is used on the edges of the doors, hinged covers.

Wheel masking

Place paper between wheel rim and tyre and plaster the paper by paste the tape with tyre tightly. Plastic sheet also can use for masking the wheel. When wheel rim is painted.

When the vehicle is painted that time cover the wheel with wheel masking cover and rear side use the paper masking to avoid the deposit of paint dust on the wheel.

Masking panel gaps

Mask close gap between adjacent panels up to foam tape (Overspray) and mask the close gap is an included operation. This operation includes the use of masking tape or foam tape to close a gap between two adjacent panels preventing over spray from entering between the panels during the refinish process.

Mask Opening Procedure

On completion of paint let allow for few minutes to paint dry. Remove the mask without damaging the paint surface. Remove the mask when paint is little wet condition. Don't remove the masks after complete paint dry it will damage the painting area edges. 90 degree pull at moderate speed for best results and speed or temperature of removal is not quite right.

Reverse Masking

Reverse masking for large areas. For two tone applications over large areas this technique involves scaling the ends or flaps of large masking bags or sheets.

Surface Cleaning

After masking the panel, apply wax on the surface to be painted. Let allow dry to few minutes. Then clean the wax and grease deposited on the panel surface with cleaning towel or clean soft cloth.

Refinishing procedure

Objectives: At the end of this lesson you shall be able to
- **state the different type paint coatings**
- **state the properties of paint used for refinishing**
- p**repare the refinishing materials.**

Functions of paint

Auto motive paint is used on automobile for both protection and decoration purposes. Water based acrylic polyurethane enamel paint is most widely used paint for resins including reducing paints environmental impacts.

OEM paint

Original Equipment Manufacture paint for repair check the vehicle for damage spot and then check vehicle paint colour code stamped on the vehicle. Select the paint colour through computer base colour mixing machine and select the quantity required to repair the damaged paint area. Mix the paint with paint mixing stick clean the paint damage are of the vehicle. Mask the vehicle where paint not to be needed. Fill the paint in paint spray gun cup. Clean the to be painted spot. Apply the paint on the panel surface till colour is match with old paint with panel. Let allow the paint dry for few minutes. Remove the masking and clean the vehicle. Check and match the paint colour with vehicle manufacture's colour code.

Difference between OEM refinish painting types

OEM finishes give a new look as factory finishes. There coats of clear are applied and no sanding or buffing is done. The finish is bright and shiny with a slight texture in the clear similar to what would expect on a new vehicle.

Each design is hand prepped and painted to fit and flow with parts. Paint finish look is fresh finish done at the factory.

Refinish painting type of paint top coat

In this system used the very best materials and techniques combined to bring a finish. Show finish get a application of three coats of top and clear coat and a fill sand and buff leaving the clear smooth as glass with no edges from graphic or logos.

This finish look as quality finish. The find finish is very durable and benefits from UV protectant clear and two applications of find clear leaving plenty of thickness to sand and buff out scratches. Show finishes covered by limited warranty.

Properties of paint

Paint known as varnishes contain a solid binder dissolved in a solvent and are dried out as a result of its evaporation. They are widely used as materials for covering surfaces for decorative and protective purposes. Varnishes also have the ability to quickly cure in a very wide temperature range.

Properties of ideal paint

- Ease of application
- Good flow out of application marks (brush marking)
- Forming continuous protective film
- High opacity
- Quick drying
- Corrosion resistance
- Water resistance
- Heat resistance

Top coats

Top coating is a transparent or translucent coat of paint applied over the underlying material as a sealer. In a paint system, the top coat provides a resinous seal over the intermediate coats and the primer. The top coat is the first is the first line of defense of many coatings against aggressive agents.

Prime coats

A prime coat is an application of a low viscosity asphalt to a granular base in preparation for an initial layer of asphalt. Prime coats hardens or toughens the surface of the base.

Preparing refinishing material

A kind of two package automotive refinishing paint of superior performance was prepared from acrylic polyurethanes modified by polyester resin. The effect of acrylic resin polyester resin and its amount curing agent the molar ratio of NCO - OH leveling agent and anti - settling agent on the film properties. That the film had the best performance. When the mass ratio of acrylic resin to polyester resin modified by CARDURA E - 10, N 3390 was used as curing agent the molar ratio of –NCO-OHW as 1.08-1.15 the ratio of acrylic levelling agent and silicone levelling agent was 10:3 and the quantity percentage of anit-settling agent was 0.54 percent, the paint film exhibited the best performance.

Pre-painting preparation

Properly prepare the surface. It should be free of rust, debris, oils, grease, water, old paints and dust. Use wire brushes, sand paper, emery cloth, files, steel stool or sand blasting to get the bare metal ready to accept the paint.

Applying prime coat

A prime coat is a coating applied directly to a prepared base before additional layers of support or coating. Prime coat asphalt preparation is a vital element, as it directly affects the shear strength of the final asphalt product.

Painting on Plastic Parts

The following steps to be followed to paint on the plastic parts of the vehicle.

- Sand & Clean the plastic parts to be painted
- Applying the primer on the parts
- Masking and apply colour.
- As with previous two steps, gradually apply, lacquer 4-5 coats to get the best finish. Make sure you leave the part for a few hours before doing anything with it.
- Once you are sure part has completely dried, take microfiber cloth and polish it up. This will get rid of any left over pieces of debris and leave the part perfect for re-application to the part.

Flash time

A flash time is a flash coat should at a minimum, be on for five to 10 minutes, which kind of paint job is doing, which type of paint using and the temperature will affect the duration of a flash coat. Also, the more coats that are used increases the length of flash time.

Basic Spray Coat

The base coat is applied after the prime coat. The coat contains the visual properties of colour and defects, and is usually the one referred to as the paint base coat used in automotive applications is commonly divided into three categories, solid, metallic and pearlescent pigments.

Method of refinishing

Modern automotive coating methods consist of five main steps. They included the following.

- **Pretreatment:** Removes and cleans excess metal and forms an appropriate surface structure enabling bonding of corrosion protection layer.
- The next step is Electro Deposition (ED) of the anti-corrosion or rust prevention layer.
- A sealer like Poly Vinyl Chloride (PVC) is applied for anti-corrosion, elimination of water leaks and minimization of chipping and vibrational noise.
- A primer is then applied to promote adhesion between the surface and the base coat, it also imparts a smoother surface for subsequent layers and has anti-chipping properties.
- Finally, the top coats that include a base coat and clear coat are applied. They provide surface properties that are sought after, including colour, appearance gloss, smoothness, and weather resistance.

Base coat/clear coat repairs

- Clean the scratched area with warm water and mild soap.
- Rub contrasting shoe polish into the scratched area with a clean rag
- Filed a small bowl with cold water and to two to three drops of mild soap. This soap water mixture will help lubricate the sand paper and make a job clear and safer.
- Wrap ultra-fine, wet/dry sandpaper (2000 or 3000 grit) around a sanding block. Dip the sand (block) paper into the bowl and allow it to soak for two to three minutes until it is thoroughly soaked.
- Sand the scratched area at alternating 60-degree angles in short, light strokes.
- Sand in light strokes until see the contrasting color disappearing
- Dry the area thoroughly with clean towel and look for any signs of the scratch
- Buff the newly-repaired area with rubbing compound to restore the shine of the clear coat. Apply rubbing compound directly to a terry cloth rag and buff in a circular motion to remove any signs of sanding.
- Rub the buffed area with a clean rag to remove any residual compound. Wash and dry the area again if necessary to remove streaks.

The following items are need to repair the base/clear coat, water, soap, bucket, sponge, rag, clean towel, shoe polish, bowl, sand paper, sanding block, rubbing compound, terry cloth rag.

Applying single stage paint

Single stage paint is a simpler process than dual stage and therefore coats less it is also quicker to apply. Single stage urethane is a one-step painting process for automobiles that avoids the necessity of clear-coat finish. The paint is durable enough to polish without altering the colour tone and using it reduces the overall refinishing time. The urethane must be mixed with hardener and reducer before spraying and, while the ratios may vary from product to product, the typical ratio is 4 parts paint to 1 part hardener to one part.

— Apply rust conditioner to rusty areas and use a plastic putty knife to fill holes and dents with body filler.

— Mask off all areas not to be painted with tape and masking paper.

— Fill the cup of the spray gun with primer and turn on the compressor. Test the spray pattern.

— Holding the gun 6 inches from the surface, begin spraying in left-right motion from end to end. Overlapping about half the width of the spray pattern.

— Lightly sand the primer with 220 grit sand paper and tack the surface.

— Fill the cup about three-quarters full of urethane and mix in hardener and reducer according to the manufacture's specification.

Spray the mixture on the surface in the same way as sprayed the primer. Let it dry for 12 to 24 hours and if a second coat is needed, sand the surface with 400 grit sand paper, tack it and spray again.

Let the finish cure for 24 to 48 hours before buffing it out and applying wax or polish.

Items need to single stage coat

Body filler, putty knife, orbital sander, rust conditioner masking tape and paper, air spray gun, compressor, respirator, primer, 220 and 400 grit wet/dry sand paper, tack cloth, urethane, hardener, reducer.

Panel Repairs

Auto body-repair is a commitment to deliver a perfect repair.

- Remove the minor dents and dings from panel, where paint has not been compromised.
- Panel repair requires extra care to avoid damage or rework
- Follow the OEM recommendations for panel bonding adhesives
- Clean the vehicle prior to disassembling
- Sand the repair area using grade 80 removing paint beyond damage by 2-4 inch. blow off with clean, dry air and re clean with surface cleaner.
- Remove the remaining panel paint coatings use the grinding disc for sanding the panel and re-clean with surface cleaner.
- Mix and apply filler.
- Initial sand the filler and clean the dust on the panel surface.
- Final sand the filler and clean the dust
- Mix and apply glaze putty.
- Sand the glaze putty.

Final sand and inspect the panel surface

Blow off the entire repair area with clean, dry compressed air, feather edge the area surrounding the filler and glaze using a 180 grade abrasive. Be sure to remove any remaining straight line scratches from the repair area and abrade the outer perimeter for primer. Inspect the entire repair for quality.

Overall refinishing

This a complex process involving sanding over the panel surface and making sure it is completely smooth and then applying mask metal conditioner, body filter, glaze putty, primer, base coat, top coat and clear coats, polish the painted surface for shinning.

Removal of masking materials

Follow the following steps to remove the masking tape and papers.

— Wait one hour after painting or until the paint feels dry to touch

— Run a razor blade along the edge of the tape when the paint pulls up with it. Pull the tape off slowly at a 45 degree angle.

— Hold the hair dryer on low heat about 3 inches away from the tape when the tape does not peel off easily.

— Use a scraper to remove any tape hair dryer cannot loosen.

— Remove the masking paper after painting done.

Colour Matching and Customized

Objectives: At the end of this lesson you shall be able to
- **state the colour theory**
- **state the colour spraying variables in the shop**
- **state the positive and negative variable**
- **state the let-down test panel procedures**
- **state the computerized paint matching.**

Introduction to colour theory

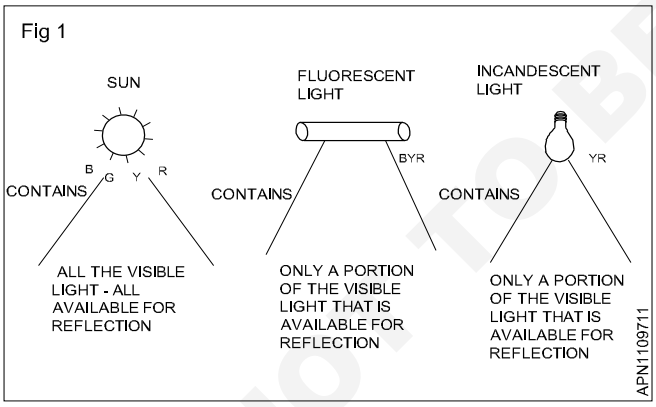
In this visual arts, colour theory is a body of practical guidance to colour mixing and the visual effects of a specific colour combination. There are also definitions of colours based on the colour wheel primary colour. Secondary colour and tertiary colour.

— Primary colours are the building blocks for all other hues, and cannot be created by mixing any other pigments. They are blue, yellow and red.

— Secondary colours are each created from two of the primaries. They are orange, green and violet. Like the primary colours they are equidistant from one another on the colour wheel.

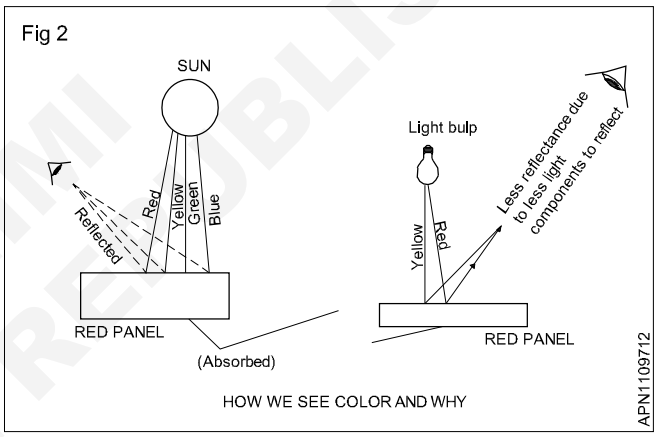
— Tertiary colours are formed by mixing a primary and secondary colour. They are yellow-green, yellow-orange, red-orange, red-violet, blue-violet and blue-green.

Light Colour Evaluation (Fig 1)



Those parts of the light spectrum available for reflection under different forms of light: B, blue; G, green; Y, yellow; R, red. When working inside the body shop, the most efficient lighting can probably be had with the colour classer fluorescent bulb. (Fig 1)

The best light for a body shop to use when matching color is natural sunlight. These figures demonstrate a condition in color matching called metamerism, in which two colors appear identical under one lighting condition but not under another. For example, a painter sprays a panel inside a body shop. It looks pretty good for match, but the car is pulled out of the shop and the customer sees a glaring mismatch. The painter should be helped to determine the best location in the shop to view color match. Help him find the location where A and B are most likely to match. The painter should be shown why he should take the car outside to make a final judgement. Remind the painter of the quality match of the two manufacturers and that he or she take this condition into account when doing color matching. (Fig 2)



Colors usually darken after drying, so a certain amount of consideration must be given when tinting the color, especially with enamel. Enamels dry much more slowly than lacquers, which creates a certain problem; it takes longer to find the true color. Another point to consider is the thickness of the film; light pastel shades will usually be lighter when a heavy film is sprayed.

Lacquers are usually sprayed to a film thickness of about 3.0 to 3.5 mils (7.6 to 8.8 µm); enamels are generally a little thicker, up to 3 to 4 mils (7.6 to 10.1 µm). This thickness includes the undercoat; more film thickness than this will at times make the film crack during great temperature changes. When the film is too thick, it loses elasticity and will crack as the metal expands and contracts.

The basic tinting bases listed in the tables should be made available by jobbers or painters so that tinting may be done in shops. Other tinting bases may be added to the basic kits as required.

Color Tinting Chart

Variations from color standards occasionally exist in the manufacture of assembly line built cars. Fade is a factor over which no one has control. Tinting and shading are often necessary to compensate for these color drifts. This color tinting chart will help you with your color problems.

Acrylic Lacquer (3000), Synthol Enamel (9000), and Acrylic Enamel (9800) base mixing colors shown in the chart below are not interchangeable or miscible. Each should be used only to tint colors of like material.

	Lighter, Add	**Darker, Add**	**Bluer, Add**	**Greener, Add**	**Yellower, Add**	**Redder Or Browner, Add**	**Grayer, Add**	**(For Poly Only) Brighter, Add**
YELLOW (Deep)	3001 9029 9800	3033 9036 9808		3032 9035 9807		3017 9038 9806		
Orange	3001 9029 9800	All colors except white				3017 9038 9806		
Blue	3001 9029 9800	All colors except white or poly chrome		3011 9030 9810		3021 9020 9812	3001 and 3002 9029 and 9023 9800 and 01	3016 9025 9824
Green	3001 9029 9800	All colors except white or poly chrome	3005 or 3009 9027 9818 or 9820		3010 or 3003 9021 or 9008 9809 or 9813	3004 or 3014 9018 or 9024 9805 or 9826	3001 and 3002 9029 and 9023 9800 or 9801	3016 9025 9824
Ivory or cream	3001 9029 9800	All colors except white			3010 9021 9809	3004 or 3004 9008 or 9018 9826 or 9828	3001 and 3002 9029 and 9023 9800 amd 9801	
Tan or beige or brown	3001 9029 9800	All colors except white			3010 or 3003 9021 or 9008 9809 or 9813	3003 or 3014 9018 or 9024 9826 or 9828	3001 and 3002 9029 and 9023 9800 amd 9801	3016 9025 9824
Off white	3001 9029 9800	All colors except white	3005 or 3009 9027 9818 or 9820	3011 9030 9810	3010 9021 9809	3014 9024 9805	3001 and 3002 9029 and 9023 9800 amd 9801	
Gray	3001 9029 9800	All colors except white or poly chrome	3005 or 3009 9027 9818 or 9820	3011 9030 9810	3003 9008 9813	3004 9018 9826		3016 9025 9824
Red		3018 or 3021 9020 9812 or 9826			3017 9038 9806			3016 9025 9824
Maroon	3017 9038 9806	All colors except white or poly chrome	3018 or 3021 9020 or 9026 9812 or 9816					3016 9025 9824

To make all polychrome colors lighter, tint with polychrome preferably same used in the formula; to make grayer, use black and polychrome.

ACRYLIC LACQUER MIXING COLORS

3001	White	3021	Violet
3002	Black	3022	Flatting Base
3003	Yellow Oxide	3023	Suede Univ.Base
3004	Red Oxide	3025	L.T Black
3005	Blue	3032	Lemon Yellow
3006	Orange	3033	Chrome Yellow
3007	Clearmix	3034	Light Gold
3008	Polychrome	3035	Ultra Polychrome
3009	Phthalo Blue	3036	Red Shade Blue
3010	Indo Yellow	3037	Yellow Shade Green
3011	Phthalo Green	3038	Amber Maroon
3012	Polychrome Regular	3039	Green Shade Blue
3013	Chinese Blue	3040	L.T. Oxide Yellow
3014	Gold	3041	Bright Maroon
3015	Indo Blue	3042	Red Shade Gold
3016	Bright Polychrome	3043	Coarse Polychrome
3017	Moly Orange	3044	Red Shade Yellow
3018	Indo Maroon	3048	Bright Aluminum
3020	Carbon Black		

SYNTHOL ENAMEL MIXING COLORS

9000	Syn-Mix	9032	Indo Orange
9001	White	9034	Permansa Red
9004	Toluidine Red	9035	Light Yellow
9005	Lemon Yellow	9036	Chrome Yellow
9008	P.T. Yellow	9038	Moly Orange
9011	Chinese Blue	9039	Violet Maroon
9014	Polychrome	9040	Ultra Polychrome
9018	Sienna	9041	Fine Polychrome
9020	Tinting Maroon	9042	Bright Maroon
9021	P.T. Green Yellow	9043	Opal Yellow Oxide
9022	P. Purple Blue	9044	Red Blue
9023	Carbon Black	9045	Yellow Green
9024	P.T. Gold	9046	Green Blue
9025	Brill. Polychrome	9047	Red Gold
9027	P. Medium Blue	9048	Medium Blue
9029	Modern White	9049	Amber Maroon
9030	Brill. Green	9050	Sparkle polychrome

ACRYLIC ENAMEL MIXING COLORS

9800	White	9821	Bright Maroon
9801	Black	9822	Opal Yellow Oxide
9803	Scarlet	9823	Medium Blue
9804	Orange	9824	Ultra Polychrome
9805	Gold	9825	Indo Blue
9806	Deep Orange	9826	Red Gold
9807	Medium Yellow	9827	Polychrome Fine
9808	Lemon Yellow	9828	Amber Maroon
9809	Indo Yellow	9829	Yellow Green
9810	Green	9830	Red Shade Yellow
9811	Blue	9831	Red Orange
9812	Violet	9832	Magenta
9813	Ferrite Yellow	9833	Bright Aluminum
9814	Iron Blue	9836	Mix-Clear
9816	Maroon	9837	H.S Coarse Polychrome
9817	Polychrome Medium	9838	H.S Medium Polychrome
9818	Red Blue	9839	A.E. Base Coat Drier
9819	Polychrome Coarse	9840	Bright Polychrome
9820	Green Blue		

PAINTER CONTROLLED

In the shop on the spot

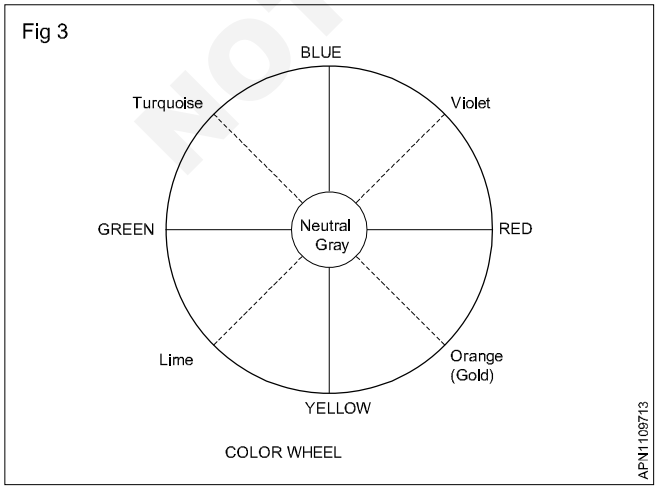
As a guide for in the shop on the spot color shading, we offer the following:

TO SHADE	USE	
Polychromatic Colors lighter	9819 Polychrome Coarse 3035 Ultra Polychrome 9040 Ultra Polychrome	Acrylic Enamel Acrylic Lacquer Synthol Enamel
Non-Polychromatic Colors lighter	9800 White 3001 White 9001 White	Acrylic Enamel Acrylic Lacquer Synthol Enamel
Dirtier and Bluer	9801 Black 3020 Carbon Black 9023 Carbon Black	Acrylic Enamel Acrylic Lacquer Synthol Enamel
Dirtier and Browner	9805 Gold 3014 Gold 9024 P.T. Gold	Acrylic Enamel Acrylic Lacquer Synthol Enamel
Greener in cast	9829 Yellow Green 3037 Yellow Shade Grn 9045 Yellow Green	Acrylic Enamel Acrylic Lacquer Synthol Enamel
Yellower in cast	9809 Indo Yellow 3010 Indo Yellow 9021 P.T. Grn. Yellow	Acrylic Enamel Acrylic Lacquer Synthol Enamel
Bluer in cast	9820 Green Blue 3039 Green Shade Blue 9046 Green Blue	Acrylic Enamel Acrylic Lacquer Synthol Enamel
Redder in cast	9812 Violet 3021 Violet 9039 Violet Maroon	Acrylic Enamel Acrylic Lacquer Synthol Enamel

Dimensions of colour value

To explain the dimensions of color, the color wheel (Fig 3) is used to provide reference points for the four colors. The hue or cast is the easiest to see; is it redder, bluer, greener, or yellower? Equal parts of red and blue make a violet color and equal parts of green and blue produce a turquoise color. When matching a red, the color that has to be matched must be determined as having a bluer or yellower hue or cast; then small amounts of blue or yellow toner are added to achieve the desired hue or cast. Table 1 shows how a particular color will change a cast or hue.

Fig 3



COLOR WHEEL

TABLE 1

How colors change in cast

Color	Variations of hue
Green	Bluer or Yellower
Blue	Greener or redder
Red	Bluer or yellower
Yellow	Greener or redder
Gold	Greener or redder
Maroon	Yellower or bluer
Bronze	Yellower or redder
Orange	Yellower or redder
White	Yellower or bluer
Beige	Greener or redder
Purple	Greener or redder
Black	Yellower or bluer
Aqua	Bluer or greener
Gray	Yellower or bluer

Source: Martin Senour, Inc.

When tinting colors, sometimes the paint may have the wrong cast or hue. A blue color may have too much of a red cast or hue. To kill the red cast, a green toner must be added. The opposite cast or hue on the color wheel must be used to kill the undesired cast. Table 2 shows what colors or toners must be added to the mixture of paint to kill the cast or hue of the particular color.

TABLE 2

If a color is "too something in cast" the following kills will change the cast

Color being matched	Adding	Kills	Subtracting
Blue	Green	"	Red
Blue	Red	"	Green
Green	Yellow	"	Blue
Green	Blue	"	Yellow
Red	Yellow	"	Blue
Red	Blue	"	Yellow
Gold	Green	"	Red
Gold	Red	"	Green
Maroon	Yellow	"	Blue
Maroon	Blue	"	Yellow
Bronze	Yellow	"	Red
Bronze	Red	"	Yellow
Orange	Yellow	"	Red
Orange	Red	"	Yellow
Yellow	Green	"	Red
Yellow	Red	"	Green
White	Yellow	"	Blue
White	Blue	"	Yellow
Beige	Green	"	Red
Beige	Red	"	Green
Purple	Green	"	Red
Purple	Red	"	Green
Aqua	Blue	"	Green
Gray	Blue kills yellow Yellow kills blue		

Saturation or chroma refers to a color's purity and richness. Look at the color wheel in the center represents the neutral color, which is gray, and any color in its weakest concentration will become gray or neutral. A line plotted from the center of the wheel to blue will change to a light blue, then to a medium blue, and then a dark blue. Also, a line plotted from the center of the wheel to green will change to light green, then to a medium green, and then to a dark green. Therefore, to darken a color a dark toner must be used. For instance, the bluest toner in the tinting system that is the richest and has the least amount of green or red cast must be added slowly. The same principle must be used for the green color; that is, use the greenest and richest toner that has the least amount of blue or yellow in it. Too often a painter, when trying to tint a medium color darker, will use black, when all that is needed is a darker toner of the same color. Also, many times white is used to lighten a color when a lighter toner of the same color family should be used.

Brightness or depth, also referred to as being brighter or grayer, refers to the amount of white or black in a given color. Brightness should never be thought of as light or dark, but as intensity. When tinting a color, its hue or cast and intensity can be maintained, while still changing the color with relation to its reflectively by adding white or black.

It is sometimes very difficult to determine how to change the saturation of a color or the brightness of the color. This is where a painter with a good eye excels, but some general rules should be followed. A black color may be used to darken most colors but not make them richer; but the side effect of using black might to be gray or muddy the color. Adding black to a red will produce an oxide tone or a brown, so to darken a red, a maroon toner should be used.

When a black is added to yellow, it will darken the yellow but a grayish-green tone may be produced. White is used to lighten colors except red, maroon, browns, dark blues, and dark greens. When lightening red, brown, and maroon, orange and yellow should be used; to add white to these colors will produce a pink tone. Green or gold are used to lighten dark green depending on its cast. The richer or cleaner a color is, the less white and black that should be used.

When a close match has been achieved when tinting a color, the painter should stop tinting and blend to finish the repair. It often happens that the last little spot of a tinting tone will change the color too far, and this will cause a loss of time and materials, because the painter has to start all over. (See Table 3)

TABLE 3

Polychrome (metallic) mixing colors

Acrylic enamel		
9824	Bright	Clean and bright
9827	Fine	Slightly dirty and chalky
9819	Coarse	Big and bright
9817	Medium	Dirty
9833	Biggest	Clean Sparkle
Synthol enamel		
9041	Fine	Clean and bright
9014	Finest	Dirty
9040	Coarse	Bright
9050	Biggest	Clean Sparkle

Acrylic Lacquer		
3008	Fine	Chalky
3012	Medium	Clean
3016	Coarse	Slightly dirty
3035	Coarser	Clean
3043	Coarsest	Clean
3048	Biggest	Diamond Sparkle

Source: Martin-Senour, Inc

The terms in Table 4 a color-matching glossary, should be learned and remembered by the painter as an aid in matching colors.

TABLE 4

Glossary of matching terms

Clean	The opposite of dirty. Describes a color with a bright appearance rather than one that has a drab appearance. The exclusion of black mares colors cleaner.
Dark	By eliminating white, solid colors become darker, while eliminating metallic flake makes metallic colors darker.
Dirty	The opposite of clean. Describes a color that has a drab appearance rather than one with a bright appearance. The addition of black makes colors dirty.
Face	The appearance of a color viewed straight on (at 90° angle). This term is most often used in comparison to the "pitch" of a color, which is the appearance of the color when viewed at any angle other than 90°. The face color is often different in lightness or darkness or in shade from the pitch, particularly when working with iridescent colors.
Flake	Particles added to a color to achieve a metallic or iridescent finish.
Flop	The appearance of a color when viewed from any angle other than straight on. The flop of a color also referred to as its pitch.
Hiding	The ability of a color to cover up (hide) a primer. Poor hiding color will allow the primer spot to show through.
Hue	Describes the basic color, is the color blue, red, yellow, green, violet, or orange? Hue is used to describe where the color would generally fall on the color wheel.
Iridescents	This term is used interchangeably with the word metallic. It is used to cover all colors which contain aluminium, mica, or other particles that impart a metallic appearance to the color. Iridescent colors must be carefully matched on the face and the pitch in order to achieve a desirable appearance.
Light	The addition of white makes solid colors lighter, while the addition of metallic flake makes metallic colors lighter.
Mass Tone	The color of a tinting base prior to intermixing with other bases.
Metallics	See iridescents.
Pitch	The appearance of a color when viewed from any angle other than straight on. This term is most often used in comparison to the "face" of a color, which is the appearance of the color when viewed at a 90° angle or straight on. Pitch is also referred to as the "flop" of a color. The pitch is often different from the face when working with iridescent colors.

Shade	This term is used to describe the variations of a color. Assuming that a color is generally blue, that is, the hue is blue, it can have a red shade or a yellow shade as well as being blue. Shade is also called undertone as it describes the subtle tone of a color.
Strength	High strength bases contain a lot of pigment. The additional pigment gives the bases good hiding.
Transparent	Bases that contain a small amount of pigment have poor hiding and are transparent. You can see through the base.

Paint Colour Chrome Saturation: Chrome saturation is the colour fullness of an area judged in proportion to its brightness (17-1136) chroma is the colourfulness of an area judged as a proportion of the brightness of a similarly illuminated area that appears white or highly transmitting. (17-139)

Paint richness: Automotive paint is paint used on automobiles for both protection and decoration purposes. The body is dipped into the electro-paint coat operation, then a high voltage is applied. The body works as a pearl pigments impart a coloured sparkle to the finish. Which works to create depth of colour modern automobile paint is applied is several layers with a total thickness of around 100 µm (0.1 mm)

Paint colour intensity or muddiness: Chroma refers to a colours level of intensity and richness. This is a vehicle being refinished and the colour of the paint being used. Darker colour than those who spray drier. Specially with metallic and pearls.

Standard colour chips: Paint colour matching is the steps needed make new paint look like existing paint. Even if you used body colour code numbers and correct formula, the new paint may not be exactly than identify colorchip next to it.

Variance colour chips: When matching automotive paint most shops will need a chip that is at least one-inch square for the best results. At paint store staff will use their spectrometer to analyze the chip and match it to their brands closest colour.

Use of colour test panel: Through the use of test panels, the colour is then evaluated to ensure that the pigmentation used to obtain the match is durable and will not change when exposed to the sun's ultraviolet rays. Test panels are normally needed when you have identified a problem colour or when experience tells you matching could be problem.

Spray- out test panel procedure: The automotive refinish industry relies heavily upon the use of test panels. Before the first coat of a new colour is sprayed on a new vehicle. Paint companies have prepared and evaluated test panels to ensure that the new formula will perform properly. The words "test panels" should remind, that is need to an evaluation before moving on to the real task at hand.

Colour spraying variables in the shop: The refinish paint is matched to an OEM standard panel. If there is any variation in the colour at the manufacturer or if the colour has shifted due to harsh atmospheric exposure, there will be obstacles to overcome. Most solid colours are easily matched. However, the use of test panel will be required. If you see the variation in colour chips or more than one formula alternate is offered. The ideal time to use the test panel process is when you are applying refinish products containing metallic or pearl elements. At the present time, less than 5 percent of OEM colours are solids and the remainder is either metallic or pearl finish.

Positive and negative variables: When the exhaust fan of the booth is turned on it creates a "negative" air pressure in the booth cabin. When there is a negative air pressure, the paint booth will try to suck in as much as possible, including dirt and debris from outside the booth.

To counter this negative pressure and air make up unit is used to supply air to replace the air being exhausted. If the air make up unit is designed to force more air into the booth than is exhausted. The booth is said to have positive air pressure. In this case, the booth has more air than outside the booth and when a door is opened, dirt and debris is pushed away from the booth.

Controlling the paint booth air flow going into the booth, with relation to the air being exhausted from the booth, is critically important to maintain the proper flow of air over the item being painted and remove the over spray effectively.

Matching solid colours and metallic finishes: Metallic paints reflect light for a much brighter shine than solids. They come in a wider variety of colours and add relatively little to the cost of the vehicle. The dirt shows more obviously on metallic finishes than solids; so you may end up cleaning.

Metallic paint wet coat: As the name wet coating is the application of a liquid paint to metal products as a metallic finishing. This metallic wet-coating can be applied with a spray gun, pump or pressurized vessel. The power coating process results in a thick final finish that is more durable than conventional wet coating.

Dry coats of metallic colour: Metallic colour is offered metallic coatings lend vitality and elegance to the surroundings and are widely appreciated wide base. Metallic coatings are available in different finishes which gives an iridescent colour effect. Metallic colour coating is the excellent clean and quick drying and perfect finish metallic paints contain aluminium flakes to create a sparking and grainy effect. So it leads to a reduction in the film thickness of the drying coating.

Importance of metallic colour mixing: Colour mixing and matching eliminates repetition and creates a sense of space and readability. Look at all flowers in the foreground on the left. They are repetitive and as such uninteresting in shape or colour. Metallic colour mixing is to improve the composition to match vehicle body colour.

Metallic colours variables to darken & Lighten: Metallic colour variables are important and accurate data base is to be developed for metallic paint system when computer color matching or colour measurement technology is for quality controls, match production or reducing the production add. Modern colour (darken and lighten) matching systems are offering solutions to colour problems and making colour matching easier. Spectrophotometer, is a colour measuring instrument used to darken and lighten metallic colour variables.

Steps for spot repair with fluorine clear coat system

1 Clean the scratched area with warm water and mild cleaning soap water. Dry the scratched area thoroughly with a clean towel.
2 Rub contrasting shoe polish into the scratched area with a clean rag.
3 The soap mixed cold water will help to lubricate the sand paper during wet sanding.
4 Use the 2000 or 3000 grit for wet sanding for spot repair.
5 Sand the scratched areas at alternating to degree in short, light strokes.
6 Sand in light strokes until find the contrasting colour.
7 Dry the area thoroughly with clean towel and look for any signs of the scratch.
8 Buff the newly repaired area with rubbing compound to restore the shine of the clear coat.
9 Rub the buffed area with a clean rag to remove any residual compound. Wash and dry the area. After repair apply car wax to add even more shine to finish.

Procedure for let-down test panel three stage finish: A three stage paint commonly referred to as a tri-coat is a colour that requires two separate base coat application steps. Since each application of mild-coat will change the colour, a certain type of spray-out card called a let-colour panel is required for colour matching process.

Steps for let - down panel testing

1 Apply base coat and allow it to dry thoroughly.
2 Cover or mask off spray out card, leaving a small section of spray out card visible.
3 Apply a coat of base coat over the exposed area.
4 Move your masked area down, exposing an additional section of the card and apply base coat.
5 Continue this process until you reach the bottom, at which point you can remove the masking and apply base coat over the entire card.
6 This will create a let-down panel that shows how your colour will look after each application of mid-coat. This will assist with colour matching and ensuring application consistency. Be sure to clear your card and mark the amount of mid-coat applications on the back.

Three stage painting repair procedure: The first step in the system for repairing OEM tri-coat finishes is to prepare a let-down panel. The let-down panel shows how many coats of mid coat, it will take to match the original finish.

Make a let-down panel Step 1

1 Apply base coat colour to hiding over the entire panel
2 Make the panel is five sections, leaving the first section exposed.
3 Apply a medium, wet coat of mid-coat and allow flash.
4 Removing the mask from next section.
5 Apply a medium-wet coat of mid coat over exposed area of the panel. Repeat the steps 4 and 5 until all five sections have been uncovered.

Steps 2 Prepare the surface

1 Clean and degrease the repair area.
2 Pre treat and prime where needed.
3 Sand the primed area with P - 400 DA grit or wet sand paper.
4 Sand all panels to be blended with 1500 grit sand paper.
5 Clean the area with an appropriate surface cleaner.
6 Seal the primed area.
7 Apply one coat of 222s™ mid coat adhesion.

Step 3 Apply the colour mid coat and cleaner

1 Apply the base coat to full hiding, extending each coat slightly beyond the previous one. Allow adequate flash time between coats.
2 Apply the number of mid coats indicated by the let-down panel. Be sure to fully cover the base colour before tapering the blend edge of each coat of mid coat. Blend each coat beyond the next, and allow sufficient flash time between coats.
3 Clear all the panels with chroma premier. Premium appearance clear coat.

Note: Use the panel as a guide to determine the number of mid coat needed to match the OEM tri-coat colour. Refer to special base coat blending procedures, technique II for additional blending options.

Steps for a panel repair with multi stage mica

1 Apply primer to area over the body filler and apply adhesion promoter to a large area.
2 Apply two or more coats of base coat to areas to full hiding, extending each coat slightly beyond the previous one.

3 Extend each mica intermediate coat beyond previous one with only last coat extending into adjacent panel.

4 Apply two coats of clear to entire repair area.

5 Apply mica intermediate coat to area covered by basecoat.

6 Apply a second mica intermediate coat well beyond edge of first coat.

7 Apply a third mica intermediate coat so that it extends to between first and second coats.

8 Apply a fourth mica intermediate coat to just beyond edge of second coat.

9 Zone repair is an option that may be required on.

10 Many base-clear finishes contain mica pigments and some are especially challenging to match.

11 Because finish may not provide full hiding, colour of the primer may show through.

12 If applies colour to full hiding, there may be a colour mismatch.

13 Colour effect test panel is required for base-clear finishes that contain mica.

Tinting

- Tinting is used to adjust colour variations in shades to match colour from manufacturer.
- Tinting is used to adjust colour on an aged or weathered finish.
- Tinting makes a colour for which there is no formula or for which there are no paint codes.
- Before tinting, determine if a colour variance chip or formula is available.

Basic reasons for tinting a paint colour

- Tinting should be based only as a last resort.
- If the colour mismatch, check whether finish has faded.
- Check that vehicle's paint code and stock number of colour are correct.
- Check that pigment and metallic flakes were properly mixed and that correct amount of reducer was added.
- Check that test panel dried and that colour.

Three angle paint colour adjustment:

The painter must known the basic adjustments for the spray gun before applying paint on a vehicle. The painter adjusts the spray gun so that the spray gun produces the proper spray pattern. The air cap be used in two different positions, to adjust this, the air cap retaining ring is turned a half a turn. If a perpendicular spray fan is desired, the air horns are adjusted so that they are in a horizontal position; this is the position most used by the painters. The air cap retaining ring is then tightened securely but not over tightly. The other adjustment is when the spray pattern is horizontal and the horns are in the vertical position.

Three main spray patterns are used. The full open pattern is used for complete paint jobs. The medium pattern is used mainly for spot repairs and blending with solvents. The small round pattern is used for small spots that requires last material build up or special repairs used some times, when refinishing. The spray gun should be held with two fingers on the trigger and the other two fingers and thumb holding the handle.

Spectrophotometer: A spectrophotometer is an electronic device for analyzing the colour of the paint on a vehicle. It electronically reads the colour frequencies in the finish to quickly find the correct paint formula for helping to achieve a colour match or tinting.

The spectrophotometer wand or box is placed on the surface to be checked. Most systems require that a test panel be sprayed for comparison. The multi angle spectrophotometers take readings at 25, 45 and 75 degrees. Each angle is read for several variables.

Most systems compare the vehicle and test panel to one another. The finish technician will get a reading on the relative lightness/darkness, hue, and chroma of the vehicle to the panel checked. It is still up to the painter to decide how to move the paint closer to the vehicle. Decisions on which tint and how much will be added must still be made using human judgment.

Computerised paint matching: Computerized paint matching systems use data from the spectrophotometer to help match the paint code. Many spectrophotometer system can input their colour data into a computer. The computer can then use its stored data to help determine how to mix or tint the paints.

Depending on the sophistication of the system, a computerized paint matching system may be able to

— Compare the actual colour of the vehicle to a computer stored set of colour formulations.

— Make a recommendation on which tint in the formula will move the sample panel closer to the vehicle colour.

— Automatically keep a record of the mixing or tinting procedure. This will let you quickly match the paint. If the vehicle returns for another repair.

Custom painting

Custom painting involves using multiple colours, metal flake paints, multilayer masking, and special spraying techniques to produce a personalized paint job. Multi-coloured strips, flames, murals, landscapes, names, and other art work can be added to the finish. Custom painting requires considerable talent, skill and knowledge. This will let you determine how to mask and spray or apply each colour. Custom painters are good at using airbrushes, stripping tools, and masking materials.

Repairing paint problems

Objectives: At the end of this lesson you shall be able to
- **state the paint problems**
- **state the final detailing.**

Introduction

Paint problems include a wide range of defects that can be found before or after painting. To maintain repair quality and safety customers, painter must be able to analyze and correct finish problems efficiently. There are a variety of causes for defects in a vehicle's finish. They usually, originate as a result of problems in the preparation of the body surface painting procedure, environment, paint ingredients and other sources.

Problems in wet paint

Paint defects while spraying, painter must decide whether to stop work immediately or whether the problem can be fixed so you can continue painting. This depends upon the type and extent of the paint problem. The metal working, body filer, or other work problem would have to be corrected before continuing to paint the vehicle.

When you painting in even the cleanest paint booth, tiny particles of dust, dirt, hair, and so on can some times fall or blow into the paint. There are several things you can do to keep foreign matters out of your freshly applied paint. Keep the spray booth doors closed for several minutes before starting to tack rag and blow off vehicle surfaces. This gives any air bone dust and dirt enough time to settle out of the air.

Don't open the spray booth doors while you are spraying. Place a keep out or do not open sign board on the spray booth doors, when you are painting.

Removing foreign matter in wet paint

Paint foreign matter includes anything you see in the paint that will adversely affect the finish. If you notice something in the wet paint try to remove it right away, the sooner the belter. A tiny piece of the lint or dust can often be lifted out of the wet paint. Depending on the type of matter in the paint, there are several ways to remove debris from wet paint.

Sharp tweezers can be used to grab and remove lint and hair from wet paint. Be careful to only touch the debris without disturbing the paint surface. After removing debris in the paint blend spray another coat of paint over that area right away.

Wet sanding between coats

Any imperfection in the colour coat, repair them before spraying the clear coats. Try lifting the particles out of the colour coat while still wet. If the paint still looks too flawed to be hidden any other coat. So you will have to let the base coat flash enough to wet sand the surface flow. Carefully wet sand right over the top of the flawed paint with ultrafine 100 to 1200 or finer grit sand paper warp the wet sand paper around a soft sponge type sanding block. Concentrate your wet sanding action over the surface. Sand lightly because the paint is flashed, but not fully dry. After sanding the flaw level, wipe the area dry, clean and tack rag the area before giving it another coat of colour. Lightly mist and blend the base coat over the surface flaw to cover any visible problem in the colour. If the piece of dust or dirt in the clear coat is too small to be lifted out.

Bull's Eye feather edge

A bulls eye featheredge is an indented that results from shrinkage of spot putty or filler, producing area that is lower over the top of the putty or filler. This problem is as follow causes.

Causes of bull's eye feather edge:

— Not allowing the spot putty to cure enough before block sanding. The use of older, slow-drying, one part lacquer based spot putty is another cause.

— Not allowing body filler to cure fully.

— Improper mixing of two part filler or putty.

Prevention

Bull eye feather edge can be prevented by only using two-part spot putty and allowing proper time for putty or filler to cure. Also be sure to mix putty and filler thoroughly.

Correcting bull's eye feather-edge

Correcting bull eye feather edging requires that you sand and refinish the affected area.

Feather edge splitting

Feather edge splitting appears as stretch marks or cracking along a feather edge.

Causes of feather edge splitting

- Using too much primer or primer surfacer in heavy and wet coats over a repair area can cause feather edge splitting solvent is trapped in lower layers that have not had sufficient time to set up.
- Material has not uniformly mixed.
- The wrong solvent is used.
- Improper surface cleaning or preparation.
- Excessive putty use and film build up.

Preventing featheredge splitting

— Apply properly reduced primer-surface in medium to full wet coats with enough flash time between coats.

— Stir all pigmented under coats and top-coats - Thoroughly.

— Select a paint solvent temperature that is suitable for existing shop condition.

— Select only reducers that are recommended for existing shop conditions.

— Thorughly clean areas that will be paint before sanding.

— Spot putty should be limited to filling minor in perfections, putty applied too heavily or too thickly will eventually shrink, causing featheredge splitting.

Correcting featheredge splitting

To correct featheredge splitting you must remove the finish from the affected areas and refinish.

Chemical spotting

Chemical spotting such as acid and alkali spotting, causes an obvious discolouration of paint surface various paint pigments react differently when they come its contact with acids or alkalies.

Causes of chemical spotting

The cause of acid alkali spotting is a chemical change of pigments. This problem is often found on older finishes that have been exposed to industrial pollution,

Prevention of chemical spotting

- Keep the finish spray away from contaminated atmosphere.
- Immediately following contamination, the body surface should be vigorously flushed with cool water and detergent.

Correcting chemical spotting

- Wash with detergent and water and follow with vinegar bath.
- Sand and refinish.
- If contamination has reached the metal before the refinishing the spot must be sanded down to the metal before refinishing.

Curing or drying failure

A curing or drying failure in the obviously slow hardening of a refinish product. The material remains wet or soft for a prolonged period of time. This might in valve a body filter spot putty, primer sealer, paint or corrosion protection material.

Causes of curing or drying failure

— Improper stirring or mixing of product ingredients.

— Sloppy surface cleaning and preparation, allowing chemical contamination of refinish materials splashing chemical paint remover.

— Faulty refinish product.

— Self life of product exceeded.

Preventing curing or drying failure

- Thoroughly clean all areas to the repaired with a wax and grease remover to avoid chemical contamination.
- Finger knead cream hardener for spot putty and body filler.
- Do not forget to add a hardener or catalyst.

Dulled finish

A dulled finish means the paint does not have or no longer has its normal gloss or shine. Dulled finished are the result of imposes repair procedures or paint deterioration.

Causes for dulled finish

- Compounding or buffing before paint has cured fully.
- Using too coarse of compound.
- Poorly cleaned surface.
- Top coats put on wet sub coats.
- Washing with caustic cleaning.

Preventing dulled finish

- Allow paint to cure properly before buffing,
- Use recommended materials.
- After using rubbing compound follow up by using a finer glazing compound.
- Never use hand-rubbing compound with a buffing machine.

Correcting dulled finish

Allow the finish to dry hard and use the correct materials to hand or machine compound the paint to a high gloss.

Color mismatch mottle

This condition may also be called off-color, wrong color, streaked, flooding, or blotchy “Colour mismatch’’ is the term applied to the appearance of adjacent areas that do not match . Mismatch of two different panels can result under the following conditions.

1 If the panels were painted with two different batches of top coat which were to different shades

2 If the color of the undercoat shows through on one panel

3 In the case of metallic colors, if the adjacent panels were not sprayed with the same degree of wetness

The terms “mottled”, “flooding” and “streaking” are applied to metallic colors and describe the appearance of light and dark areas within a panel. These difference depend on the wetness or dryness of the coating during application.

Causes

1 Improper spraying techniques.

2 Refinish color not thoroughly agitated.

3 Insufficient hiding.

4 Applying the top coat to a cold surface or in a cold room.

5 Failure to use a mist coat on metalics.

6 Using a solvent that evaporates too slowly.

Preventions

1 Use good spraying techniques. Keep the gun a constant distance from the work. trigger the gun end of each stroke, and avoid "toeing" and "heeling" the gun. Spray a test panel to check colour match before you apply color to the vehicle.

2 Throughly agitate topcoat materials before application. Failure to do this causes uneven pigment dispersion in the paint and results in mottling or off color.

3 Apply the required number of topcoats. Insufficient hiding is almost always causes by films that are too thin.

4 Never spray on a cold surface or in a cold room.

5 Spray a mist coat over metallic colors to obtain color uniformity.

6 Use solvents that are compatible with your shop conditions. Use of a slow – drying solvent where a regular – drying solvent would to call cause pigment particles to drift to uneven layers in the paint film.

Repair

In some cases of off color in metallic, a light area can be corrected by polishing and buffing, as this will tend to darken the appearance. If polishing and buffing does not correct the mismatch condition, the off color area must be repainted.

Cracking and checking

This condition may also be crazing crow's – foot checking, spider webbing, cob webbing, alligatoring, hairline cracks, cold cracking. The terms "cracking" and "checking" describe durability problems which show up with extended service of 6 to 24 months after exposure to the weather. There are fracture in the paint film resulting from shrinkage which is caused by oxidation or extreme cold.

"Cracking" is the term applied to a fractures which extends down through the paint film to the surface painted. It may be accompanied by curling of the edges of the fracture and peeling, also rusting if the finish peels off bare metal. Cracking is often observed in excessively thick films (10 mills or more) which have been exposed to a low temperature.

"Checking" is the term applied to a fractures. If they occur only on the surface of the topcoat and do not extend down through to the film. It may be observed in combination with chalking or dulling.

Causes

1 Application of a new finish over an old finish which has already checked.

2 Application of a new finish over a surface which is too soft or under cured.

3 Application of a new finish over an undercoat that is either too thick or not dry

4 Insufficient stirring and mixing

5 Improper thinners, for example, using a lacquer thinner in an enamel

6 Application of extremely thick finish coats

7 Adding unproven additives ,such as gloss improvers, with the color coat

8 Addition of excessive amounts of clear lacquer or enamel to a color

Preventions

1 Check the old finish carefully with a magnifying glass. If the old film shows any sign of checking, remove it completely

2 Apply in undercoats in medium-thin coats, allowing plenty of time for each coat to flash off

3 Make sure each coat is thoroughly dry before applying the next coat

4 Stir all materials thoroughly. Thinned materials settle faster. So occasionally agitate the material while it is in the spray cup.

5 Always use the solvents recommended by the paint manufacturer. Don't intermix the solvents from one company with materials from another.

6 Don't apply the paint too thick.

7 Don't add anything to refinishing materials that is not specifically recommended by the manufacture.

8 Don't shoot several coats of clear enamel over the color coat. Clear enamel has a tendency to check on prolonged exposure to sunlight or sudden changes in temperature.

Repair

Checking or cracking found to any type of paint film can be repaired only by stripping off the defective film and repainting.

Craters and fisheyes

This condition may also be known as crawling or poor wetting. Craters or fisheyes are surface conditions caused by paint flowing away from contaminated spot before it dries. This contamination are surface conditions caused by paint flowing away from contaminated spot before it dries. This contamination may be water, oil, grease, silicone, wax, soap and detergent. It may affect a small localized area or extend over a complete panel. The contamination exist on the surface before paint is applied. It may fall into the film while paint is being applied, or it may fall on the wet paint after the last coat has been applied.

Causes

1 Silicon containing wax not completely removed from original paint surface.

2 Oil or grease not cleaned from surface before repainting.

3 Oil or water from air compress sprayed into finish.

4 Airborne dirt containing silicone failing into wet paint.

5 Residue from dirty are contaminated shop towels remaining on surface before application of paint.

Preventions

1 Clean the surface of the original finish thoroughly by using silicone – and wax remover.

2 Use disposable paper towels for all clean up operation.

3 Drain air compresses, air line pressure regulators, and blow- off air lines daily

4 Confine topcoats painting to a spray booth supplied with cleaned tempered air.

5 Use fisheye eliminator, following the manufacturer's instruction.

Repair

Shallow craters in the original finish may be removed by sanding, polishing and buffing. If the crater is deep or if the cratering is extensive, It will be necessary to sand out the defeat and repaint the affected panel.

Chalking and dulling

This condition may be called poor gloss or no luster. The terms describe the paint durability problem which may show up in extend service (6 to 24 months). Chalking and dulling is usually confined to the horizontal surfaces of the vehicle such as the hood, tops of fenders roof , tops of quarters panel and deck lid. Chalking is the presence of loose, non adherent pigment on the finish. Dulling is the loss of luster.

Causes

1 Dry spray resulting from improper spray techniques (high air pressure, low paint flow, wide air fan, gun distance too great, etc) poor reducing solvent (evaporation to fast low solvency etc) or an excessive amount of reducer or thinner.

2 Poor holdout of undercoat and resulting absorption of topcoats, which may also be accompanied by sand scratches showing excessively.

3 Dry overspray falling on incompletely masked surface adjacent to the one bring repainted.

4 Application of paint to a surface contaminated with wax, oil, grease, soap, etc.

5 Use of abrasives which are too coarse when sanding the undercoat.

6 Application of topcoat to a heavily chalked or checked finish without adequate sanding.

7 Applying material from a can which had been previously opened and used but which had been improperly mixed. The remaining material would have an excess of pigment in proportion to the vehicle remaining and therefore would have low gloss.

8 Mixing improper additives, such as flatting agents with the finishes.

9 Applying topcoat to primer, primer- surface, or spot or glaze putty which is not sufficiently dried.

10 Insufficient topcoat film thickness.

Preventions

1 Use spray techniques and reducing solvents which will provide a wet film and good flow – out.

2 Use undercoats (primer, primer – surfacer, sealer and putties) which are formulated for the particular refinishing material employed – lacquer or enamel. Also use all materials from the same source of manufacture. Using a sealer coat is good insurance against poor hold out.

3 Carefully mask adjacent surfaces. If refinish the paint overspray should get old finish, remove the overspray before it dries with enamel reducer or lacquer thinner.

4 Thoroughly mask adjacent surfaces to be painted using a wax-and-silicone remover.

5 Use fine abrasive, such as 400 grit, in all final sanding of the old finish an under rated grit applying painted.

6 Completely sand off. All old chalked or checked original brush.

7 Always be sure that all material are completely mixed in the original package before using.

8 Do not use unknown additives. Use only those recommended by the manufacturers.

9 Be sure undercoats have been sufficiently air or force-dried in line with applier's recommendations before applying finish coats.

10 Always apply sufficient undercoat and topcoat to provide a full, glossy finish. Low film thickness of either can lead to a dull coating.

Repair

Poor gloss encountered in original finishers or refinishing can usually be improved by polishing with a line compound and buffing. However, the painting and buffing should take place only after the finish has become thoroughly dry and hard. If this does not produce the desired gloss, refinishing will be necessary.

Bleeding

Bleeding is the result of coloured soluble hues or pigments in the old finish or undercoat, which dissolve in the solvents of the refinish paint, causing it to go off color. This is

usually a problem only when a color change is involved in repainting. It also usually occurs only with maroon or red original finishes.

Cause

Bleeding is caused by the solubility of the dyes or pigments used in previous paint applications. There is nothing you can do to change the solubility of an old paint coat. However, a few precautions can be used to reduce bleeding problems.

Preventions

1 Before repainting over a color suspected of being a bleeder, spray a small area with the new color. Bleeding will generally appear in a few minutes. If the old finish bleeder. If this a bleeder, either remove the old finish or use a "bleeder sealer" before applying the finish coats.

2 When using refinish materials which are known to be bleeders, never allow overspray to fall on any other vehicles. Also thoroughly clean your equipment after spraying a bleeder to avoid contamnating subsequent colors.

Repair

The best way to repair a bleeding paint job is to remove the paint and refinish. Mild cases of bleeding can often be corrected by spraying a bleeder sealer followed by additional finish coats.

Blisters, bubbles and pop-ups

Blistering is the formation of many small eruptions in the finish and may occur between the metal and the undercoats or between the undercoats and the enamel topcoat. Blisters usually follow one of two distribution patterns, usually they are either uniformly distributed over a comparatively large area or concentrated in a localized area in the shape of a water spot or drip streak. Sometimes they are so small that they are difficult to identify without using a magnifying gloss. On other cars, blisters may be confused with dirt. To verify the condition, prick the suspected area with a sharp point and note whether a void (hole) or water exists. If so, blistering is confirmed. As the problem progresses, it may be accompanied by peeling if the eruption flaked off and by rusting, if the blister extends down to the metal.

A pit has the appearance of a void in the base metal or undercoat that is not filled or covered with paint. "Pop-up" is the term applied to a problem in the paint film around a pit. It results from the formation of a bubble in wet paint over the pit. If the bubble does not break, it is called a pop-up, if the bubble does break while the paint is still wet, a craterlike ring is formed.

The causes, prevention and repair of blisters, bubbles and pop-ups are indicated below.

Causes

1 Moisture or contamination on the surface such as water, oil, grease, tar or silicone.

2 Moisture in the spray lines.

3 Rust under the surface.

4 Not enough drying time of undercoat.

Preventions

1 Clean the surface thoroughly. Use a metal conditioner on bare metal. Use wax-and-silicone remover on old finishers. Keep bare hands off bare metal and primed surface.

2 Make sure all the water is wiped off the surface after wet sanding.

3 Drain air compressors, transformers and lines daily.

4 Make sure the undercoat is dry before applying either more undercoat or topcoats. Failure to do this can trap solvents under the film and cause blisters.

Repair

The only way to repair a blistered finish is to remove the blisters to their full depth and repaint.

Pop-ups found in factory finishes sometimes can be repaired by sanding, polishing and buffing.

If the pop-up is so large that it cannot be removed by light sanding, polishing and buffing, it will be necessary to fill the defect with air-dry lacquer applied with a fine-dipped brush.

An excess of lacquer should be applied to completely fill the void after drying (drying time can be accelerated by using a heat gun). After the lacquer is dry, lightly sand to level it out to the depth of the original surface. Then polish and buff, in extreme causes. It may be necessary to remove the blemish and repaint.

Blushing

This condition occurs during or after acrylic lacquer is applied in hot, humid weather. Some of the fast-drying thinner evaporates rapidly. This lowers the surface temperature, causing the moisture in the air to condense in and on the paint film. This gives the finish a dull, hazy or cloudy look.

Causes

1 Moisture droplets trapped in the wet paint film.

2 Excessive air pressure at the gun.

3 Too fast a thinner.

Preventions

1 In hot, humid weather, try to paint early in the morning.

2 Reduce air pressure to minimize cooling, effect of the spray.

3 Use a slow-evaporating thinner that is suitable for the temperature and humidity.

Repair

Add 1 or 2 ounces of retarder to each quart of thinner or reduced color. Then apply a final coat.

Sand scratches

Metal finishing marks are the result of poor surface preparation techniques. Usually they are caused by gouging metal with coarse grinder disks or files. Sometimes they are caused by the use of too coarse, a grit of sandpaper on undercoats. These marks went not resolved in the final metal-finish operation or were not properly filled and surface with putty.

Causes

1 Improper metal-finishing techniques.

2 Too thin a coating of primer surfacer.

3 Failure to use putty which required.

4 Failure to allow primer-surfacer in putty to dry long enough before sanding.

5 Cross sanding.

6 Poor sanding techniques.

7 Use sanding too coarse a sandpaper.

8 Use of poor or improper topcoat solvents.

Preventions

1 Always finish off a stripping or metal finishing operation with a fine-grit abrasive. (No.80 or liner)

2 Apply coating of primer surfacer, but not too heavily. Very heavy applications of primer-surfacer often lead to sand scratches.

3 Use glaze putty to fill surface variations that primer-surface won't fill. Don't try to fill deep scratches with heavy applications of primer-surface. Apply the putty in thin layers.

4 Allow both primer-surface and putty to flash off before applying succeeding coats. Failure to do this results to crusting, a defect which eventually makes sand scratches show up more.

5 Use good sanding techniques. The best sanding jobs usually come from wet-sanding operations. If you do use dry sandpaper, tap it frequently to remove the sanding sledge. Never cross-sand. Use a sanding block never your fingers.

6 Use the putty or grit sandpaper. Try to finish all sanding operations with No.400 grit paper or finer.

7 Use the solvent recommended by the topcoat manufacturer. Poor solvents usually lead to sand-scratch swelling.

Repair

Metal finishing marks and sand scratches found can original factory finishes can usually to repaired by a combination of sanding, polishing and buffing. In some extreme cases, the surface may have to be repainted.

The long cure time of finishing enamels prevents polishing and buffing being used on newly painted surfaces. Most cases of metal-finishing marks or sand scratches found on refinished cars will have to be re-painted.

Orange peel

"Orange peel" is a term which indicates the uneven appearance of a paint film which has not flowed out to a smooth, glossy surface.

Causes

1 Wrong solvent or improper reduction.

2 Poor gun techniques.

3 Improper air pressure.

Preventions

1 Always reduce the paint with the amount and type of solvent specified by the paint manufacturer. Poor-quality solvents, fast-evaporating solvents and under reduction are common causes of orange peel.

2 Use good gun techniques. Apply topcoats in wet coats, holding the gun 6 to 10 inches/150 to 250 mm/from the surface, keeping the gun at right angles to the area being painted.

3 Use the proper air pressure. Too high an air pressure causes a dry spray and prevents the paint from flowing out. Too low an air pressure causes poor atomization. Poor flow-out and atomization both result in orange peel.

Repair

Orange peel found to any painted surface can usually be repaired by a combination of sanding, polishing and buffing as long as completely cured.

Peeling

This is also known as it scaling or flaking, "Peeling" is the term applied to the separation of a paint film from the surface to which it has been applied. It includes peeling of the finish coats from the primer, separation of topcoat films (enamel from enamel or striping lacquer from enamel) or peeling of the finish from the metal, which may be accompanied by rusting.

Causes

1 Presence of any foreign material such as wax, silicone or oil on the surface before painting.

2 Improper or no use of metal conditioner and conversion coating on bare metal.

3 Too high an air pressure on the undercoat.

4 Use of the wrong undercoat for example, using an enamel undercoat under lacquer.

5 Insufficient sanding.

6 Applying additional coats of primer surfacer before preceding coats are thoroughly dry.

7 Using cheap solvent.

8 Surface material or solvents too hot or too cold.

Prevention

1 Remove all dirt, wax and grease before sanding.

2 Use a metal conditioner and conversion coating on bare material.

3 Thoroughly sand all surfaces where paint is to be applied.

4 Follow manufacturer's directions for thinning, applying, drying and recoating.

5 Prime bare metal areas as soon as possible to prevent rusting.

6 Keep surface, paint and thinners at room temperature.

Repair

Remove all of the paint having poor adhesion and repaint as required.

Water spotting

Water spotting is usually caused by exposing the surface of a paint film (that has not dries sufficiently) to snow, rain or dew. The effect of this water is magnified.

If the droplets are dried by sunlight. The damage may appear either as a roughening of the surface of the paint or as a circular, whitish water residue embedded in the surface.

Causes

1 Allowing rain, snow or dew to get on the surface or washing the surface before it is thoroughly dry.

2 Applying excessively thick coats or using any techniques that cause poor drying.

Prevention

1 Allow freshly painted vehicles sufficient air-dry or force-dry time before exposing them to the elements.

2 Use materials that have maximum resistance to water spotting.

3 See also preventions listed in E36-19. Poor drying and hardness.

Sags and runs

This condition may also be called drips, blobs, tears, curtains. All these terms describe a condition resulting from the application of an excessive amount of paint to a localized area. Then the paint flows downward and accumulates in objectionable thickness.

Causes

1 Spraying over a surface contaminated with wax, oil, grease or silicone.

2 Solvent material, surface or spray booth too cold.

3 Using too much or too little solvent or a solvent that dries too slowly.

4 "Piling on" coats by recoating before preceding coats have flashed off.

5 Using too low an air pressure.

6 Improper spray-gun adjustment.

7 Improper spray-gun technique.

Prevention

1 Thoroughly clean the surface to be painted. Use a wax-and-silicone remover before applying paint in a previously painted surface.

2 Keep the surface solvents and material at room temperature. Delay spraying in a spray booth until the booth has reached normal room temperature.

3 Make sure the paint is properly reduced following the paint manufacturer's recommendations. Runs can be caused by over reduction and use of a solvent which evaporates for slowly. Sags can be caused by under reduction, in which results in "Piling on" in heavy coats.

4 Allow preceding coats in flash off before applying the next coat. Failure to do this can cause sags.

5 Make sure sufficient air pressures is used low air pressure can cause sags, because the paint will not properly atomize.

6 Properly adjust the fluid and fan control on the spray gun. Too narrow a fan with too much paint will cause sags.

7 Keep the gun at the proper distance from the work. Holding the gun too close piles on the paint and invites sags. Also, avoid using a jerky spray stroke and moving the gun too slowly.

Repair

Sags found in original nonmetallic finishes can usually be corrected by cutting off the excess paint with a knife or razor blade followed by sanding, polishing and buffing to remove the excess paint. Sags in metallic colors when they are not accompanied by a change in color can be repaired in the same way. However, when there is a change in color the area will have to be repainted

Runs or sags causes by refinishers in local paint shops will usually have to be sanded off or washed off (If the paint is still wet and them repainted. Sometimes a sag

that is still wet can be removed by picking up the excess paint with a wet finger or by flowing it of the panel by spraying it with solvent.

Wrinkling

Wrinkling is seldom encountered in today's original finishes. However, it does occur in thick air-dry finishes as the result of uneven drying between the top surface and undersurface of the finish-coat material.

Causes

1 Too heavy a coats of paint; rapid drying of the top surface of the film while the film underneath remain soft.

2 Force drying of enamels without using a baking additive to retard surface setup.

3 Use of lacquer thinner in enamel, which may cause wrinkling or lifting of the original finish or the primer surfacer.

4 Exposing enamel to sunlight before it is thoroughly dry.

5 Any technique or condition that would produce sags or slow drying.

6 Abnormally hot and humid weather.

Prevention

1 Don't spray enamel too tick. Avoid pilling on.

2 If you force dry enamels, make sure you add a baking converter to the paint if it is recommended by the paint manufacturer.

3 Use the solvent recommended by the paint manufacturer.

4 Try to keep the spray booth and car at normal temperature.

5 Avoid spray-gun techniques that cause very heavy applications of paint (for example, holding the gun very close to the work and moving the gun very slowly.

6 Keep the car out of the sunshine until it has thoroughly dried.

Repair

The only way to repair a wrinkled surface is to remove the wrinkled film and to repaint.

Dirt in paint

This is also called foreign material, contamination, hair, lint, sand, grit, transitive. It is due to a foreign body under in the finish. It is covered by paint so that is has the same color is the topcoat but becomes objectionable because it protrudes above the finished surface.

Causes

1 Improper surface preparation techniques.

2 Dirty spray booth.

3 Dirty air lines or spray guns.

4 Improper solvent, adding the paint in the solvent or adding the solvent to the paint too quickly.

5 Spraying in air open room.

6 Dirty car or clothing.

7 Improper straining of or not straining the paint.

Preventions

1 Thoroughly clean the surface being painted. Wash the vehicle with warm water and a mild detergent. Rinse and then apply wax-and-silicone remover. Make sure to blow out all cracks and body joints while the car is outside the spray booth. Once the vehicle is in the spray booth, always tack it off thoroughly with new tack rags immediately before the application of paint.

2 Make sure the spray are to clean. Wetting down the booth, frequently changing the air filters in the booth and never sanding in the booth will help ensure jobs that are free from dirt.

3 Always use clean equipment. Dirty air regulators, air lines and spray guns are frequently the cause of dirt in paint.

4 Always use the type and amount of solvent recommended by the paint manufacturer. Also, be careful how you mix the paint and the solvent. Adding the paint to the solvent or adding the solvent to the paint too quickly can result in "kick-out", which looks like dirt in the paint.

5 Never spray any paint in an open are where either work is being done. Continue spraying operations to the spray booth.

6 Make sure the car being painted is thoroughly blown off before it enters the spray booth. Seal the door jambs and edges with a thin wet coat of paint before painting the surface. Always wear clean, lint-free clothing and a cap to prevent dirt, oil, lint, hair, dandruff, etc., from failing on a freshly painted surface.

7 Always strain the reduced material through a fine strainer. Some recommendations are to strain the material a second time through the same strainer.

Repair

In some cases, dirt found in original factory finishes can be repaired by polishing and buffing.

Dirt found in enamel paint sprayed by refinishes will usually have to be sanded out repainted the cause of the long cure time required for refinishing enamels. Dirt found to used for refinishing can usually to removed by sanding and polishing.

Solvent popping

Cause	Preventions	Remedy
• Insufficient drying of primer filler in corders, edges, rebates and below decorative ships.	• Apply normal film thickness.	• After drying, repaint without sanding (Within 24 hrs) or sand with scotch brite ultrafine.
• Solvent or air trapped in film, which can escapes leaving pop marks due to incorrect spraying viscosity, spraying pressure, flash-off times and drying times.	• Check oven temperature regularly.	• After drying and sanding, fill pin holes with polyester spray filler or remove damaged finish and repaint.
• Incorrect choice of hardeners, and thinners.	• Follow recommendations on technical data sheets.	• Sand, prime and repaint.
• Film build too high.		
• Wrong spraying technique.		

Lifting

Cause	Preventions	Remedy
• Occurs when chemical reaction takes place between two incompatible substrates.	• Avoid working on high film thicknesses..	• Removing all coating and refiish from metal stage.
• High film builds.	• Ensure oil products used one part of a refinish system.	• Alternative remedies are not guaranteed and can be unstable.
• Over coating on uncured substrate.	• Allow materials to flash of and dry in accordance to technical date sheets.	
• Wet-on-wet system combined with incorrect hardener/thinner.	• Use recommended hardener/ thinner combination.	

Pin holes

Cause	Preventions	Remedy
• Substrate insufficiently dried.	• Allow preparation materials to dry thoroughly.	• Fill pin holes with spray filler.
• Polyester material not isolated with 2K filler.	• Deeply sand pores or re-apply filler/stopper.	• Sand damaged area and repaint.
• Pores not deeply sanded.	• Use a fine stopper to finish repair.	• Use proper air pressure.
• Gun too close to surface.	• Mix hardener and shaper as completely as possible avoid air bubbles.	• Use proper paint ratio.
• Fluid pressure too high.	• Stopper application at a right angle prevents the formations of pores.	• Maintain the gun distance as per guide book.
• Fluid too heavy.	• Strokes 6 to 8 inches from surface.	
	• Reduce pressure.	
	• Thin fluid with reducer.	

Paint colour fade

Cause	Preventions	Remedy
• Sunlight UV light effect on on certain paint pigments in surface. • Refinish paints of low quality with little or no UV blocker.	• Frequent wax polishing to provide protection.	• Can be removed in part by machine polishing with fine abrasive paste. • Avoid over polishing, can be checked with film thickness gauge. • Refinish if necessary.

Rust under the finish

Cause	Preventions	Remedy
• Moisture penetration through broken areas in paint film. • Exposed bare metal areas. • Climate and fine influence degree of corrosion damage.	• Frequent washing and wax polishing of the vehicle, particularly in winter. • Refinish broken paint surfaces immediately ro prevent corrosion starting..	• Remove paint affected areas, sand blast heavily affected areas. • Treat with neutralizing acid. • Refinish with approved system.

Crazing

Crazing results in fine spills or smell cracks that completely checker an area in an irregular manner. This problem was common with older lacquer finished.

Causes

1 Shop temperature too cold.

2 Surface tension of the original material is under stress and it litterly shelters under the softening action of the solvents being applied.

3 OEM lacquer crazes due to age and temperature extremes.

Preventing crazing

1 Select the thinner to reducer that is suitable for existing shop conditions.

2 Schedule painting to avoid temperature and humidity extremes in the shop or between the temperature of the shop and the job.

3 Bring the vehicle to room temperature before refinishing.

Repair

- Continue to apply wet coats of top coat to melt the crazing and flow pattern together. Using the wettest slowest possible solvent that shop condition will low.
- Remove crazed finish and repaint with appropriate materials for shop conditions.

Micro checking

Micro checking appears as severe dulling of the film but when examined with magnifying glass it contains many smell microscopic cracks.

Causes

Micro checking is the beginning of film breakdown and mights be an indication that film failures, such as cracking or crazing will develop.

Prevention

- Do not pile on top coats allow sufficient flash and drying times do not dry by gun tanning.
- Thoroughly clean all areas that will be painted before sanding. Be sure the surface is completely dry before applying any undercoats or top coats.

Repair

Sand off the colour coat to remove the cracks, then recast as required. Make sure you sand down deep enough to remove all microscopic cracks in each refinish materials.

Prime coat show through

Prime coat show through is a variation in the surface colour.

Causes

1 Insufficient colour coats used.

2 Tint the sealer to match in the vehicle colour.

Repair

To correct prime coat show through, you must sand and refinish.

Final detailing

Final detailing involves a series of steps to properly clean and shine all visible exterior and interior surfaces of the vehicle, taking special care not to harm newly painted surfaces. Basically, surface without new paint and hand-washed and the interior is vacuumed.

Some shops or work orders stipulate a complete vehicle detailing, including paint touch-up work to unrepaired body panels. If minor paint problems were found in the new paint, such as debris in the finish, these problems must also be repaired before the vehicle is released to the customer.

Corrective steps for paint detailing include the following.

1 Detail wet sand the flaws in new paint.

2 Machine compound with an abrasive liquid and high-speed buffer equipped with a wool pad.

3 Machine glaze with a finer abrasive liquid and a buffer equipped with a foam pad.

4 Hand-rub and glaze small areas that cannot be machine buffed.

5 Clean all interior and exterior surfaces.

Each of these steps has its own requirements. As a general rule, increasingly finer grades of products-wet sand paper and compounds-are used for all of these steps. Also, a single product line should be used throughout the repair and manufacturer's recommendations should be followed.

Detail sanding

Detail sanding involves using a small dirt nib sanding block and ultrafine sand paper to level and smooth small specks of debris in paint. A small detail sanding block held in your finger is used on dust and dirt in the finish. A larger handled sanding blocks is used on larger paint flows. such as paint runs.

In the past detail technicians used a dirt nib file an a white stone to run and abrade off minor paint flows. Nowadays technicians used a detail sanding block and very fine grits of wet sand papers to repair paint flows. Detail sanding mini sand paper disc commonly used during minor paint repair range from 600 grit to 1500 grit.

After paint flow has sanded level wet sand with 1500 grit or 2000 grit wet sand paper to remove sand scratch in the paint. The water on the paint will let you find any remaining surface flows use soft rubbers sanding pad or block to squeeze the water off the flawed area.

Detail sanding procedure

Paint type	Paint condition	Procedure			
		Wet sanding	Compounding	Machine glazing	Hand glazing
Refinish paints: cured enamels and urethanes* (air-dried more than 48 hours or baked)	1 Minor dust or mismatched orange peel (light sanding)	1 Ultraline #1500	1 -	1 Finishing material	1 Hand glaze
	2 Heavy orange peel, dust, paint runs or sags	2 #1000 then #1500	2 Microfinishing compound	2 Finishing material	2 Hand glaze
Refinish paints: fresh material enamels/ urethanes* (air-dried 24 to 48 hours)	1 Minor dust or mismatched orange peel (light sanding)	1 Ultraline #1500	1 Microfinishing compound	1 Micro finishing glaze	1 Hand glaze
	2 Heavy orange peel, dust, paint runs or sags	2 #600, #1000 then #1500	2 Microfinishing compound	2 Micro finishing glaze	2 Hand glaze
Refinish paints: acrylic lacquer	1 Over gloss or overspray	1 -	1 -	1 Machine glaze	1 Hand glaze
	2 Low gloss, minor orange peel or over spray	2 -	2 Paste or rubbing (heavy cut)	2 Machine glaze	2 Hand glaze
	3 Low gloss, moderate orange peel or dust nibs	3 Ultrafine #1200	3 Mcrofinishing compound (medium cut)	3 Machine glaze	3 Hand glaze
	4 Low gloss, heavy orange peel, paint runs or sags	4 Ultrafine #1000	4 Paste or rubbing (heavy cut)	4 Machine glaze	4 Hand glaze

Paint type	Paint condition	Procedure			
		Wet sanding	Compounding	Machine glazing	Hand glazing
All factory applied	1 New car prep or fine wheel marks	1 -	1 -	1 -	1 Hand glaze liquid polish
	2 Coarse swirl marks, chemical spotting or light oxidation	2 -	2 -	2 Finishing material	2 Hand glaze
	3 Overspray or medium oxidation	3 -	3 Microfinishing compound (meduim cut)	3 Finishing material	3 Hand glaze
	4 Heavy oxidation or minor acid rain pitting	4 -	4 Rubbing compound (heavy cut)	4 Finishing material	4 Hand glaze
	5 Dust minor scratches, or major acid rain pitting	5 Ultrafine #1500	5 -	5 Finishing material	5 Hand glaze
	6 Orange peel, paint runs or sags	6 Ultrafine #1200 or #1500	6 Microfinising Compound (medium cut)	6 Finishing material	6 Hand glaze

Repairing paint runs

To repair a paint run without repainting, you must carefully wet sand the run while trying not to sand through the clear coat and into the colorcoat. Use a full-size stiff rubber sanding block and coarse #600-grit wet sandpaper first. Then final sand the paint run with finer #1500 or finer wet sandpaper until smooth and level. If you get lucky, you will not sand through to the colorcoat. If you do, the area will have to be repainted.

With a paint run, you want to plane of the high points without cutting through the clear coat. If you initially try to block sand a run with fine sandpaper, you will cut too deep in the low spots and “wallow out” the low spots, usually cutting through the clear coat.

The low spots in a paint run will be softer than the high spots. This is because softer resins will tend to flow down and collect in the low spots of a paint run.

Fill a bucket with clean water. Some technicians like to add a mild soap to the water. The soap-and-water solution will help keep the wet sandpaper iron sticking and digging into the fresh paint.

First, block sand the paint run using #600 sandpaper on a stiff rubber sanding block. Only use this grit sandpaper to cut the tops off the run. Use plenty of water and watch how the surface dulls to see where you are sanding and removing clearcoat. Wipe the area with a rubber squeegee so you can see the run. Stop as soon as the high spots of the run are sanded level. A few more passes with #600-grit sand paper could cut into the colorcoat and require repainting.

Next, lightly block sand the paint run area with #1000-grit wet sandpaper. Use the finer grit, wet sandpaper to feather and level the run with the surrounding paint surface.

As soon as the run is sanded level, use the sanding block with finer #1500-grit wet sandpaper to smooth the surface and prepare it for machine buffing. Sand very gently, because the clear coat will be very thin at this point.

Repairing chipped paint

Chipped paint results from mechanical impact damage to the paint film. It is a condition, where small flakes or areas of paint have been crushed and damaged. The areas around the missing paint chip have lost adhesion with the substrate.

Chipped paint is normally caused by the impact of stones or hard objects. Chipped paint also happens when someone opens a car door and it hits another car or object. Chips in the paint are most common on the front bumper, front edge of the hood, doors and around the rear of wheel openings on fender and quarter panels.

If the whole vehicle is not refinished, you may need to touch up chipped paint on panels that have not been painted. Use the paint mixed for the repair. It will usually have hardener in it to speed curing.

Degrease the area with wax-and-grease remover. If you use a small paint brush, slowly move the touch-up paint straight into each chip. On smaller chips, a toothpick will reach into the chip more efficiently. If you are using a solid color, use a thicker viscosity touch-up paint to fill the chip in one application. If you have metallic paint, use thinner touch-up paint and several coats to help match the color.

Allow the paint to cure sufficiently before wet sanding and polishing the chip repairs to level the repair.

Panel detail sanding

Panel detail sanding can be done to smooth the paint surface on larger areas, as when removing orange peel. It is detail sanding, but over a large surface area, using a larger sanding block and sandpaper.

Panel detail sanding should normally be done with a backing pad or rubber sanding block to avoid crowning of the paint surface. A pad or block will help keep large, relatively flat surfaces level and uncrowned. On restricted and curved surfaces, you can use only your hand to color sand.

Sanding blocks and sandpaper are available in a variety of grit sizes. For major surface repairs, use coarser wet sandpapers, #400 to #600. For detail sanding, use #1000, #1500 and finer grits of wet sandpaper.

Wet sand in a back-and-forth or small circular motion, depending on the shape of the surface problem and the contour of the body panel. Use plenty of water to flush away paint debris. Dip the block in a bucket of water. You can also use a sponge, garden hose or spray bottle to flow water over the area. Some air sanders are equipped with a wet sanding, attachment that uses a small plastic hose to feed flushing water up to the sanding pad.

Check the defect often when using a sanding block. You do not want to cut too deeply into the finish. If you cut through the clearcoat or color, repainting will be necessary. Wash surfaces thoroughly with clean water and a sponge after panel detail sanding.

Study the basic steps for touching up a paint chip (Fig 1)

a Use a toothpick or small brush to apply catalyzed paint in to the chip.

b Let the first coat flash and apply another drop of paint over the chip.

c After allowing the paint to cure, detail wet sand the paint flush.

d Hand or power buff the repair area to return the gloss.

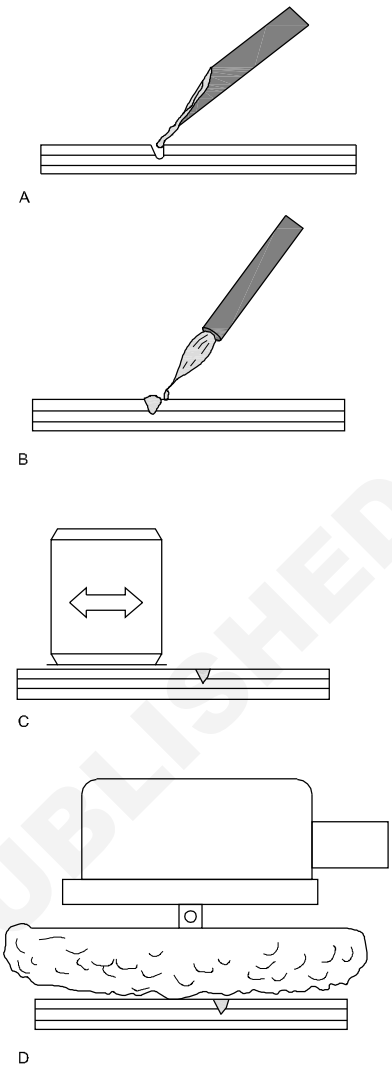
Paint compounding

Paint compounding involves using different adhesive pastes and liquids to hand and machine polish a surface to a high gloss or shine. You must be familiar with each type of compounding material to select and use them correctly.

Rubbing compound

Rubbing compounds also called hand compounds, generally contain the coarsest grit abrasive. They are used to abrade and smooth a surface film by hand to level minor surface imperfections. Rubbing componds remove the surface gloss and must be followed up with a hand-glazing compound to restore paint shine. They are commonly used on smaller parts or areas that cannot be compounded with a buffing machine.

Fig 1



Rubbing compounds are available in various cutting strengths. Hand compounds are oil-based to provide lubrication. Small or blended areas are best treated by hand compounding. On large surface machine compounding a recommended.

Rubbing compounds are used to:

- Eliminate fine sand scratches around a repair area.
- Correct a gritty surface.
- Smooth and bring out some of the gloss of lacquer topcoats.
- Repair paint on areas that cannot be bulled with a machine.

Hand compounding

Fold a soft, line-free cloth into a thick pad or roll it into a ball and apply a small amount of hand compound to it. Use straight, back-and-forth strokes and medium-to-hand pressure until the desired smoothness is achieved.

Hand-compounding takes a lot of elbow grease and is time-consuming. To keep the compounding of topcoats to a minimum. It is important to apply the clear coats as full wet coats, without sags or runs.

When using hand polished or glazes, apply the glaze to the surface using a clean dry cloth. Rub the glaze thoroughly into the surface. Then wipe it dry.

Table shows some applications for different rubbing and polishing compounds.

Table

Polishing and rubbing compounds

Grade	Liquid	Paste	Use and Application
Very fine	Machine or hand	-	Used to remove swift marks on topcoat. Spread material evenly with buffing wheel pad before starting compounding.
Fine	Machine on hand	Hand (add water for machine use)	Used to level orange peel. Can also be used to clean, polish and restore older finishes leaving no wheel marks or swirls.
Medium	Machine on hand	Paste (add water for machine use)	Used for quick levelling orange peel. Can be used to repair other minor paint defects.
Coarse	Machine	Machine	Used for compounding before final top coating.

Machine Compounding: Machine compounds are water-based to disperse the abrasive while using a power buffer. Some product manufacturers rate their compounds or liquids and pastes by a grit rating system. #1000, #1500, #2000 and finer. Just like sanding, you would start out with a coarser rated compound and follow up with finer compounds to bring the paint to a high gloss and shine.

Refer to the label directions for the machine compound or glaze to learn about is cutting and polishing characteristics. The label directions will give instructions for buffer speed, surface temperature and so on for property using their buffing product.

A buffing pad is rotated by an electric or air buffer to force the compound over the paint surface. If done property, this will quickly bring the wet sanded paint surface back to a glossy shine. There are different kinds of machine buffing compounds and pads.

A buffing machine uses a spinning or rotating action to level and quickly smooth a paint surface. Machine buffing can be done with either a soft wool pad or a foam rubber pad to apply abrasive compound to the paint. Most paint repair technicians use the wool pad first and the soften foam pad second. A polishing machine uses an orbital action to bring out the full paint gloss or shine. Instead of spinning the pad in a circle, the pad is spun and moved sideways by the dual action of the machine. An orbital action polishing machine is needed to bring out a “show-type finish” in a paint. It will remove swirl marks and the finish will look like it has been hand polished.

Paint swirl marks are patterns of very fine scratches produced when power buffing or compounding. They are caused by a dirty, worn buffing pad, too much pressure on the buffer or using too coarse a compound. Always keep your buffing pad clean and replace it when worn.

To avoid swirl marks most detail technicians first buff the surface with a wool part and a coarser machine compound. Then they follow with a foam pad used with finer glazing compound. The wool pad buffs more quickly and the foam pad smooths the surface to take out any remaining swirl marks. Some shops like to follow the wool and foam pads with an orbital action polisher to remove any remaining trace of swirl marks.

Using buffer and polishers

When using buffing and polishing pads, there are several things you must remember to avoid paint damage. In untrained hands, an air or electric buffer can quickly cut through and damage a paint job a costly mistake.

Note: Wear eye protection when machine compounding or buffing. It is very easy for the abrasive liquid to fly into your face and eyes. It is also possibe for chunks of buffing pad to fly into your face. Stuff so that any debris files away from your body and face, not toward it.

Inspect, clean or replace buffing pads often to avoid problems. If a wool pad is worn and no longer fluffy, replace it. If a foam pad is torn or worn, replace it. When machine compounding paint, the buffing pad should be in good conditions to help avoid damaging the finish.

A pad spur tool is used to clean and fluff up a wool buffing pad before machine compounding. It has a handle and a spoiled meal wheel (like a cowboy’s spur) that will remove dry compound from the buffing pad. Lay the buffing machine on the ground and hold the spur on the pad.

While wearing eye protection, turn the buffer on and move the spur over the pad while pressing lightly. Hold th e spur on the side of the pad that is spinning away from you. This will keep the debris from flying in your direction. Spin spur on the pad and all dried compound is forced out of the pad and the wool fibres are fluffed up and soft.

Note: Do not use a spur cleaning tool on a foam pad or you can damage the pad. Remove the foam pad from the buffer and wash it in a sink.

Foam pads should be washed thoroughly before each use. You should clean the pores of the foam pad out so they can hold compound and polish properly.

Avoiding paint burn-through (Figs 2 & 3): Paint burn-through is damage caused by the machine buffing pad removing too much clear coat. This is a costly time-consuming mistake that necessitates repainting of the panel. There are several things you can clear coat burn-through is hard to see. The exposed color coat area will be slightly duller than the clearcoat. The clear coat was cut through into the basecoat in the center area of the photo.

Do to avoid burn-through and paind damage.

Fig 2

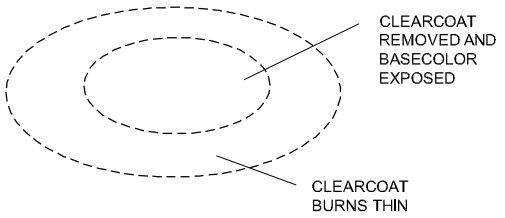
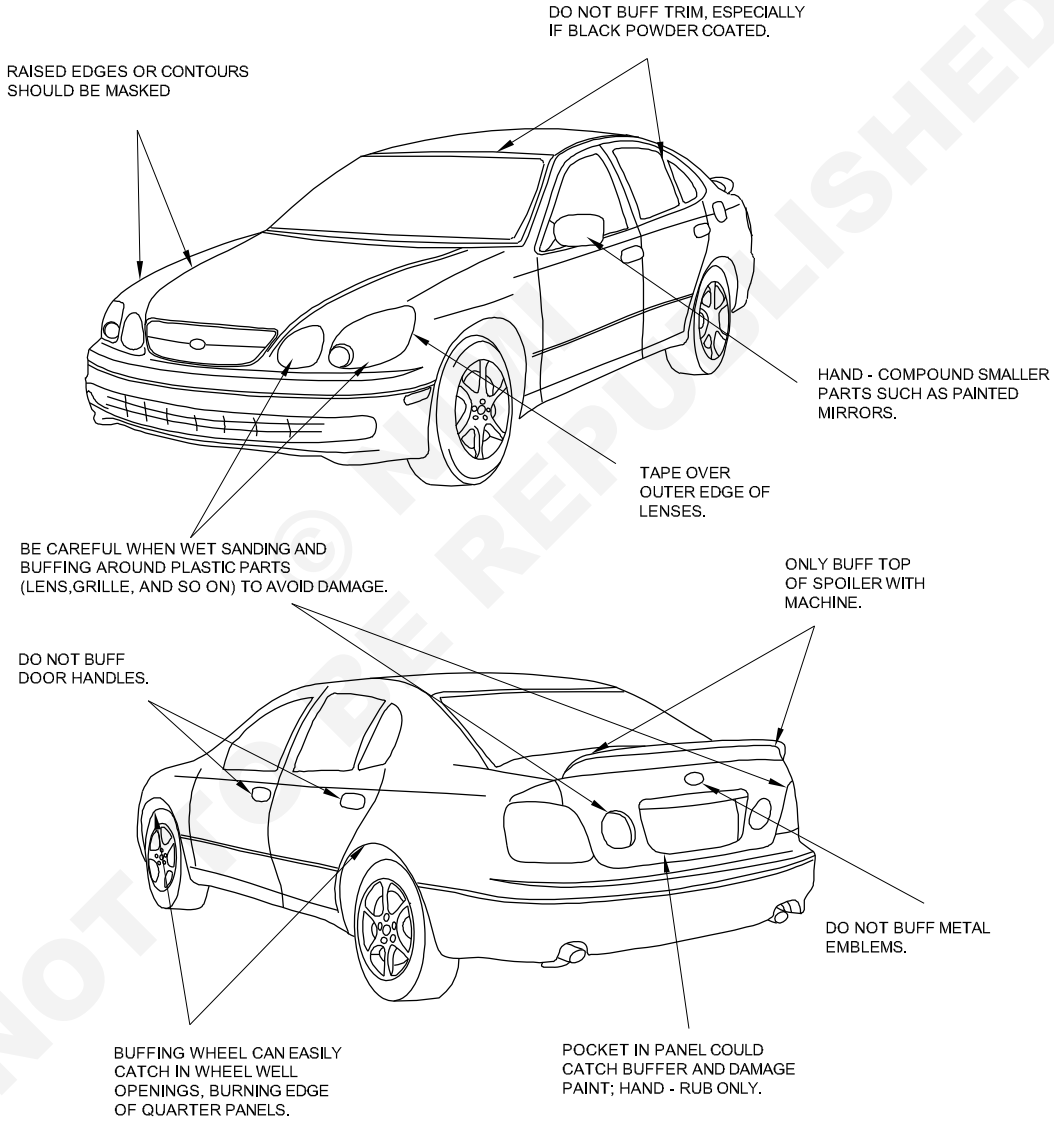


Fig 3



Edge masking involves taping over panel edges and body lines prior to machine buffing to protect the paint from burn-through. Masking tape is applied to these surfaces to protect them. Buff right up to the tape. After buffing surfaces and removing tape hand compound these edges. Place masking tape over all sharp body edges. A buffing pad can burn the paint on sharp edges almost instantly. Place masking tape on panel edges to you can buff over the tape without danger of burning through the paint.

You should also mask door handles, emblems, trim, plastic headlight and taillight lenses and similar parts. The spinning buffing pad can easily damage these parts requiring their replacement. Today's flat black trim pieces are very prone to damage from a buffer. The black coating can be instantly marred if touched with a high-speed buffing pad. Tape over any part that could be damaged when buffing the paint.

Use separate pads for different grades and types of products. One wool pad should be used for initial buffing with a coarser machine compound. Another foam pad should only be used for applying a finer machine glaze.

To avoid paint burn-through, always move the buffer in even passes over the body surface, as when you paint a car. Make one pass across the panel and then move down a little. Buff in passes across the panel so you can keep track of how much paint has been buffed. Avoid buffing too much in one location. Do not press down on the buffing machine. Let the weight of the machine do the work. Stay oil crowned body contours and sharp edges with the buffing pad. If needed, these surfaces can be hand compounded quickly after you are done machine compounding.

Machine buffing procedures

Make sure you are using the appropriate machine compound. Read the directions on the bottle before use.

When applying the compound, apply an "X" of the product to the surface. Only apply enough compound to buff an "arm's length" area on the panel. Work the compounding liquid around the face of the pad and over the surface before hitting the machine's trigger. This will help prevent compound from flying and spraying all over when you first turn on the buffing machine.

Because the compound has a tendency to dry out, do not try to buff too large an area at one time. Always keep the machine moving to prevent cutting through or burning the topcoat. As the compounds start to dry out, lift up a little on the machine so the pad speed increases. This will make the surface start to shine.

Buffer speed and pressure have an effect on the paint cutting and polishing action. For example, the higher the rpm, the higher the cutting rate, the lower the rpm, the lower the cutting rate.

The faster the buffer is moved across the panel, the slower the cutting rate. The slower the buffer is moved the higher the cutting rate.

The flatter the panel surface, the slower the buffer will cut into clearcoat. The more round or sharp a panel surface, the faster the buffer will cut into the paint.

Excessive buffing heat can cause swirl marks, warping discolouring and hazing and make the material dry out too quickly. If the area is hot to the touch, there is too much heat. Cool it with water.

When using a buffer, the detail technician should use the following procedures.

1 Keep the pad flat or at about a 5 degree angle to the surface on flat body surfaces. Only tilt the pad to rech into or match a curved surface on the body.

2 Let the weight of the machine do the work. If you press down on a buffing machine, it can quickly cut through the clearcoat.

3 Use care around panel edges and body lines to avoid burn-through. Do not let the edge of the buffing pad get down into panel gaps or you could even burn through your protective masking tape and the paint.

4 Check the repair area often and apply more product as needed. Buff as little as possible to smooth and shine the paint surface.

5 Compound until the product begins to dry. Do not keep buffing if the compound has dried, because you will burn through the paint surface.

6 Never lay the face of a buffing pad on a workbench or any surface that could contaminate the pad with dirt and debris. One speck of sand in the pad can badly scratch the paint.

7 Never use a power buffer with a hand-rubbing compound. This will cause deep scratches, swirl marks and burn-through. Only use machine compounds when power buffing.

8 Place masking tape over gaps in panels. This will keep compound out from behind panels so time is not wasted cleaning these areas after buffing.

9 Hand-rub small parts and internal pockets in panels that could be easily damaged by the spinning buffing pad. Hand-compound these areas to avoid burn-through.

10 After initial compounding with a wool pad, buff again highly with a foam pad and finer glazing compound. This will help remove swirl marks and bring out the paint gloss.

11 After the machine compounding, remove the tape and hand-compound all edges and contour just enough to produce a smooth finish. keep in mind that body lines usually retain less paint than flat surfaces and thus should get only minimal compounding.

Hand and machine glazing an d polishing

Glazing or polishing involves using very fine grit compound to bring the paint surface up to full gloss. It is usually done after compounding. You can hand-polish small or hard-to-reach areas. Machine polish larger areas to save time.

Slight defects in the topcoat can be repaired by polishing. The choice of compound depends on the extent of the damage. Final polishing should always be done with an ultrafine polishing compound.

When using rubbing compounds and machine glazes be sure to follow these procedures.

1 Use a single manufacturer's product line.

2 Follow the manufacturer's recommendations for use.

3 Use the materials sparingly.

4 Use the buffing wheel to evenly distribute the material over the area that is being repaired.

5 Keep the pad flat and directly over the surface being repaired.

6 Use a slow, methodical motion so you can keep track of how much area has been buffed.

7 Use the finest grit product possible last. Using a finer grit product may take a little longer initially but will generally require less time to complete the repair.

8 Reduce swirl marks by avoiding coarse products and worn buffing pads.

Instead of a circular action buffer, you should use an orbital action machine for final polishing. An orbital action polisher will move the polishing compound in a random manner to remove swirl marks from buffing.

Final cleaning

Final cleaning or get ready is the last, through clean up before returning a vehicle to a customer. You must do all the “little things” that make a big difference to customer satisfaction. The interior and exterior of the vehicle should be cleaner than when the customer brought it in. Vacuum the interior of the vehicle carefully. Clean the seats, door panels, seat belts and carpet. If dusty, clean the treat vinyl surfaces with a conditioner. Be sure to remove all excess cleaner/conditioner from the seat crevices and folds. Stubborn stains, such a blood, should be cleaned with a recommended cleaning solution.

Carefully remove any over spray that may have been left on windows or chrome. If it can be done without dripping on the new finish, use paint solvent (thinner or reducer) Clean and polish chrome, moldings, and bumpers thoroughly clean all the glass, including windows, mirrors and lights. Use a brush with soap and water to clean the tires and wheels. Do not let dirty wheels and tires spoil the appearance of an otherwise quality job. Coat them with the conditioner.

Note: Avoid using strong cleaning agent on the plastic parts in the dash panel. Some cleaners will dissolve and damage plastics, a costly mistake. You should always avoid having any product with silicone in it in the body shop.

Steel wool should not be used to polish chrome, because pieces of the wool can easily become embedded in the new finish. Instead, use a commercial chrome polish.

Spray rubberized undercoating to blacken wheel openings and any other exposed and undercarriage parts, because color overspray often gets on these areas. The customer generally will not necessarily notice the undercoating, but certainly will notice if it is not done. Replace wipers, moldings and emblems that were removed before finishing. Take the time to clean off these items and be certain that everything is replaced. Make sure all weather stripping is installed properly. If the vehicle has a vinyl, top, do not forget to wipe it with a damp cloth or a commercial vinyl cleaner. As a finishing touch, clean the engine compartment using a pressure washer. A clean engine compartment usually makes a big impression on the customer. Be careful not to damage any paint on the fenders when pressure washing. Keep strong engine degreasing agents off the paint.

Caring for a new finish

A newly refinished vehicle must receive special care, as the paint can still be curing for several days or months. Each paint manufacturer have specific recommendations for caring for a new finish. Explain all of these precautions to the vehicle owner.

To care for a new finish, you and the customer should.

- Avoid commercial car washes and harsh cleaners for one to three months
- Hand–wash using only water and a soft sponge for the first month. Dry with cotton towels only. Do not use a chamois.
- Avoiding waxing and polishing for up to three months. After that time, use a wax designed for base coat clear coat finishes, as they are the least aggressive.
- Flush gas, oil or fluid spills with water as soon as possible for the first month. Do not wipe off.