SHEET METAL WORKER

NSQF LEVEL - 3

TRADE THEORY

SECTOR : CAPITAL GOODS AND MANUFACTURING

(As per revised syllabus July 2022 - 1200 of hrs)

Directorate General of Training

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

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

Sector : Capital Goods & Manufacturing

Duration : 1 st - Year

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FOREWORD

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

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

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

Jai Hind

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

New Delhi - 110 001

PREFACE

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

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

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

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

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

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

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

Chennai - 600 032 **EXECUTIVE DIRECTOR**

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisation to bring out this IMP **(Trade Theory)** for the trade of **Sheet Metal Worker - NSQF Level - 3 (Revised 2022)** under the **C G & M** Sector for ITIs.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

Shri. C. Ramachandran	-	Junior. Training Officer, Govt. I.T.I Tiruchendur.

NIMI - COORDINATORS

Shri. Nirmalya Nath	-	Deputy Director, NIMI, Chennai - 32.
Shri. V. Gopalakrishnan	-	Manager NIMI, Chennai - 32.

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

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

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

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intended to be used in practical workshop. It consists of a series of practical exercises to be completed by the trainees during the course. These exercises are designed to ensure that all the skills in compliance with NSQF LEVEL - 3 (Revised 2022) syllabus are covered.

The manual is divided into Eleven modules.

Module 1 Basic Fitting Processes

Module 2 Metal Cutting

Module 3 Folding & Locking

Module 4 Soldering

Module 5 Brazing

Module 6 Welding

Module 7 Advanced Sheet Metal Processes

Module 8 Uses of Machines

Module 9 Gas Welding

Module 10 Specification of Aluminium

Module 11 Mudguard and Radiator

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

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

TRADE THEORY

The manual of trade theory consists of theoretical information for the Course of the **Sheet Metal** Trade Practical NSQF Level - 3 (Revised 2022) in **CG&M**. The contents are sequenced according to the practical exercise contained in NSQF LEVEL -3 (Revised 2022) syllabus on Trade Theory attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This correlation is maintained to help the trainees to develop the 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 trade theory connected to each exercise at least one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

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

CONTENTS

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

Sl. No	Learning Outcome	Ref.Ex No
1	Select sheet of required type, thickness (gauge) and size and mark it with scriber, square, divider, steel rule etc., according to drawing or sample following safety precautions. (Mapped NOS: NOS:CSC/N0301)	1.1.01 - 07
2	Shears or bends the sheet wherever necessary by machine or hand shear. (Mapped NOS: NOS:CSC/N0301)	1.2.08 - 09
3	Form sheet metal to required shape and size by bending, seaming, forming, riveting etc., using mallets, hammers, formers, sets, stakes, etc., or by various operations such as shearing, bending, beading, channelling, circle cutting. (Mapped NOS: NOS:CSC/N0301)	1.3.10 - 26
4	Perform different type of MS pipe joints by Gas welding (OAW). (Mapped NOS: CSC/N0301)	1.4.27 - 34
5	Perform soldering, brazing operations on sheet metal. (Mapped NOS: CSC/N0301)	1.5.35 - 36
6	Perform Arc welding, Gas welding , TIG welding & MIG welding and Spot welding on sheet metals (Mapped NOS: NOS: CSC/N0301)	1.6.37 - 41
7	Make sheet metal articles according to drawing or sample following safety precaution. (Mapped NOS: NOS:CSC/N0301)	1.7.42 - 66
8	Plan & work in different sheet metals such as tin, copper, brass. (Mapped NOS: NOS:CSC/N0301)	1.8.67 - 74
9	Perform Arc welding, Gas welding , TIG welding & MIG welding and Spot welding on sheet metals (Mapped NOS: NOS:CSC/N0301)	1.9.75 - 81
10	Perform Aluminum frame works. Makes ducts, cabins & panels. (Mapped NOS: CSC/N0301)	1.10.82 - 84
11	Perform repair work of mudguard, Radiators etc. (Mapped NOS: NOS:CSC/N0301)	1.11.85 - 86

SYLLABUS

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 63 Hrs; Professional Knowledge 10 Hrs	Select sheet of required type, thickness (gauge) and size and mark it with scriber, square, divider, steel rule etc., according to drawing or sample following safety precautions. (Mapped NOS: NOS:CSC/N0301)	1 Induction of training Familiarisation with the Institute, Importance of trade in Training Machines used in the trade. (10 hrs) 2 Induction to safety devices used in shop floor. (10 hrs)	General discipline in the institute Elementary of First aid Importance of the sheet metal work in the Industry. General safety precautions Safety precaution in sheet metal work. (03 hrs)
		3 Identification of Tools and Equipments Induction and use of marking tools. (08 hrs) 4 Practice in Reading, Steel Rule, Scribing of straight lines, Bisecting of straight lines (on the sheet metal) using marking tools. (15 hrs)	Metals and Non-Metals and their Characteristics, Types, Sizes and uses of Sheet Metals as per BIS. Use of reference table. Raw material information: CRCA, HRCA & MS Material Terms & definitions in sheet metal work. (04 hrs)
		5 Mark and cut through the straight lines Planishing of Sheet Metal. (06 hrs) 6 Practice in drawing simple Geometrical shapes. (08 hrs) 7 Practice in marking and cutting of sheets to various angles. (06 hrs)	Marking and laying out tools and accessories Measuring Tools : steel Rule, calipers, try square, L square, Micrometer, Vernier caliper, Vernier height gauge, Combination set, screw pitch gauge, radius gauge, SWG, Bevel Protractor etc. Marking Tools: Scratch AWL, divider, Trammel point, punches etc. Cutting tools: Snips, shears, hacksaw, chisel, cutting plier, files, drills, tap & die sets etc. (03 hrs)
Professional Skill 20 Hrs; Professional Knowledge 04 Hrs	Shears or bends the sheet wherever necessary by machine or hand shear. (Mapped NOS: NOS:CSC/N0301)	8 Practice on cutting with different types of snips. (10 hrs) 9 Tin snips (Straight cut, Right cut and Left cut) cutting off inside and outside curve, cutting off notches and cutting off profiles. (10 hrs)	Hand tools: mallets, hammer, sheet metal hammers, groovers, riveting tools, screw drivers, wrench and spanners etc. Holding tools & accessories: vices, C clamps, stakes, stakes holder, hollow mandrel, wooden former, Jigs & fixtures, soldering bits etc. (04 hrs)
Professional Skill 111 Hrs; Professional Knowledge 21Hrs	Form sheet metal to required shape and size by bending, seaming, forming, riveting etc., using mallets, hammers, formers, sets, stakes, etc., or by various operations such as shearing, bending, beading, channelling, circle cutting. (Mapped NOS: NOS:CSC/N0301)	10 Practice on Sheet Metal seams. "Grooved seam, Locked Grooved seam, Pane down seam, Bottom lock seam or Corner Fold (Knocked-up seam), Corner Clip Lock, Double Bottom Lock, Clip Lock (Cap Lock), snap Joint etc. (Folded Joints) and hemming practice. (15 hrs)	Sheet Metal Folded Joints: Description of Sheet Metal Seam, Grooved seam, Locked Grooved seam, Paned down seam, Knocked up seam inside and outside, capstrip seam, pitsburg seam etc. (03 hrs)
		11 Forming rectangular shapes using stakes. (06 hrs) 12 Forming Cylindrical job using various stakes such as Hollow Mandrel, Hatchet Stake; Tin Man's' Anvil stake etc. (10 hrs)	Folding and joining allowances, edge stiffing, wiring allowances and false wiring, types of notches in sheet metal. (03 hrs)

		13 Folding, Bending Sheet Metal to 90 degree using wooden mallet, 'C' clamps etc. (03hrs) 14 Making a radius using Wooden blocks using Hairpin Folder. (03 hrs) 15 Making a cylindrical container with knocked- up, bottom (Bottom Locked), Grooved Joint and hemmed Top. (04 hrs) 16 Forming frustum of Cone. (03 hrs) 17 Making of Mug, scoop, measuring can. (04 hrs) 18 Hemming (single, Double) wire edge by hand process. (04 hrs)	Definitions of pattern, Development, stretched out pattern, Master pattern (gross pattern) and templates Development of by parallel line method, radial line method. (03 hrs)
		19 Make a taper chute square to rectangle transition. (10 hrs) 20 Make a taper chute square to round. (08 hrs)	Development of surfaces: Triangulation method and geometrical construction methods. (04 hrs)
		21 Making holes with solid punches, round punches as per BIS. (10 hrs) 22 Use of hollow punches making hole in sheet metal with help of wood block. (08 hrs)	Solid and Hollow Punches. Description of hand punches as per BIS. Sizes of solid and hollow Punches and their uses. (04 hrs) Rivets and its parts, Selection of Rivet heads.
		23 Riveting practice using various types of rivet heads. (03 hrs) 24 Single chain riveted joint. Double chain and Zig- zag, Lap & butt riveted joints Making a dust pan (Corner and handle riveted) (08 hrs) 25 Making a fire bucket with lap riveted joint on one side and Locked Grooved Seam on the other side. (08 hrs) 26 Bottom Hollowing and Bottom Lock Seam. (04 hrs)	Types of Rivet and their uses. Standard sizes of Rivets and Riveting Tools. Calculation for Riveting allowances (pitch and Lap) (04 hrs)
Professional Skill 136 Hrs Professional Knowledge 29 Hrs	Perform different type of MS pipe joints by Gas welding (OAW). (Mapped NOS: CSC/ N0301)	27 Solder Lap joint. (10 hrs) 28 Single plated solder butt joint. (12 hrs)	Fastening of Sheet Metal: Self taping screws, Clips and Connectors; Their uses, Types and Allowance of 'S' Clips, Government Clips, Drive Clips, Mailing Clips etc
		29 Making oil Can by hand process by soldering. (10 hrs) 30 Making funnel by soldering process. (12 hrs)	Solder, Different types of solder and their composition. Types and uses of fluxes, their effect on different metal. (04 hrs).
		31 Make by soldering:- - Elbow 90¢X equal dia. pipe. (09 hrs.)	Process of soft soldering, hard soldering (brazing).

		- T joint 90¢X equal dia. pipe. (09 hrs.) - T joint 90¢X unequal dia. pipe by soldering. (08 hrs)	Heating appliances (Hand Forge, Blow Lamp, L.P.G.) (04 hrs)
		32 Make by soldering:- T Pipe 60°branch joint unequal dia pipe Offset T joint equal dia. (22 hrs)	Development & laying out pattern of elbow pipe, T pipe and offset pipe in equal diameter. (05 hrs)
		33 Make a taper lobster back bend 90 degree from oblique cone by soldering. (22 hrs)	Development of T pipe, round equal and unequal. Introduction to tubes and pipes. (06 hrs)
		34 Forming square section segmental quarter bend pipe with suitable lock and forming round section segmental quarter bend pipe. (22 hrs)	Laying out pattern of 600 off-set 'T' pipe. Pattern Development of 'Y' pipe. Preparation of pickling solution. Protection-Coating, Cleaning and preparing of Sheet Metals Corrosion and anti corrosion treatment of sheet metal. (06 hrs)
Professional Skill 50 Hrs; Professional Knowledge 14 Hrs	Perform soldering, brazing operations on sheet metal. (Mapped NOS: CSC/ N0301)	35 Making a square duct elbow with snap block. (25 hrs)	Method of galvanizing, tinning, anodising, sheradising and Electroplating. (07 hrs)
		36 Make a conical hopper by soldering. (25 hrs)	Development and laying out of pattern of segmental quarter bend pipe. (07 hrs)
Professional Skill 78Hrs; Professional Knowledge 12Hrs	Perform Arc welding, Gas welding , TIG welding & MIG welding and Spot welding on sheet metals (Mapped NOS: NOS:CSC/N0301)	37 Setting up of Oxy-acetylene plant and types of flames. (20 hrs)	Need for ducting. Places where ducting is employed and the working principle of
		38 Setting up of Arc welding plant and striking & maintaining the arc & laying short beads. (20 hrs)	Safety precaution in gas & arc welding Description of Oxyacetylene plant and the equipments, accessories & tools. (04 hrs)
		39 Fusion run with/without filler rod in flat position. (10 hrs) 40 Square butt joint in flat position by gas. (08 hrs)	Types of oxy-acetylene flames & its uses. Types and description of flux. Types of welding blow pipes & its functions. (04 hrs)
		41 Brazing copper sheet in lap joint in flat position. (20 hrs)	Various types of pipe joints. Method of metal preparation & cleaning them base metal before welding. Gas welding defects causes & remedies. Arc welding defects causes & remedies. (04 hrs)
Professional Skill 137 Hrs; Professional Knowledge 22 Hrs	Make sheet metal articles according to drawing or sample following safety precaution. (Mapped NOS: NOS:CSC/N0301)	42. Importance of machinery used in the trade. (05 hrs) 43. Types of job made by the trainees in trade. (07 hrs) 44. Introduction to machinery safety including fire fighting equipment and their uses etc. (10 hrs)	Importance of the trade in the development of Industrial Economy of the Country. Review of Types of sheet metal Fabrication. Methods of developments. (03 hrs)
		45. Locked groove joint by aluminum sheet. (04 hrs)	Introduction to Aluminum fabrication, and its applications. Ferrous and Non-

		46 Single riveted lap joint by aluminum sheet. (04 hrs) 47 Double strap single row riveted butt joint by aluminum sheet. (04 hrs)	Ferrous metals. Use of Copper and Alloys. Laying out pattern of conical elbows. Pattern development of lobster back bend. Chemical and Physical properties of Aluminium. Use of Aluminium and its Alloys. (05 hrs)
		48 Exercise involving practical work on Aluminium Sheet, and using Pop Rivet. (04 hrs) 49 Aluminium Windows with different extruded sections, Aluminium Soldering. (07 hrs)	Brief Description of hand punch machine. Hand and Power operated drilling Machines. Drill Bits, parts and effects of cutting angles. Angles for Drilling Sheet Metals, effect of speed, Feed Cutting Fluids, etc., on metals. Difference between drilled and punched holes. (03 hrs)
		50 Making holes in sheet metal using Punching Machine. (02 hrs) 51 Making holes in sheets with a twist drill. (04 hrs) 52 Tri-paning with use of hand and electric drilling machine. Grinding a drill bit. (04 hrs) 53 Practice in Drilling Holes in walls and Ceilings as applied to ducting work. (06 hrs) 54 Use of rawl bits and rawl plug. (04 hrs)	Description of swaging and beading machine, its parts, operating principles etc. Description of Fly Ball press. Operating Principles of Power Press and press brakes. Method to calculate the pressure adjustment. Clearance between Die and Punch. Introduction to "C" and "H" frame presses. (03 hrs)
		55 Practice on hollowing and rising on non-ferrous sheet as well as ferrous sheet. (07 hrs) 56 Practice on removing dents of spherical or hemi-spherical articles using wheeling and raising machine. (Repairing mud guards etc.) (07 hrs)	Properties of stainless steel and its uses. Properties and uses of tin, lead, zinc and silver. Description and Physical properties of Muntz Metal, Gun Metal, White Metal etc. (02 hrs)
		57 Practice on pipe bending by hand. (04 hrs) 58 Pipe bending using Hydraulic Pipe bending' machine. (04 hrs) 59 Development of a cone: Cylinder fitted to a cone. (06 hrs) 60 Equal dia pipe joint with crimping and Ogee beading. (04 hrs)	Introduction to pipe/tube bending. Brief description of Hydraulic pipe bending machine. Operating Principles etc. Description of roll forming machine types and operating principles, description of slip roll forming machine and its function. (02 hrs)
		61 Practice on external threading using "Die stock". (05 hrs) 62 Practice on internal threading using taps. (05 hrs) 63 Typical folding, Bending Practice, Making Steel-Racks, Reinforcement with angle iron. (07 hrs) 64 Use of self taping screws and other fasteners. (05 hrs)	Use of Die and Die Holder, Description of taps and tap wrench. (02 hrs)

		65 Project work such as Steel Stool, Aluminium Ladder etc. (08 hrs) 66 Metal Spinning: Making a cylindrical medicine container of Aluminium Sheet. (10 hrs)	Method to operate folding/brake folder for typical folding. Description and use of jigs and fixtures. (02 hrs)
Professional Skill 85 Hrs; Professional Knowledge 18 Hrs	Plan & work in different sheet metals such as tin, copper, brass. (Mapped NOS: NOS:CSC/N0301)	67 Making a Copper article by use of power press and also making brass and stainless steel articles. (10 hrs) 68 Practice of Buffing and polishing. (10 hrs)	Definition of Planishing and its application. Brief description of polishing machine. Various types of bobs and polishing compounds. (04 hrs)
		69 Angle iron bending in different angles and different radii. (10 hrs) 70 Twisting the M.S. square rod and flats. (10 hrs)	Operating principles of spinning lathe. Description of spinning. (04 hrs)
		71 Gas welding Square butt joint on M.S. sheet in down hand position Fillet Tee& Lap joint on M.S sheet in down hand position. (20 hrs)	Different process of metal joining types of weld joint &weld positions. Oxy-acetylene welding equipments & application, Types of flame& their uses. (04 hrs)
		72 Pipe butt joint in down hand position. (08 hrs) 73 Butt joint on MS flat in down hand position by arc. (08 hrs) 74 Fillet lap and T joint on MS flat in down hand position. (09 hrs)	Principle of arc welding. Types of welding machines and their uses. Advantages and disadvantages of AC/DC welding machines. Arc length and its importance Welding defects. (06 hrs)
Professional Skill 100 Hrs; Professional Knowledge 18 Hrs	Perform Arc welding, Gas welding , TIG welding & MIG welding and Spot welding on sheet metals (Mapped NOS: NOS:CSC/N0301)	75 Resistance welding. Spot welding, seam welding. (20 hrs)	Principle of resistance welding. Types and applications. Welding symbols. (02 hrs)
		76 Co_2 welding. Deposit bead on MS sheet in flat position. (10 hrs) 77 Lap joint T joint and butt joint in down hand position. (10 hrs)	Introduction to CO_2 welding process. Welding equipments and accessories. Advantages and application of CO_2 process. (04 hrs)
		78 TIG welding. Deposit bead on SS sheet in flat position. Making butt, Tee and corner joint. (20 hrs)	TIG welding process. Advantages. Description of equipments. Types of polarity and application. (04 hrs)
		79 TIG welding. Deposit bead on Aluminium sheet in flat position. (10 hrs) 80 Making butt, Tee and corner joint. (10 hrs)	Types of Tungsten Electrodes, Filler rods, Shielding Gases. Defects, causes and remedy in TIG welding process. (04 hrs)
		81 MS/SS pipe butt and Y joint by TIG welding process. (20 hrs)	Latest sheet metal cutting techniques: Plasma cutting, Laser cutting, water jet cutting and punching etc. (04 hrs)
Professional Skill 20Hrs; Professional Knowledge 06 Hrs	Perform Aluminum frame works. Makes ducts, cabins & panels. (Mapped NOS: CSC/N0301)	82 Make models of Aluminium sliding windows and doors. (10 hrs) 83 Partitions of mini model rooms by using aluminum channels beadings etc (06 hrs)	Specification of aluminium channels angles, strips, tubes beadings, packing rubber, cardboard, glasses etc. Tools and equipments used in aluminium fabrication. Assembly & Sub assembly: Gaurding assembly,

		84 Electrical Panel, trunk boxes & ducts fabrication and Painting. (04 hrs)	Door assembly, Chassis assembly, Cabinet assembly, Power pack assembly etc. Process of painting. Spray painting. Etch primer painting, Powder coating, buffing, grinding, and sanding. Selection of different grit sizes. (06 hrs)
Professional Skill 40 Hrs; Professional Knowledge 08 Hrs	Perform repair work of mudguard, Radiators etc. (Mapped NOS: NOS:CSC/N0301)	85 Special Exercises: Repairing Mudguard and Radiators and testing of Sheet metal containers. (20 hrs)	Types of Radiators and construction of Radiators, Mufflers, Estimation of work. (04 hrs)
		86 Any Special Exercises: Repairing Blocked Silencer and fuel tank. (20 hrs)	Material handling: handling of light, medium and heavy materials. Use of cranes and types. Estimation and costing. (04 hrs)

General discipline in the Institute

Objectives: At the end of this lesson you shall be able to
- **follow the general discipline for a trainee laid down by the Institute**
- **avoid any undesirable actions as a learner**
- **keep up the moral image and reputation of the Institute.**

General discipline: Always be polite, courteous while speaking to any person. (Principal, Training and Office staff, your co-trainees and any other person visiting your institute)

Do not get into arguments with others on matters related to your training and with the office while seeking clarifications.

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

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

Do not be late to the theory and practical classes.

Do not unnecessarily interfere in other's activities.

Be 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 or be playful while undergoing training.

Keep the institute premises neat and avoid poluting the environment.

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

Always attend the institute well dressed and with good physical appearance.

Be regular to attend the training without fail and avoid abstaining from the theory or practical classes for simple reasons.

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.

Elementary first aid

Objectives: At the end of this lesson you shall be able to
- **understand the First Aid treatment to be given for**
  - **breathing problems**
  - **electric shock**
  - **burns caused by direct flame or by chemical**
  - **large wounds with or without severe bleading**
  - **eye injuries due to hot flying particles.**

Electrical shock and breathing problems: The severity of an electric shock will depend on the level of the current which passes through the body and the length of the time of contact. Do not delay, act at once. Make sure that the electric current supply has been disconnected.

If the person is still in contact with the electric supply - break the contact either by switching off the power, removing the plug or wrenching the cable free. If not, stand on some insulating material such as dry wood, rubber or plastic, or using whatever is at hand to insulate yourself and break the contact by pushing or pulling the person free. (Figs.1 & 2)

Fig 1

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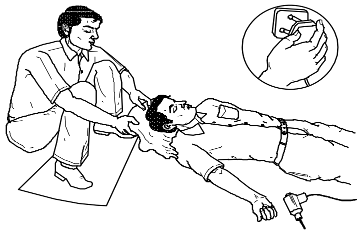
Fig 2



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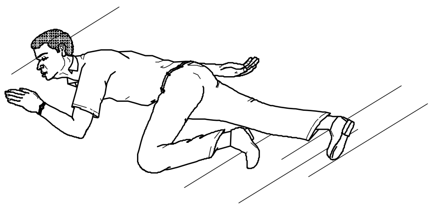
If you remain un-insulated, do not touch the victim with your bare hands until the circuit is made dead or he is moved away from the equipment.

If the victim is at a height from the ground level, proper safe actions must be taken to prevent him from falling or atleast make him fall safe.

Electric burns on the victim may not cover a big area but may be deep seated. All you can do is to cover the area with a clean, sterile dressing and treat for shock. Get expert help as quickly as possible.

If the affected person is unconscious but is breathing, loosen the clothing about the neck, chest and waist and place the affected person in the recovery position.(Fig.3)

Fig 3



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Keep a constant check on the breathing and pulse rate.

Keep the affected person warm and comfortable. (Fig.4)

Send for help.

Fig 4

SM20N110114

Do not give an unconscious person anything by mouth.

Do not leave an unconscious person unattended.

If the casualty is not breathing - Act at once - don't waste time!

Electric shock: The severity of an electric shock will depend on the level of the current which passes through the body and the length of time of the contact.

Other factors that contribute to the severity of shock are:

– the age of the person

– not wearing insulating footwear or wearing wet footwear

– weather condition

– floor is wet

– mains voltage etc.

Effects of an electric shock: The effect of the current at very low levels may only be an unpleasant tingling sensation, but this in itself may be sufficient to cause one to lose his balance and fall.

At higher levels of current, the person receiving the shock may be thrown off his feet and will experience severe pain, and possibly minor burns at the point of contact.

At an excessive level of current flow, the muscles may contract and the person may be unable to release his grip on the conductor. He may lose consciousness and the muscles of the heart may contract spasmodically (fibrillation). This may be fatal.

Electric shock can also cause burning of the skin at the point of contact.

Treatment for electric shock:

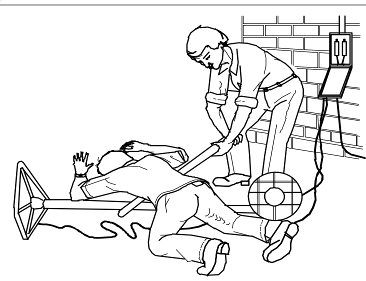
Prompt treatment is essential.

If assistance is available nearby, send for medical aid, then carry on with emergency treatment.

If you are alone, proceed with treatment at once.

Switch off the current, if this can be done without undue delay. Otherwise, remove the victim from contact with the live conductor, using dry non-conducting materials such as a wooden bar, rope, a scarf, the victim's coat-tails, any dry article of clothing, a belt, rolled-up newspaper, non-metallic hose, PVC tubing, bakelite paper, tube etc. (Fig.1)

Fig 5



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Avoid direct contact with the victim. Wrap your hands in dry material if rubber gloves are not available.

Electrical burns: A person receiving an electric shock may also get burns when the current passes through his body. Do not waste time by applying first aid to the burns until breathing has been restored and the patient can breathe normally - unaided.

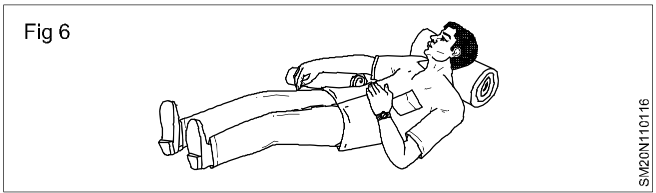
Burns and scalds: Burns are very painful. If a large area of the body is burnt, give no treatment, except to exclude the air, eg.by covering with water, clean paper, or a clean shirt. This relieves the pain.

Severe bleeding: Any wound which is bleeding profusely, especially in the wrist, hand or fingers must be considered serious and must receive professional attention. As an immediate first aid measure, pressure on the wound itself is the best means of stopping the bleeding and avoiding infection.

Immediate action: Always in cases of severe bleeding:

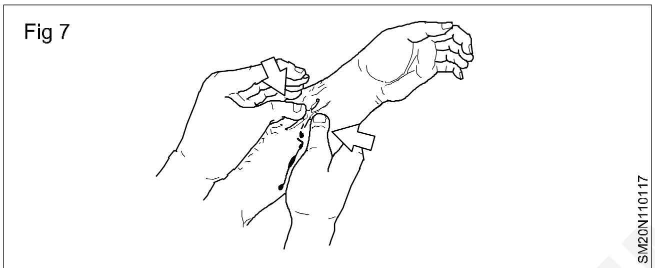
- make the patient lie down and rest
- if possible, raise the injured part above the level of the body (Fig.2)
- apply pressure on the wound
- call for assistance.

Fig 6



To control severe bleeding: Squeeze together the sides of the wound. Apply pressure as long as it is necessary to stop the bleeding. When the bleeding has stopped, put a dressing over the wound, and cover it with a pad of soft material. (Fig.3)

Fig 7



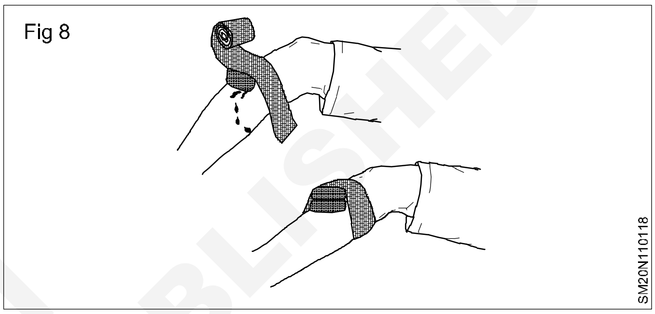
For an abdominal stab wound, such as may be caused by falling on a sharp tool, keep the patient bending over the wound to stop internal bleeding.

Large wound: Apply a clean pad (preferably an individual dressing) and bandage firmly in place. If the bleeding is very severe apply more than one dressing. (Fig.4)

Follow the right methods of artificial respiration.

Eye injury: For eye irritation caused by arc flashes, use a mild eye drop and apply 2 to 3 drops for 3 or 4 times a day. If the injury is due to a metal chip or slag particles entering the eye then take the injured person to an eye doctor immediately for treatment. Never rub the eye for any type of eye injury as it will cause a permanent vision problem. Also do not apply any eye drop or ointment without consulting an eye doctor.

Fig 8



Importance of sheet metal work in industries

Objectives: At the end of this lesson you shall be able to
- **state the scope and the importance of the trade.**

Introduction

Many engineering products are made out of sheet metal. The person who works on metal sheets is called sheet metal worker. The skilled sheet metal worker make and install various kind of sheet metal products. (Fig 1)

- roofings
- ductings
- vehicles body buildings like 3 wheelers, 4 wheelers, ships, air crafts etc.
- furnitures
- house hold articles
- railway equipment

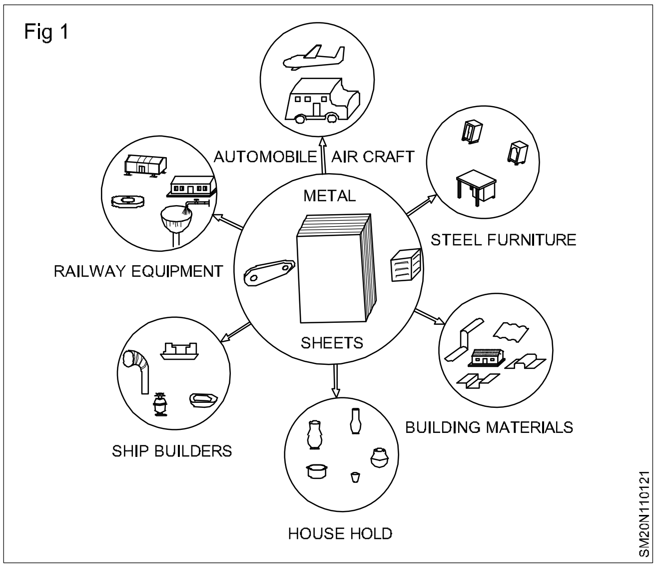
Also repairing of the above items.

To carry out these works, the sheet metal worker has to plan, layout and determine the size and the type of the sheet metal to be used.

The sheet metal worker carries out the operations such as cutting, folding, forming, fastening and assembling manually and by means of power machines.

The above requirements needs proper training and to know the basic principles of operation and process. All the advance technologies are developed from basic principles only. The advance technologies facilitates for mass production, consistance in accuracy of product and the volume of needs.

Fig 1

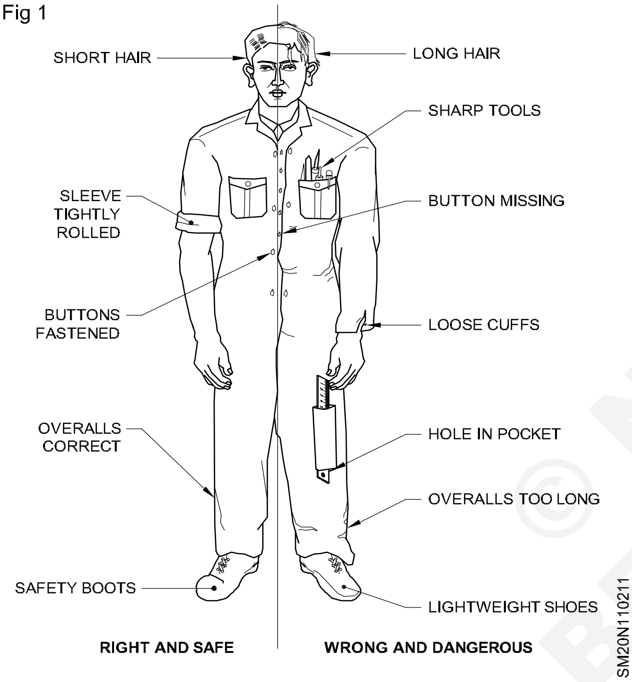


General Safety Precautions

Objectives: At the end of this lesson you shall be able to
- **state the importance of safety**
- **list out and explain the safety precautions to be observed in a work shop**
- **Identify the four basic categories of safety signs.**

Generally accidents do not happen; they are caused. Most accidents are avoidable. A good craftsman, having a knowledge of various safety precautions, can avoid accidents to himself and to his fellow workers and protect the equipment from any damage. To achieve this, it is essential that every person should follow safety procedure. (Fig 1)

Fig 1



Safety in a workshop can be broadly classified into 3 categories.

- General safety
- Personal safety
- Machine safety

General safety

1 Keep the floor and gangways clean and clear.

2 Move with care in the workshop, do not run.

3 Don't touch or handle any equipment/ machine unless authorised to do so.

4 Don't walk under suspended loads.

5 Use the correct tools for the job.

6 Keep the tools at their proper place.

7 Wipe out split oil immediately.

8 Replace worn out or damaged tools immediately.

9 Ensure adequate light in the workshop.

.10 Sweep away the metal cuttings.

11 Know everything about the machine before you start it.

Personal safety

1 Wear a one piece overall or boiler suit.

2 Keep the overall buttons fastened.

3 Wear safety shoes or boots or chain.

4 Cut the hair short.

5 Don't wear a ring, watch or chain.

6 Never lean on the machine.

7 Don't remove guards when the machine is in motion.

8 Don't use cracked or chipped tools.

9 Never touch the electrical equipment with wet hands.

10 Don't use any faulty electrical equipment.

11 Ensure that electrical connections are made by an authorised electrician only.

12 Don't try to stop a running machine with hands.

Machine safety

1 Switch off the machine immediately if something goes wrong.

2 Keep the machine clean.

3 Do not attempt operating the machine until you know how to operate it properly.

4 Do not adjust tool or the work piece unless the power is off.

5 Stop the machine before changing the speed.

6 Disengage the automatic feeds before switching off.

7 Never start a machine unless all the safety guards are in position.

8 Take measurements only after stopping the machine.

9 Use wooden planks over the bed while loading and unloading heavy jobs.

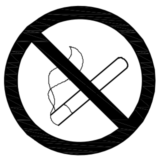
afety signs: As you go about your work on a construction site you will see a variety of signs and notices. Some of these will be familiar to you - a 'no smoking' sign for example;

Safety signs fall into four separate categories. These can be recognised by their shape and colour. Sometimes they may be just symbols 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 safety signs are as follows.

- prohibition signs
- mandatory signs
- warning signs
- information signs

Prohibition signs


PROHIBITION SIGN

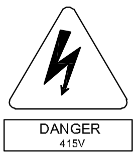
Shape	Circular.
Colour	Red border and cross bar. Black symbol on white background.
Meaning	Shows it must not be done.
Example	No smoking.

Mandatory signs


MANDATORY SIGN

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

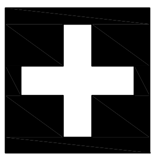
Warning signs



WARNING SIGN

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

Information signs


INFORMATION SIGN

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 9)

Mandatory signs (Fig 10)

Warning signs (Fig 11)

Fig 2

PROHIBITION SIGNS

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Fig 3

MANDATORY SIGNS

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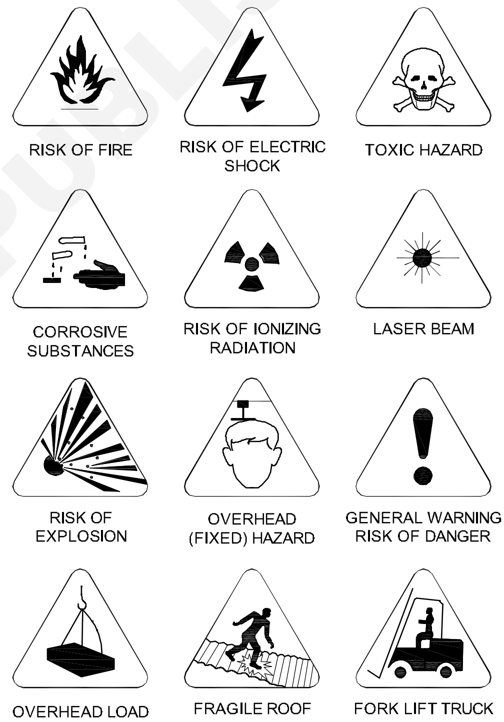
Fig 4



WARNING SIGNS

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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'?

Safety precautions in sheet metal work shop

Objectives: At the end of this lesson you shall be able to
- **state various improper practices while working in a SMW shop**
- **state different precautions to be taken for safe working in a SMW shop.**

Whenever a work is done in a shop the following aspects may create an injury to the workman/trainee or to others working nearby.

1 Way of handling the materials, tools and machine.

2 Cleaning of the work area/shop floor.

3 Damaged/faulty tools, machines and safety appliances.

4 Carelessness and negligence of the workman/trainee.

5 Ignorance of general safety rules.

To avoid the accident/injuries taking place, while working it is very important to follow certain safety precautions. They are:

– Do not bend your whole body while lifting heavy loads. Instead use your thigh muscles for lifting.

– Use gloves while handling thin sheets.

– Use chipping screen during chiseling operation.

– Avoid using a mushroom head chisel.

– Arrange the tools properly over the work table so that the tools are not allowed to fall from the table on your foot.

– Wear proper size safety shoes.

– Remove burrs by filing from a plate or sheet after cutting them by chisel or hacksaw.

– Do not use a hammer with a broken or damaged handle.

– Fix the hammer head with the handle securely using a wedge.

– Do not wear loose garments/dress.

– Wear plain goggles/face shield while grinding.

– Do not grind materials which are 3mm or less in thickness and non-ferrous metals.

– Adjust the gap between the work rest and the grinding wheel to 1-2mm.

– Select and use the right kind of tool for the right job.

– Keep the floor on the work area neat and clean without any cut pieces of material, oil, etc.

– Keep a separate bin/basket for throwing cotton waste, metal chips etc.

– Always keep fire fighting equipment and the First Aid Box ready for use in case of any emergency.

– After completion of work keep the tools in the tool box.

– Wear helmet if anybody is working above your work place, either to repair at the roof or on a overhead crane.

– Use tongs while handling hot objects.

– Do not try to check the sharpness of any tool with bare fingers.

– Switch off the mains of a machine while leaving the machine after completion of work.

– Do not try to rectify any electrical fault by yourself. Call an electrician for doing any electrical repair work.

– Wherever and whenever possible avoid poluting the environment.

– If any other person is affected by electric shock, immediately switch off the mains or separate the person from the electrical contact using a wooden rod or any other insulating material.

– Always fix the job at a convenient height on the vice.

– Use sufficient leverage while tightening or loosening a nut or bolt.

Metals and non-metals

Objectives: At the end of this lesson you shall be able to
- **state the different metals and their alloys**
- **state the different types of ferrous and non-ferrous metals**
- **state the difference between the metals and the non-metals**
- **state the different non-metals.**

Metals are desirable materials for product manufacturing because of their many outstanding properties. For example, they are good conductors of heat and electricity, they are opaque, shiny, tough, ductile and they are easily machined.

Alloy metal is a mixture of two or more metals. Usually it consists of a base metal and a smaller amount of other metals. Metals are divided into two groups. The ferrous metals which have large percentage of iron and the non-ferrous metals which have little or no iron.

1 **Cast iron** is used for the heavy parts of many machines and to make castings. It contains 2 to 4 percent of carbon. The basic kinds of cast iron are white, grey, and malleable iron. They are very brittle. Cast irons are difficult to weld.

2 **Wrought iron** is almost pure iron. It contains only less amount of carbon. Wrought iron forges well, can easily be bent hot or cold and can be welded.

3 **Carbon steels** are classified by the amount of carbon, they contain.

a) Low carbon steel, often called mild steel or soft steel contains 0.1 to 0.3 percent carbon. It is not suitable for heat treatment. This type of steel is available as black iron sheet, band iron, bars and rods, because it is easily welded, machined and formed.

b) Medium carbon steel has 0.3 to 0.6 percent carbon. It is used for many standard machine parts.

c) High carbon steel contaims 0.6 to 1.7 percent carbon. It is used for making cutting tools, such as chisels, files, scribers, axe etc.

4 **Alloy steels** have special properties, which are determined by the mixture and the amount of other elements, particularly the metals added.

a) Nickel is added to increase the strength, toughness and resist corrosion.

b) Chromium adds hardness, toughness and resistance to wear. Gears and axles for example are often made of chromium nickel steel because of its strength.

c) Manganese is used in steel to produce a clean metal and adds strength to steel.

d) Silicon is often used to increase the resistence of steel for making springs.

e) Tungsten is used with chromium, vanadium, molybdenum or manganese to produce high speed steel, used in cutting tools.

f) Molybdenum acts tougher and adds strength to steel. It is used in making high speed steels.

g) Vanadium improves the grain of the steel. It is used with chromium to make Chrome-Vanadium steel from which transmission parts and gears are manufactured. This type of steel is very strong and has excellent shock resistance.

Methods of Identification of steel: Steels are identified by the number system, colour code and the spark test.

Non-Ferrous metals and Alloys

Aluminium: Bluish white metal, very light in weight with a specific gravity of 2.7 and a melting point of 658°C malleable and ductile at 100°C to 150°C. Good conductor of heat and electricity. Resists corrosion forms.

Uses: It is used in making utensils, electrical wires, engines and aeroplane bodies, Railway carriages, bus ;bodies, ship building etc. Nowadays aluminium sections are used in making partitions, sliding windows and doors.

Copper: It is reddish brown in colour. Soft, malleable and ductile metal with a specific gravity of 8.2 and a melting point of 1083°C. Good conductor of heat and electricity. Highly resistance to corrosion by liquids. Forms important alloys like bronze and gun metal. It can be cast forged or rolled.

Uses: It is used in making electric wires and cables, parts of electrical machinery, coins and house hold utensils like boilers, oil tubes etc.

Lead: Soft bluish grey metal with a specific gravity of 11.36 and a melting point of 326°C, malleable and ductile.

Uses: It is used for water pipes and sanitary fittings and to prepare soft solders and coating material for chemical containers.

Zinc: Bluish white grey in colour. It is a crystalling metal. Brittle at ordinary temperature but malleable and ductile between 100°C to 150°C. Good conductor of heat and electricity. Specific gravity 7.0 and melting point 420°C.

Uses: Used for galvanizing on iron sheets. Making dry cells cover and for making zinc points, forms a number of alloys like brass silver spelter, silver.

Tin: Silver white in colour, malleable and ductile metal.

Specific gravity 7.8 and melting point 230°C.

Uses: It is used as protective covering for iron and steel sheets and pulleys.

It is used in ship building work. In ice rooms internal linings to protect from atmospheric effects and also for preparing alloys.

Brass: It is yellowish colour metal. Zinc varying from about 60% to 70%. Hardness of the alloy depends upon the amount of zinc percent in it. Malleable and ductile; resists corrosion.

Uses: It is extensively used for making household utensils. Water pumps and certain machine parts and for light metal casting.

Bronze: It is an alloy of 90% copper and 10% tin easily machined and cast. Resists corrosion and takes a fine polish. It is also touch. It has good electrical and thermal conductivity.

Uses: It is used in the manufacture of household utensils and coins. It is used for bearings especially where corrosion resistance is required. Used in making engineering parts like worm wheel, basement of machine tools.

Gun metal: Copper 88%, Tin 10%, Zinc 2%. It is tough, strong and hard, high corrosion resistance. Bearing and wearing qualities are high. Zinc promotes fluidity and so it is suitable for castings.

Uses: It is used for making minor accessories, bearings, glands, steam pipes, fittings and gears.

Mumtz metal: Mumtz metal consists of 60% copper and 40% zinc. Mumtz metal primarily is hot working alloy is used where cold working is not required. This metal possess good mechanical properties, combining strength with ductility, corrosion resistance is very good. This brass is having pleasing colour. This yellow brass is invented by george F.Mumtz in 1832.

White metal: White metal is an alloy of lead antimony tin employed for machine bearings, packings and linings to the low melting point alloys. It is used for toys, ornaments and fusible metals and to the type metal. White metal consists of 85%, copper 5%, antimony 10%.

Phosphorous bronze: Tin 10% to 14% phosphorous 0.3 to 1% remaining copper. It is having good tensile strength. Very high corrosion resistance and excellent bearing quality.

Uses: It is used for bearing, gears, worm wheels, slide valves, springs etc.

Silver: A white metal symbol (AB) specific gravity is 10.7 and the melting point is 964°C. Sterling silver is applied only to the specific silver copper alloy.

Uses: It is used to prepare spelters for silver solder. It is also used for making ornaments and jewelleries.

Gold: It is a royal metal, bright yellow in colour, very malleable and ductile. It is very soft in its purest form hence it is alloyed with copper to make it hard and ductile to make it suitable for ornamental works. Pure gold is having 24 carats. Melting point of gold is the best conductor of electricity.

Uses: It is commonly used in making ornaments and jewelleries and it is also used for electrical contacts in radars, rockets as special applications.

Copper and its alloys: Metals without iron are called non-ferrous metals. Eg. Copper, Aluminium, Zinc, Lead and Tin.

Copper: This is extracted from its ores 'MALACHITE' which containes about 55% copper and 'PYRITES' which contains about 32% copper.

Properties: Reddish in colour. Copper is easily distinguishable because of its colour.

The structure when fractured is granular, but when forged or rolled is fibrous.

It is very malleable and ductile and can be made into sheets or wires.

It is a good conductor of electricity. Copper is extensively used as electrical cables and parts of electrical apparatus which conduct electric current.

Copper is a good conductor of heat and also highly resistant to corrosion. For this reason it is used for boiler fire boxes, water heating apparatus, water pipes and vessels in brewery and chemical plants. Also used for making soldering iron.

The melting temperautre of copper is 1083°C.

The tensile strength of copper can be increased by hammering or rolling.

Bronze: Bronze is basically an alloy of copper and tin. Sometimes zinc is also added for achieving certain special properties. Its colour ranges from red to yellow. The melting point of bronze is about 1005°C. It is harder than brass. It can be easily machined with sharp tools. The chip produced is granular. Special bronze alloys are used as brazing rods.

Bronze of different compositions are available for various applications.

Lead and its alloys: Lead is a very commonly used non-ferrous metal and has a variety of industrial applications.

Lead is produced from its ore 'GALENA'. Lead is a heavy metal that is silvery in colour when molten. It is soft and malleable and has good resistance to corrosion. It is a good insulator against nuclear radiation. Lead is resistant to many acids like sulphuric acid and hydrochloric acid.

It is used in car batteries, in the preparation of solders etc. It is also used in the preparation of paints.

Lead alloys

Babbit metal: Babbit metal is an alloy of lead, tin, copper and antimony. It is a soft, anti-friction alloy, often used as bearings.

An alloy of lead and tin is used as 'soft solder'.

Zinc and its alloys: Zinc is a commonly used metal for coating on steel to prevent corrosion. Examples are steel buckets, galvanized roofing sheets, etc.

Zinc is obtained from the ore-calamine or blende.

Its melting point is 420°C.

It is brittle and softens on heating; it is also corrosion-resistant. It is due to this reason it is used for battery containers and is coated on roofing sheets etc.

Galvanized iron sheets are coated with zinc.

Tin and Tin alloys

Tin: Tin is produced from cassiterite or tinstone. It is silvery white in appearance, and the melting point is 231°C. It is soft and highly corrosion-resistant.

It is mainly used as a coating on steel sheets for the production of food containers. It is also used with other metals, to form alloys.

Eg. Tin with copper to form bronze. Tin with lead to form solder. Tin with copper, lead and antimony to form Babbit metal.

Non-Metals: Materials that are non-conductors of electricity are called non-metals.

Wood, Rubber, PVC, Porcelein, Mica, glass, fiber glass, graphite etc are examples of non-metals.

Physical and mechanical properties of metals

Objectives: At the end of this lesson you shall be able to
- **state the different physical properties of metals**
- **state the mechanical properties of metals.**

Properties of metals: Metals have different properties. Depending on the type of application, different metals are selected.

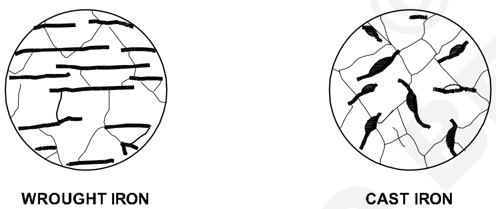
Physical properties of metals

Colour: Different metals have different colours. For example, copper is of a distinctive red colour. Mild steel is of a blue/black colour.

Weight: Metals have different weights. A metal, like aluminium is lighter (specific gravity 2.8) than many others and a metal like lead, is heavy (specific gravity 9)

Structure (Figs 1&2): Generally metals can also be differentiated by their internal micro structure. Metals like wrought iron and aluminium have a fibrous structure, and metals like cast iron and bronze have a granular structure.

Fig 1



Conductivity (Fig 3&4): Thermal conductivity and electrical conductivity are the measure of the ability of a material to conduct heat and electricity. Conductivity will vary from metal to metal. Copper and aluminium are good conductors of both heat and electricity. Copper is used for soldering irons and electrical conductors.

Tenacity (Fig 12): Tenacity of a metal is its ability to resist the effect of the tensile forces without rupture. Mild steel, wrought iron and steel are examples of tenacious metals.

Elasticity (Fig 13): Elasticity of a metal is the property of returning to its original shape after the applied force is released. Properly heat treated spring is a good example of elasticity.

Machinability: Metal which can be easily machined and gives a longer tool life, better surface finish, at maximum cutting speed is said to be a good machineable metal.

Example: Aluminium is a good machineable metal in comparison with cast iron. Cast iron is a good machineable metal in comparison with cast steel.

Fig 2

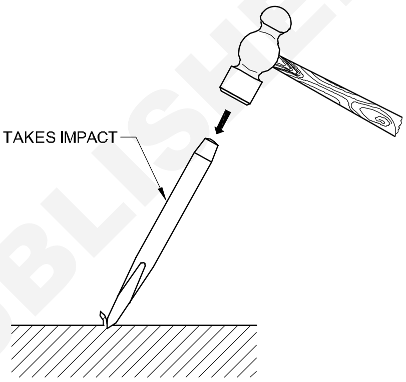


Fig 3

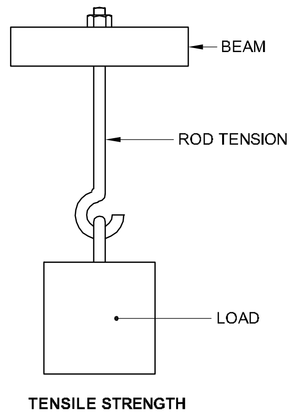
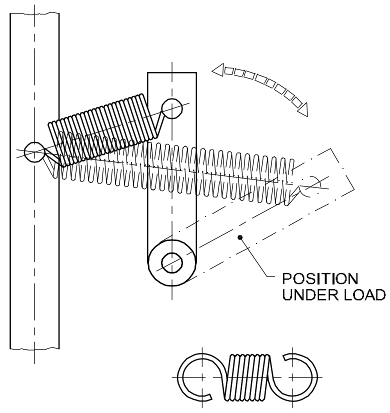


Fig 4



Specification of Steel Flats and Strips

Objectives: At the end of this lesson you shall be able to
- **designate the size of steel flats and sheets as per indian standard specifications**
- **determine the weight of a particular size of flat and sheet**

Importance of specifying steel sections correcly

A fitter should be able to correctly specify steel sections and also interpret the specifications given in a drawing. This will help in selecting and ordering raw materials required for fabrication.

Steel flats

Hot rolled steel flats are designated by the width (mm) followed by the letters ISF. and the thickness (mm) as per IS 1730: 1989.

Example:50ISF10

(Where the width and the thickness of the flat are 50 mm and 10mm respectively)

Table 1 will assist in selecting the standard sizes of flats and also to determine the weight of the flats of different width and thickness.

What should be the weight of 50ISF 10 of ten meter

Answer

flats and also to determine the weight of the flats of different width and thickness.

What should be the weight of 50 ISF 10 of ten meter

Answer

Fig 1

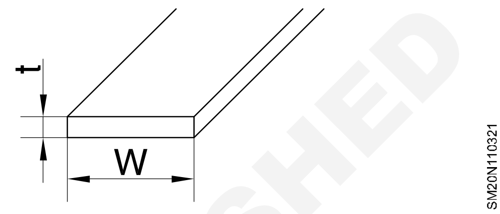


TABLE 1

Dimensions and Mass of Hot Rolled Steel Flats

Width mm	Mass*, kg/m for Varying (mm) Thickness												
	3	4	5	6	8	10	12	15	20	25	30	40	50
10	0.236	0.314	0.393	0.471	-	-	-	-	-	-	-	-	-
16	0.377	0.502	0.628	0.754	1.00	1.10	1.51	-	-	-	-	-	-
20	0.471	0.628	0.785	0.942	1.26	1.57	1.88	2.30	-	-	-	-	-
25	0.589	0.785	0.981	1.18	1.57	1.96	2.36	2.94	-	-	-	-	-
30	0.707	0.942	1.18	1.41	1.88	2.36	2.83	3.53	4.71	-	-	-	-
35	0.824	1.10	1.37	1.65	2.20	2.75	3.30	4.12	5.50	-	-	-	-
40	0.942	1.26	1.57	1.88	2.51	3.14	3.77	4.71	6.28	7.85	9.42	-	-
45	1.06	1.41	1.77	2.12	2.83	3.53	4.24	5.30	7.07	8.83	10.6	-	-
50	1.18	1.57	1.96	2.36	3.14	3.93	4.71	5.89	7.85	9.81	11.8	-	-
60	1.41	1.88	2.36	2.83	3.77	4.71	5.65	7.07	9.42	11.8	14.1	18.8	-
65	-	2.04	2.55	3.06	4.08	5.10	6.12	7.65	10.2	12.8	15.3	20.4	-
70	-	2.20	2.75	3.30	4.40	5.50	6.59	8.24	11.0	13.7	16.5	22.0	-
75	-	2.36	2.94	3.53	4.71	5.89	7.07	8.83	11.8	14.7	17.7	23.6	-
80	-	2.51	3.14	3.77	5.02	6.28	7.54	9.42	12.6	15.7	18.8	25.1	31.4
90	-	-	3.53	4.24	5.65	7.07	8.48	10.6	14.1	17.7	21.2	28.3	35.3
100	-	-	3.93	4.71	6.28	7.85	9.42	11.8	15.7	19.6	23.6	31.4	39.2
120	-	-	-	5.65	7.54	9.42	11.3	14.1	18.8	23.6	28.3	37.7	47.1
130	-	-	-	6.12	8.16	10.2	12.2	15.3	20.4	25.6	30.6	40.8	51.2
140	-	-	-	6.59	8.79	11.0	13.2	16.5	22.0	27.5	33.0	44.0	55.0
150	-	-	-	7.07	9.42	11.8	14.1	17.7	23.6	29.4	35.3	47.1	58.9
160	-	-	-	-	10.0	12.6	15.1	18.8	25.1	31.4	37.7	50.2	-
180	-	-	-	-	11.3	14.1	17.0	21.2	28.3	35.3	42.4	56.5	-
200	-	-	-	-	-	15.7	18.8	23.6	31.4	39.2	47.1	62.8	-
250	-	-	-	-	-	19.6	23.6	29.4	39.2	49.1	58.9	78.5	-
300	-	-	-	-	-	-	28.3	35.3	47.1	58.8	70.7	94.2	-
400	-	-	-	-	-	-	-	47.1	62.8	78.5	94.2	126	-

*Based on the density of steel =7.85 gm/cm3 as per Indian Standard are designated as ISSH received by figures denoting length (mm) x width (mm) x thickness (mm) of the sheet as per IS 1730 : 1989.

Example

ISSH 3200 x 600 x 1.00

where

3200 is the length of the sheet (mm)

600 is the width of the sheet (mm)

1.00 is the thickness of the sheet (mm)

Table 2 gives the weight of steel sheets of different standard sizes.

EXERCISE

Calculate the weight of the steel sheet given below.

ISSH 1800x1200 x 1.40mm

____

____

TABLE 2

Standard Nominal Dimensions and Mass of Sheet

Size mmXmm	Standard Nominal Surface Area in m^2	Standard Nominal Thickness in mm												
		0.40	0.50	0.63	0.80	0.90	1.00	1.12	1.25	1.40	1.60	1.80	1.90	2.00
1800 x 600	1.08	3.39	4.24	5.34	6.78	7.65	8.47	9.50	10.6	11.9	13.6	5.3	16.1	17.0
750	1.35	4.24	5.30	6.67	8.48	9.54	10.6	11.9	13.2	14.8	17.0	19.1	20.1	21.2
900	1.62	5.09	6.35	8.01	10.2	11.4	12.7	14.2	15.9	17.8	20.3	22.9	24.2	25.4
950	1.71	5.37	6.71	8.45	10.7	12.1	13.4	15.0	16.8	18.8	21.5	24.2	25.5	26.8
1000	1.80	5.65	7.06	8.90	11.3	12.7	14.2	15.8	17.7	19.8	22.6	25.4	26.8	28.3
1100	1.98	6.22	7.77	9.79	12.4	14.0	15.6	17.4	19.4	21.8	24.9	28.0	29.5	31.1
1200	2.16	6.78	8.48	10.7	13.6	15.3	17.0	19.0	21.2	23.7	27.1	30.5	32.2	33.9
1250	2.25	7.07	8.83	11.1	14.1	15.9	17.6	19.8	22.1	24.7	28.3	31.8	33.6	35.3
1400	2.52	7.91	9.90	12.5	15.8	17.8	19.8	22.2	24.7	27.7	31.7	35.6	37.6	39.6
1500	2.70	8.48	10.6	13.4	17.0	19.1	21.2	23.8	26.5	29.7	33.9	38.2	40.2	42.4
2000 x 600	1.20	3.77	4.71	5.93	7.53	8.47	9.42	10.6	11.8	13.2	15.1	17.0	17.9	18.8
750	1.50	4.71	5.88	7.42	9.42	10.6	11.8	13.2	14.7	16.5	18.8	21.2	22.4	23.6
900	1.80	5.65	7.06	8.90	11.3	12.7	14.1	15.8	17.7	19.8	22.6	25.4	26.8	28.3
950	1.90	5.97	7.45	9.39	12.0	13.4	14.9	16.8	17.9	20.8	23.6	26.8	28.3	29.8
1000	2.00	6.28	7.85	9.89	12.6	14.1	15.7	17.6	19.6	22.0	25.1	28.3	29.8	31.4
1100	2.20	6.91	8.63	10.9	13.8	15.5	17.3	19.3	21.6	24.2	27.6	31.1	32.8	34.5
1200	2.40	7.53	9.42	11.9	15.1	17.0	18.8	21.1	23.6	26.4	30.1	33.9	35.8	37.7
1250	2.50	7.85	9.80	12.4	15.7	17.7	19.6	22.0	24.5	27.5	31.4	35.3	37.2	39.2
1400	2.80	8.79	11.0	13.8	17.6	19.8	22.0	24.6	27.5	30.8	35.2	39.6	41.8	44.0
2500	3.00	9.42	11.8	14.8	18.8	21.2	23.6	26.4	29.4	33.0	37.7	42.2	44.7	47.1
2200 x 600	1.32	4.14	5.18	6.52	8.28	9.32	10.4	11.6	13.0	14.5	16.6	18.7	19.7	20.7
750	1.65	5.18	6.47	8.16	10.4	11.7	13.0	14.5	16.2	18.1	20.7	23.3	24.6	25.9
900	1.98	6.22	7.77	9.78	12.4	14.0	15.5	17.4	19.4	21.8	24.9	28.0	29.5	31.1
950	2.09	6.56	8.20	10.3	13.1	14.8	16.4	18.4	20.5	23.0	26.2	29.5	31.2	32.8
1000	2.20	6.91	8.63	10.9	13.8	15.5	17.3	19.3	21.6	24.2	27.6	31.1	32.8	34.5
1100	2.42	7.60	9.50	12.0	15.2	17.1	19.0	21.3	23.7	26.6	30.4	34.2	36.1	38.0
1200	2.64	8.29	10.4	13.1	16.6	18.7	20.7	23.2	25.9	29.0	33.2	37.3	39.4	41.4
1250	2.75	8.63	10.8	13.6	17.3	19.4	21.6	24.2	27.9	30.2	34.5	38.9	41.0	43.2
1400	3.08	9.67	12.1	15.2	19.3	21.8	24.2	27.1	30.2	33.8	38.7	43.5	45.9	48.4
1500	3.30	10.4	13.0	16.3	20.7	23.3	25.9	29.0	32.4	36.3	41.4	46.6	49.2	51.8
2500 x 600	1.50	4.71	5.88	7.42	9.42	10.6	11.8	13.2	14.7	16.5	18.8	21.2	22.4	23.6
750	1.875	5.88	7.35	9.26	11.8	13.2	14.7	16.5	18.4	20.6	23.6	26.5	27.9	29.4
900	2.25	7.07	8.83	11.1	14.1	15.9	17.7	19.8	22.1	24.7	28.3	31.8	33.6	35.3
950	2.375	7.45	9.32	11.7	14.9	16.8	18.6	20.9	23.3	26.1	29.8	33.6	35.4	37.2
1000	2.50	7.85	9.80	12.4	15.7	17.7	19.6	22.0	24.5	27.5	31.4	35.3	37.2	39.2
1100	2.75	8.63	10.8	13.6	17.3	19.4	21.6	24.2	27.0	30.2	34.5	38.9	41.0	43.2
1200	3.00	9.42	11.8	14.8	18.8	21.2	23.6	26.4	29.4	33.0	37.7	42.4	44.7	47.1
1250	3.125	9.81	12.3	15.5	19.6	22.1	24.5	27.5	30.7	34.3	39.2	44.2	46.6	49.1
1400	3.50	11.0	13.7	17.3	22.0	24.7	27.5	30.8	34.3	38.5	44.0	49.5	52.2	55.0
1500	3.75	11.8	14.7	18.5	23.6	26.5	29.4	33.0	36.8	41.2	47.1	53.0	55.8	58.9

* Based on the density of steel = 7.85 g/cm^2
For determining the mass of sheet above 2 mm thickness refer to IS1730:1989.

Indian Standard strips are designated as ISST followed by width (mm) x thickness (mm) of the strip as per IS 1730 - 1989.

Example

ISST 1050 x 3.15: Where 1050 mm is the width of the strip and 3.15mm is the thickness.

Table 3 gives the weight in kg of a particular strip per metre length.

EXERCISE

Calculate the weight of a ISST 500 x 4 of 2 metres

Answer

____

____

Fig 2

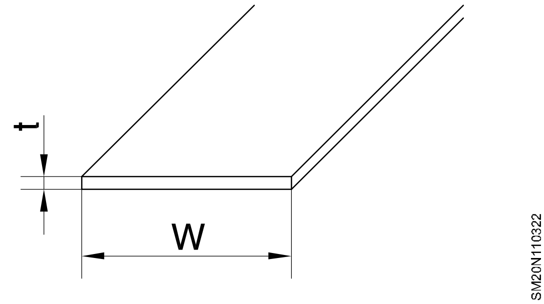


TABLE 3

Standard Nominal Dimensions and Mass of Strip

Width in mm	Thickness in mm 1.60	1.80	2.00	2.24	2.50	2.80	3.15	3.55	4.00	4.50	5.0	6.0	8.0	10.0
	Mass * kg/m													
100	1.25	1.41	1.57	1.76	1.96	2.20	2.47	2.79	3.14	3.53	3.92	4.71	6.28	7.85
125	1.57	1.77	1.96	2.20	2.45	2.74	3.08	3.48	3.92	4.41	4.90	5.88	7.85	9.81
160	2.01	2.26	2.51	2.81	3.14	3.52	3.95	4.46	5.02	5.65	6.28	7.53	10.0	12.6
200	2.51	2.82	3.14	3.52	3.92	4.39	4.94	5.58	6.28	7.06	7.84	9.42	12.6	15.7
250	3.14	3.53	3.92	4.40	4.90	5.49	6.17	6.97	7.85	8.83	9.80	11.8	15.7	16.6
320	4.02	4.52	5.02	5.62	6.28	7.05	7.90	8.92	10.0	11.3	12.5	15.1	20.0	25.1
400	5.02	5.65	6.28	7.04	7.85	8.78	9.88	11.1	12.6	14.1	15.7	18.8	25.1	31.4
500	6.28	7.05	7.85	8.79	9.51	11.0	12.4	13.9	15.7	17.7	19.6	23.6	31.4	39.2
650	8.16	9.17	10.2	11.4	12.7	14.3	16.1	18.1	20.4	23.0	25.5	30.6	40.8	51.0
800	10.0	11.3	12.6	14.1	15.7	17.6	19.8	22.3	25.1	28.3	31.4	37.7	50.2	62.8
950	-	13.4	14.9	16.7	18.6	20.8	23.5	26.5	29.8	33.6	27.3	44.7	59.7	74.6
1000	-	-	15.7	17.6	19.6	22.0	24.7	27.9	31.4	35.3	39.2	47.1	62.8	78.5
1050	-	-	16.5	18.5	20.6	23.3	26.0	29.2	33.0	37.1	41.2	49.5	65.9	82.4
1150	-	-	-	20.2	22.6	25.2	28.4	32.0	36.1	40.6	45.1	54.2	72.2	90.3
1250	-	-	-	-	24.5	27.5	30.9	34.8	39.2	44.2	49.1	58.9	78.5	98.1
1300	-	-	-	-	-	28.6	32.1	36.2	40.8	45.9	51.0	61.2	81.6	102
1450	-	-	-	-	-	-	35.8	40.4	45.5	51.2	56.9	68.3	91.1	114
1550	-	-	-	-	-	-	383	43.2	48.754.7		60.8	73	93.3	122

Indian Standard steel plates are designated as ISPL followed by figures denoting length (mm) x width (mm) X thickness (mm) of the plates as per IS 1730 : 1989.

Example:

ISPL 2200 x 950 x 8

where 2200 is the length of the plate (mm)

950 is the width of the plate (mm)

8 is the thickness of the plate (mm)

EXERCISE

Calculate the weight of the following steel plate.

ISPL 5600 x 1400 x 5. (Refer Table 4)

Ans______________________________________

TABLE 4

Mass Per Metre of Plates

Thickness in mm	Width in mm: 900	950	1000	1100	1200	1250	1400	1500	1600	1800	2000	2200	2500
	Mass * per metre, kg												
5	35.3	37.3	39.2	43.2	47.1	49.1	55.0	58.9	62.8	70.6	78.5	86.4	98.1
6	42.4	44.7	47.1	51.8	56.5	58.9	66.0	70.6	75.4	84.8	94.2	104	118
7	49.4	52.2	55.0	60.4	66.0	68.7	76.9	82.4	87.9	98.9	110	121	137
8	56.5	59.7	62.8	69.1	75.4	78.5	87.9	94.2	100	113	126	138	157
10	70.6	74.6	78.5	86.4	94.2	98.1	110	118	126	141	157	173	196
12	84.8	89.5	94.2	104	113	118	132	141	151	170	188	207	236
14	98.9	104	110	121	132	137	154	165	176	198	220	242	275
16	113	119	126	138	151	157	176	188	201	226	251	276	314
18	127	134	141	155	170	177	198	212	226	254	283	311	353
20	141	149	157	173	188	196	220	236	251	283	314	345	392
22	155	164	173	190	207	216	242	259	276	311	345	380	432
25	177	186	196	216	236	245	275	294	314	353	392	432	491
28	198	209	220	242	264	275	308	330	352	396	440	484	550
32	226	239	251	276	301	314	352	377	402	452	502	553	628
36	254	268	283	311	339	353	396	424	452	509	565	621	706
40	283	298	314	345	377	392	440	471	502	585	628	691	785
45	318	336	353	389	424	441	495	530	565	634	706	777	883
50	353	373	392	432	471	491	550	589	628	706	785	864	981
56	396	418	440	484	528	550	615	659	703	791	879	967	1079
63	445	470	495	544	593	618	692	742	791	890	989	1088	1239

* Based on the density of steel = 7.85 g/cm^3

Raw material information CRCA, HRCA.MS

Objectives: At the end of this lesson you shall be able to
- **state the types of metals used in sheet metal work**
- **state the uses of the different types of metals.**

In sheet metal work, different types of metal sheets are used. The sheets are specified by their standard gauge numbers.

It very essential to know the different uses and applications of these metal sheets.

Black iron sheets: The cheapest sheet metal is the black iron, which is rolled to the desired thickness. The sheets are rolled in two conditions. When it is rolled in cold state, it is called cold rolled and when it is rolled in hot state, it is called hot rolled. Hot rolled sheets have a bluish black appearance, and are often referred to as uncoated sheets, since they are uncoated. They corrode rapidly.

Cold rolled sheets have plain silver whitish appearance and are uncoated. To decrease the work hardness, the cold ruled sheets are annealed in a closed atmosphere. These sheets are known as C.R.C.A (Cold roled close annealed) sheets.

The use of this metal is limited to making articles that are to be painted or enamelled such as tanks, pans, stoves, pipes etc.

Galvanised iron sheets: Zinc coated iron is known as 'galvanised iron'. This soft iron sheet is popularly known as G.I.sheet. The zinc coating resist corrosion and improves the appearance of the metal and permit it to be soldered with greater ease. Because it is coated with zinc, galvanised iron sheet withstands contact with water and exposure to weather.

Articles such as pans, buckets, furnaces, heating ducts, cabinets, gutters etc. are made mainly from G.I.sheets.

Stainless sheets: This is an alloy of steel with nickel, chromium and other metals. It has good corrosive resistance and can be welded easily. Stainless steel used in a sheet metal shop can be worked similar to galvanised iron sheets, but is tougher than G.I. sheets. The cost of stainless steel is very high.

Stainless steel is used in dairies, food processing, chemical plants, kitchenware etc.

Copper sheets: Copper sheets are available either as cold rolled or hot rolled. They have a very good resistance to corrosion and can be worked easily. They are commonly used in sheet metal shops. Copper sheet has better appearance than other metals.
Gutters, expansion joints, roof flashings, hoods, utensils and boiler plates are some of the common examples where copper sheets are used.

Aluminium sheets: Aluminium cannot be used in its pure form, but is mixed with very small amount of copper, silicon, manganese and iron. Aluminium sheets are whitish in colour and light in weight. They are highly resistant to corrosion and abrasion.

Aluminium is now widely used in the manufacture of articles such as household appliances, refrigerator trays, lighting fixtures, windows and also in the construction of airplanes and in many electrical and transport industries.

Tinned plate: Tinned plate is sheet iron coated with tin, to protect it against rust. This is used for nearly all solder work, as it is the easiest metal to join by soldering.

This metal has a very bright silvery appearance and is used in making roofs, food containers, dairy equipment, furnace fittings, cans and pans etc.

Lead sheets: Lead is very soft and heavy in weight.

Lead sheets are used for making the highly corrosive acid tanks.

When lead is coated on black iron sheets, they are called Terne sheets. They are highly anti-corrosive and commonly used in preservation of chemicals.

Technical Terms in Sheet Metal work

Objectives: At the end of this lesson you shall be able to
- **state the meaning of various terms used in sheet metal work.**

1 **Bench machines**: Machines clamped to a bench and operated by turning a crank. Used by the sheet metal worker to turn edges on circles and round pipes.

2 **Bench stakes**: Steel anvils of various specialized shapes that the sheet metal worker uses to form and seam sheet metal objects.

3 **Black iron**: Iron and steel sheets covered with an oxidized coating only.

4 **Embossing**: A stamping process that produces a shallow relief design on sheet metal.

5 **Flux**: Chemical used to clean metal and remove the oxides from the metal surface prior to soldering.

6 **Gage**: The system of classifying the thickness in which sheet metal is produced. Also a tool used for measuring and determining the thickness of a metal sheet.

7 **Hem**: A folded edge on a sheet metal object.

8 **Parallel line development**: A method of pattern drafting employing parallel lines.

9 **Pickle**: To clean dirt and oxide from metal by immersing it in an acid bath.

10 **Pictorial drawings**: A drawing of an object in three dimensions as it actually appears after being formed into shape.

11 **Primer**: A first coat of finish on a metal, it binds and adhers to the metal giving good base for later coats.

12 **Punching**: The process of making holes in sheet metal by the use of dies.

13 **PVC (polyviny/chloride)**: A plastic often used for hoods and tanks that require high corrosion resistance.

14 **Radial line development**: A method of pattern drafting using lines radiating from a center and using arcs.

15 **Raw acid**: Hydrochloric acid (HCl)

16 **Rivets**: Fasteners used to join two pieces of sheet metal together. The rivet is inserted in a hole and a head is formed by pounding the rivet with a hammer.

17 **Sheet metal**: Any type of metal sheets that are 1/8" thick or less.

18 **Square-to-round**: The name of a common sheet metal fitting that is square or rectangular on one end and round on the other end.

19 **Stainless steel**: A special steel containing other types of metals such as chromium, nickel and molybdenum. There are many types of stainless steel sheets. All of them vary in corrosion resistance.

20 **Swage**: A special forging tool used for smoothening and finishing.

21 **Sweat soldering**: The process of soldering two pieces of metal together by making the solder “sweat” completely through the seam.

22 **Tinning**: Covering an area of metal with molten solder.

23 **Transition piece**: A sheet metal fitting that changes size or shape from one end to the other.

24 **Triangulation**: A method of pattern drafting employing the use of triangles.

25 **Wired edge**: A sheet metal edge folded around a piece of wire for added strength.

Tools & equipments used in sheet metal worker

Objectives: At the end of this lesson you shall be able to
- **know about measuring tools**
- **know about marking tools**
- **know about production tools**
- **know about machines & appliances.**
- **know about the draw the free and sketch .**

Measuring Tools	Marking Tools	Machines & Equipment
Steel Rule	Vernier IT gauge	Electric hand drill(light)
Micro meter	Straight Edge	Electric hand drill (heavy
Vernies caliper	Try Square	Phenmatic hand drill
Combination set	Tinman's square	Soldering iron
Standard wire gange	Straight Scriber	Gas heated soldering copber
Radius gauge	Bend Scriber	St. soldering copper with handle
Screw pitah gauge	Scratech AWL	Adjustable soldering bit
Com pass	Center punch	Handy soldering copper bit
Jenny caliper	Dot punch	Electric copper soldering
Templates	Prick punch	Hatchet soldering iron
Trammel		Lazy tong
Beam Trammel		Ratchet drilling m/c
Surface plate		Pedastal type spot weld
		Hand lever shear
		Breast drilling m/c
		Blow lamp

Production Tools

Wooden mallet	Peening hammer	Round bottom strake	Revolving bench plate
Proffing mallet	Tarmeans shear	Half moon stake	C clamp
End-pached mallet	Universal combination or Gillow shear	Funmel stake	Angle iron
Raw hide mallet	Pipe shear	Beak or Bickiron stake	Folding bars
Ballpeen hammer	Scotch shear	Crasing iron	Solid pench
Cross peen hammer	Block shear	Tinman's Hosse	Hollow Pench
Straight peen hammer	Roudes shear	Round bottom wead	Tinner's hand punch
Setting hammer	Straight scrips	Amil lead	Hand lever pench
Riwelting hammer	Bend scrips	Half moon head	Hand Riveter
Creasing hammer	Hauvk-billed shear	Round head	Pop Riveter
Stretching hammer	Aviation shear	Triman's Anvil	Blind rivetting equipment
Hollowing hammer	Bench shear	Universal stake holder	File
Bullet hammer	Double cutting shear	Copper smith stake	Chisel
Olanishing/Plateneming hammer	Electric portable shear	Hand seaner	Hacksaw
		Bar folder m/c	Groover
		Bench plate	

Marking and laying out tools & Accessories

TOOLS & EQUIPMENT

FOR SHEET METALWORKER.

MEASURING TOOLS

Fig 1

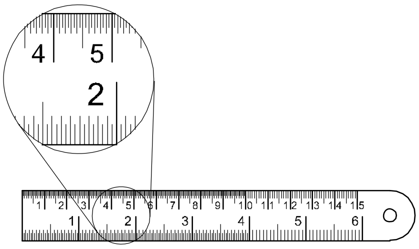


Fig 2

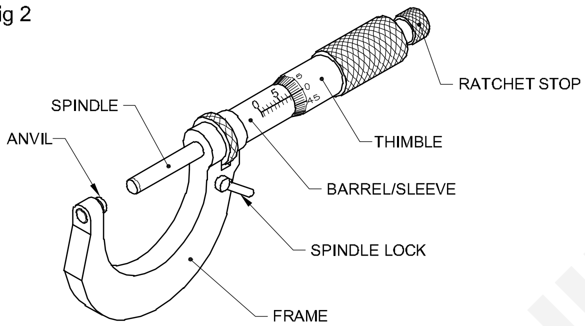


Fig 3

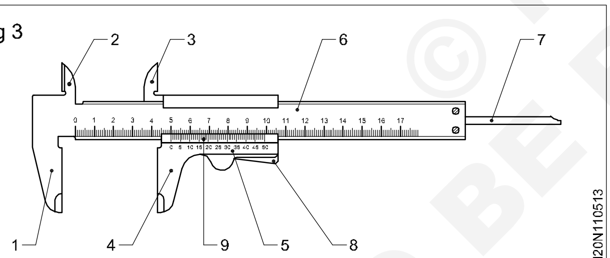


Fig 4

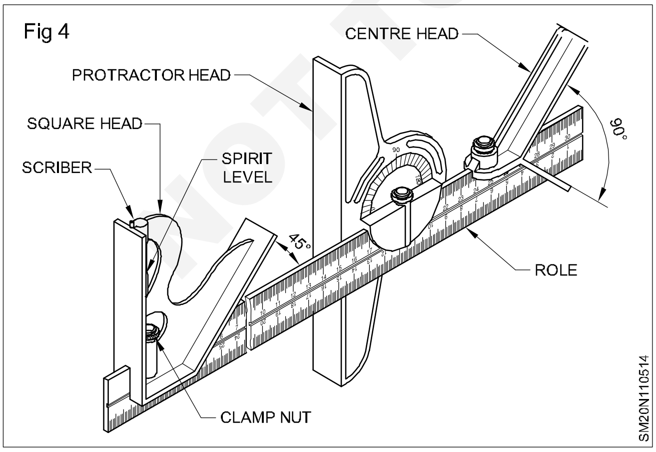


Fig 5

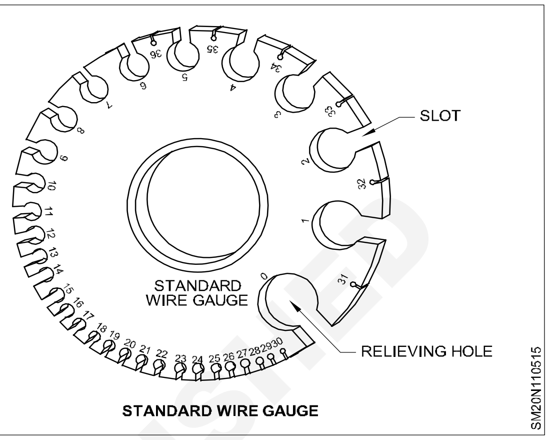


Fig 6

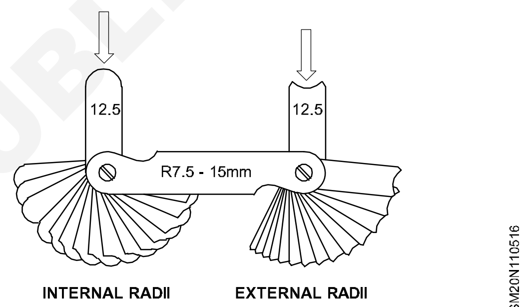


Fig 7

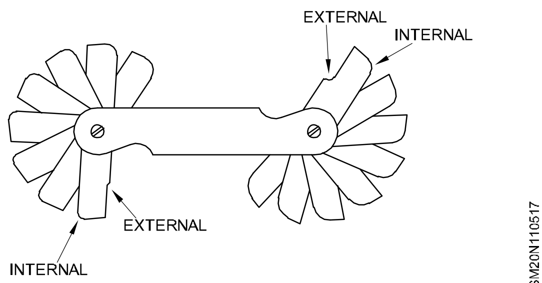
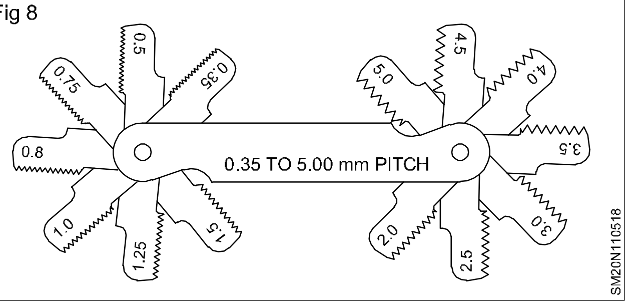


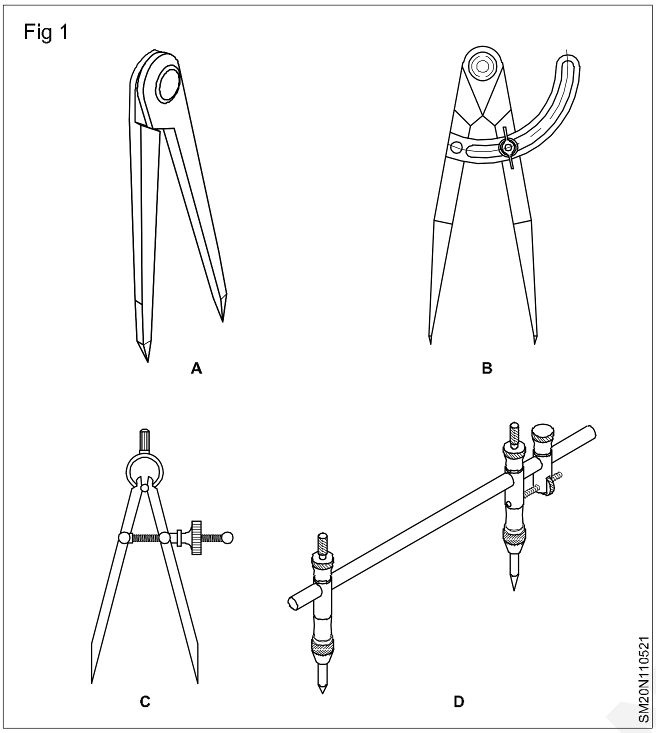
Fig 8

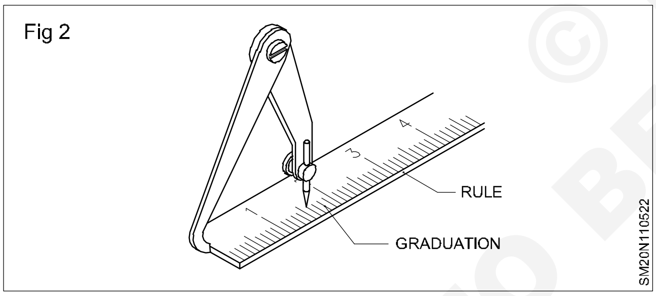


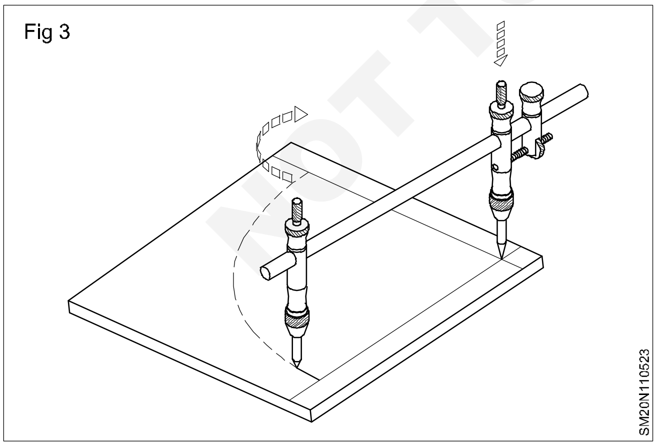
TOOLS & EQUIPMENT

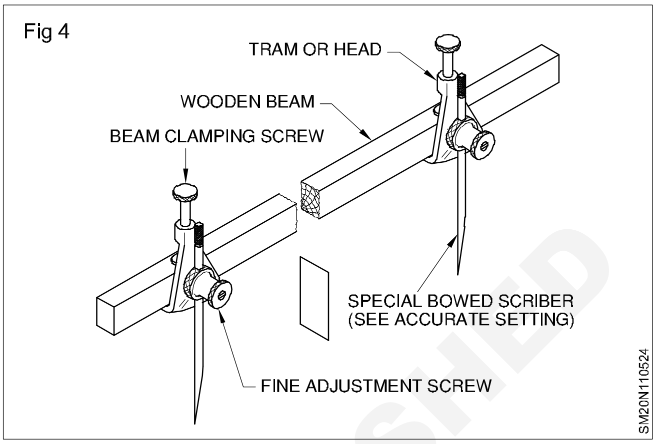
FOR SHEET METALWORKER

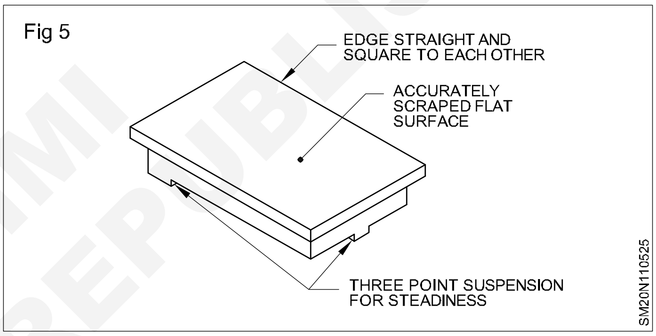
MARKING TOOLS

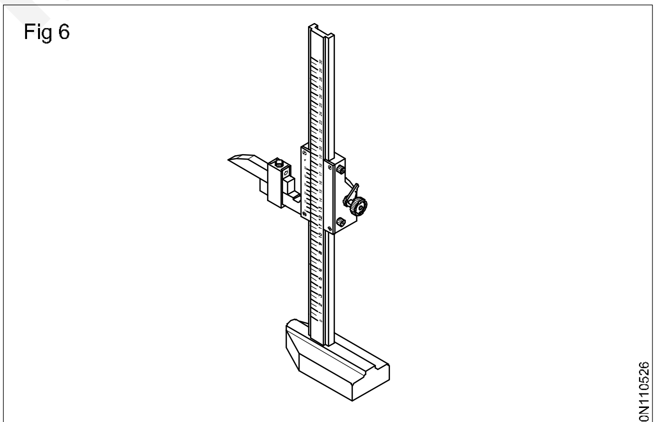












VERNIER HEIGHT GUAGE

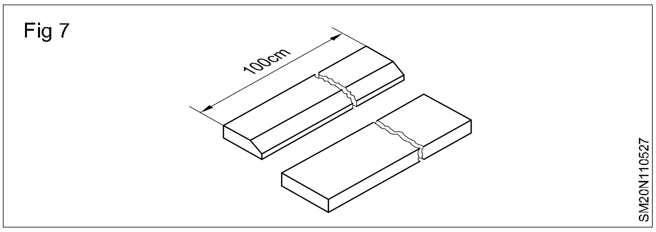


Fig 8

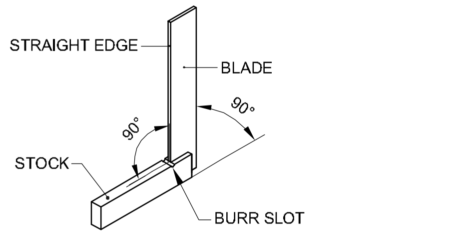
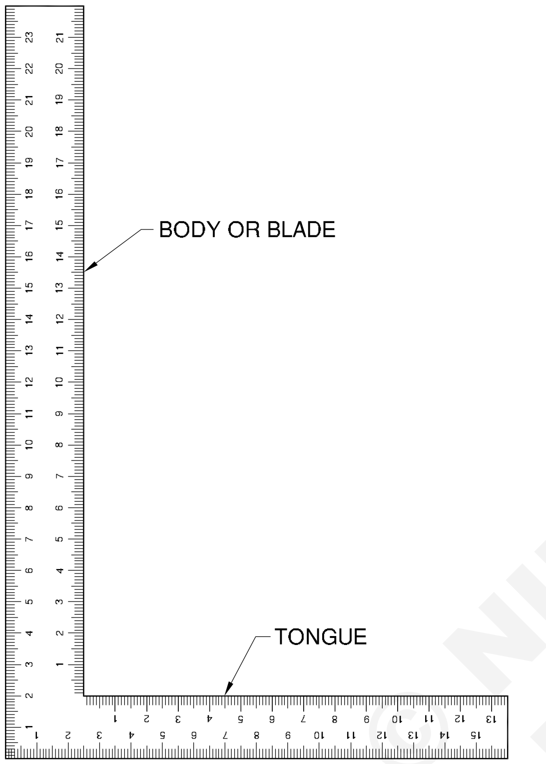
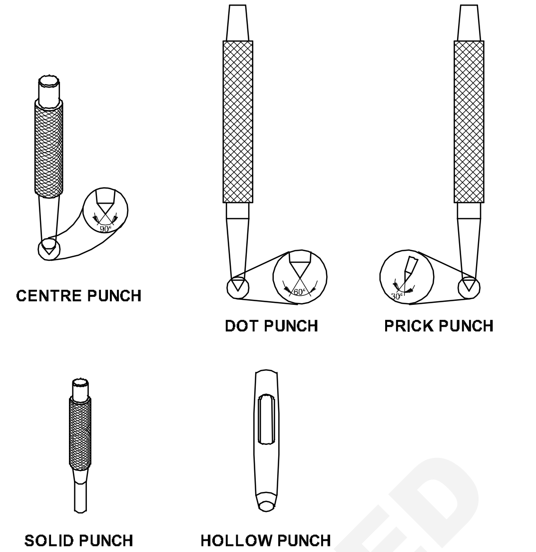


Fig 9



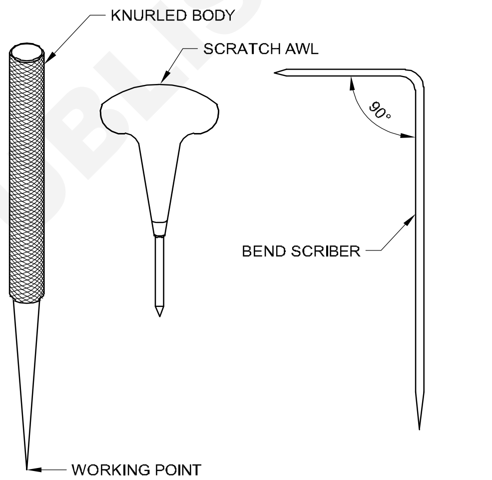
TINMAN'S SQUARE

Fig 10



CENTRE PUNCH

Fig 11



STRAIGHT SCRIBER

TOOLS & EQUIPMENT
FOR SHEET METALWORKER.

PRODUCTION TOOLS

Fig 1

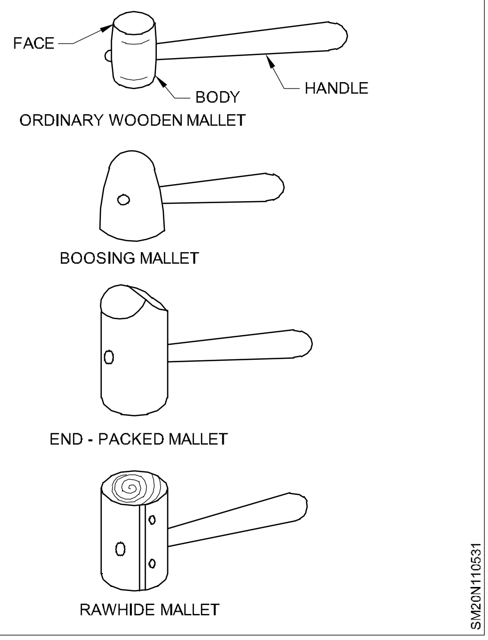


Fig 2

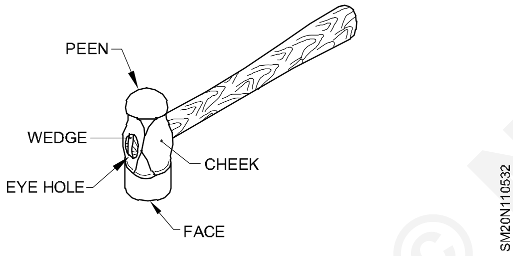


Fig 3

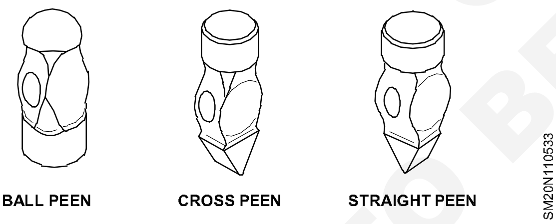


Fig 4

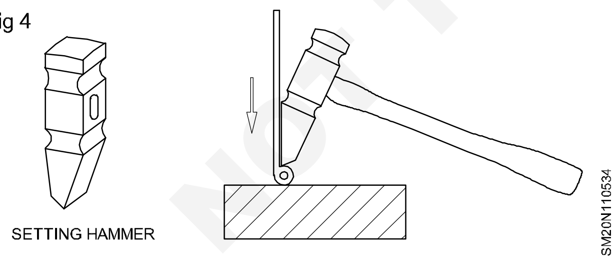


Fig 5

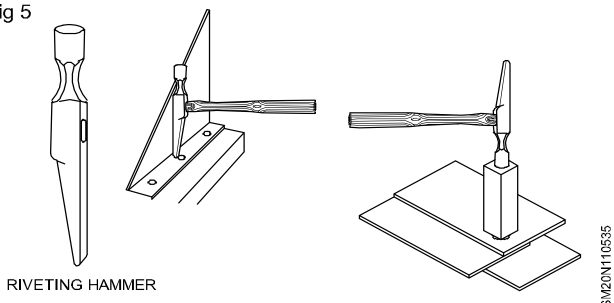


Fig 6

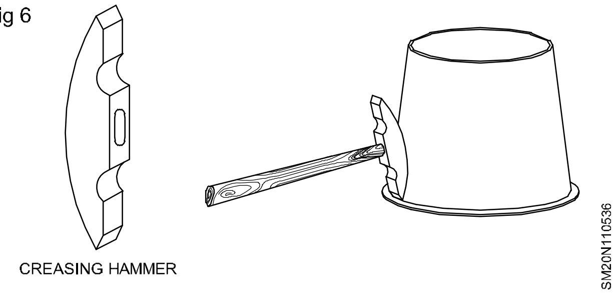


Fig 7

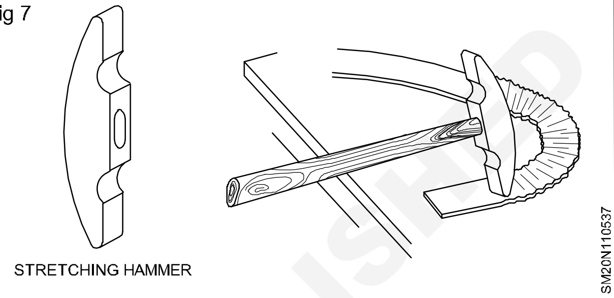


Fig 8

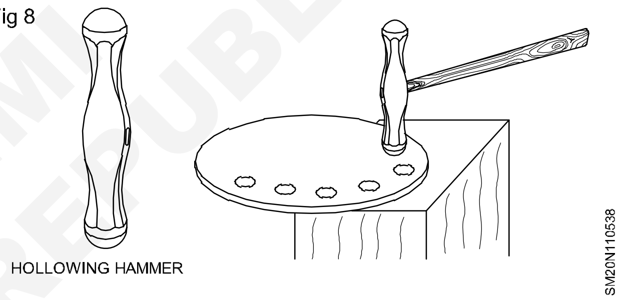


Fig 9

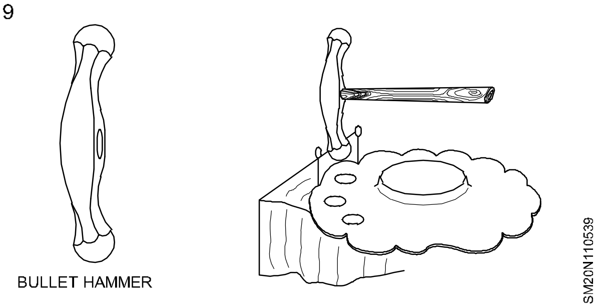


Fig 10

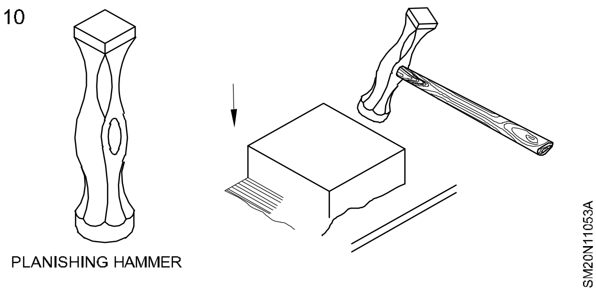
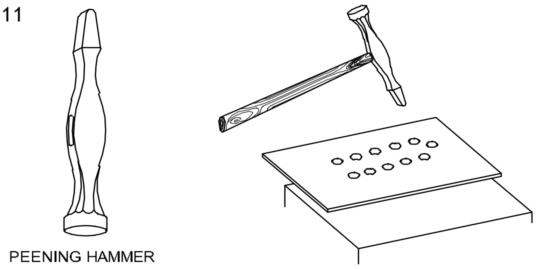


Fig 11



PEENING HAMMER

Fig 12

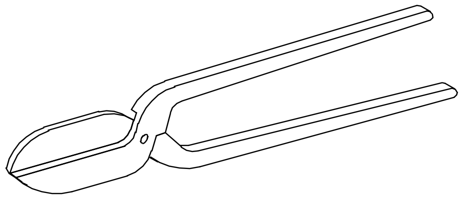
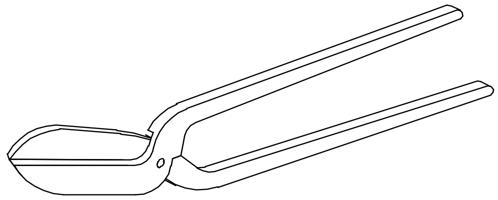
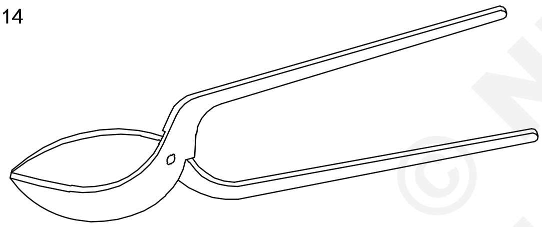


Fig 13



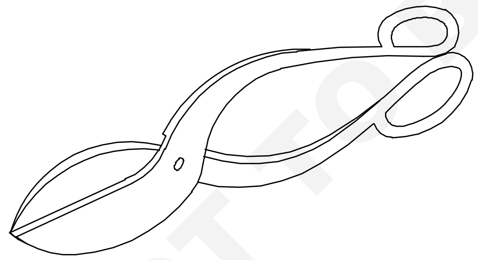
UNIVERSAL COMBINATION OR GALLOW SHEAR

Fig 14



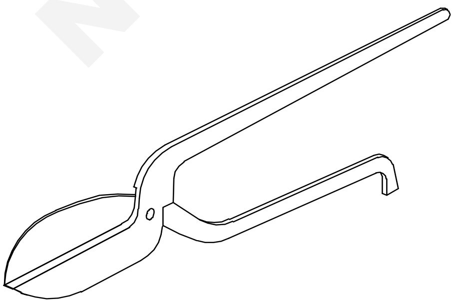
PIPE SHEAR

Fig 15



SCOTCH SHEAR

Fig 16



BLOCK SHEAR

Fig 17

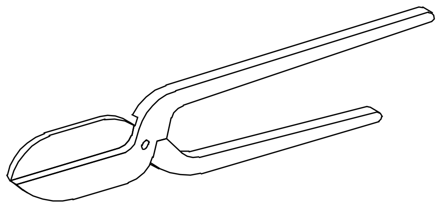


Fig 18

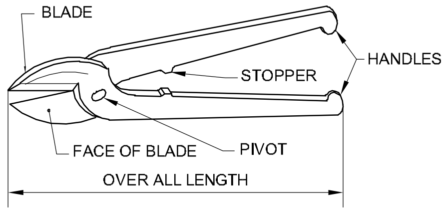


Fig 19

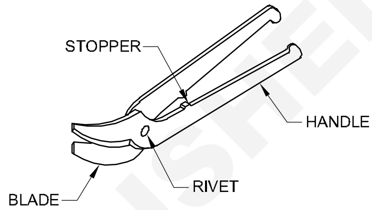
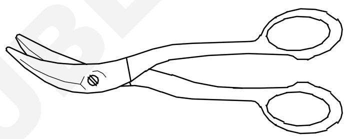
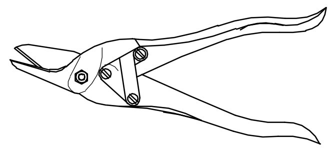


Fig 20



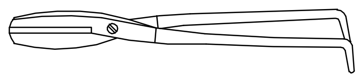
HAWK-BILLED SHEAR

Fig 21



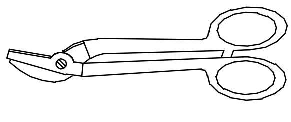
AVIATION SHEAR

Fig 22



BENCH SHEAR

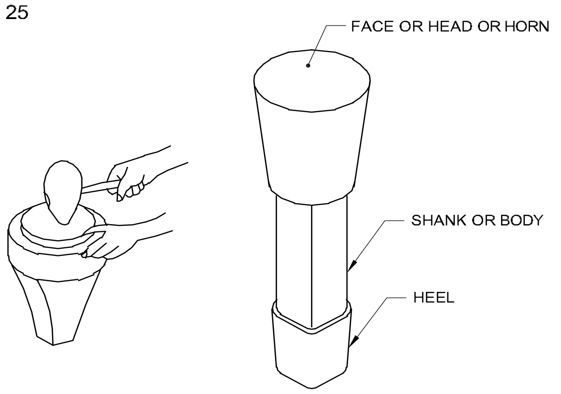
Fig 23



DOUBLE CUTTING SHEAR

Fig 24

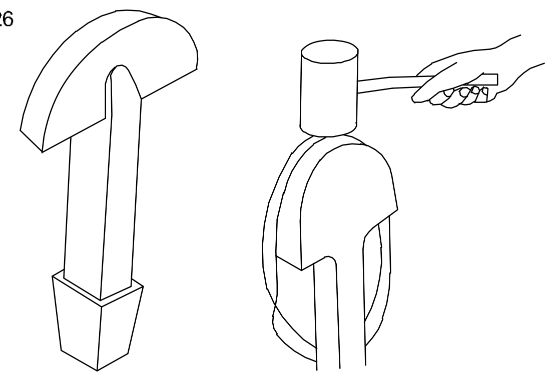
Fig 25



ROUND BOTTOM STAKE

SM20N11053P

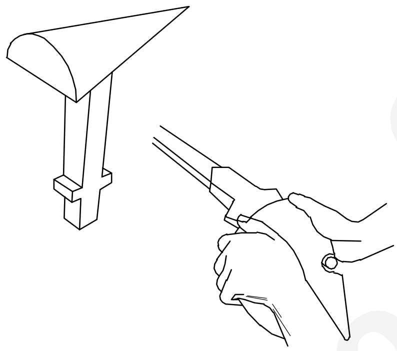
Fig 26



HALF MOON STAKE

SM20N11053Q

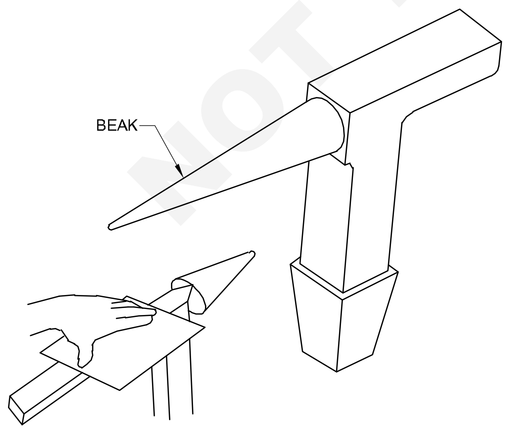
Fig 27



FUNNEL STAKE

SM20N11053R

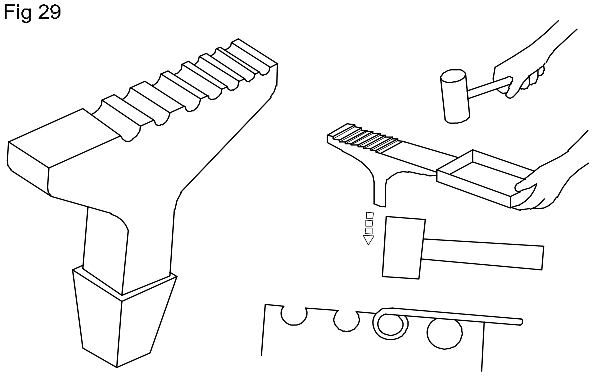
Fig 28



BEAK OR BICKIRON

SM20N11053S

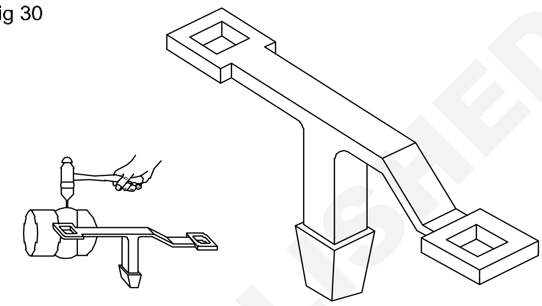
Fig 29



CREASING IRON

SM20N11053T

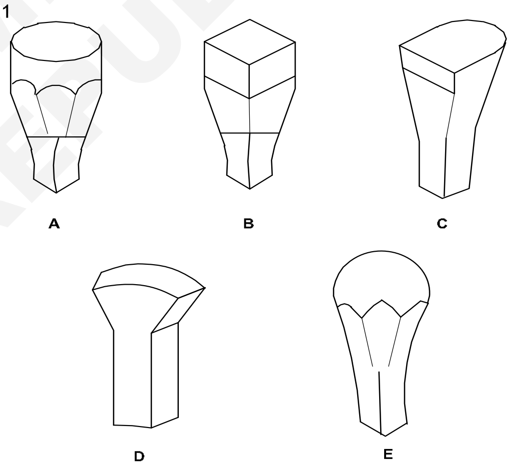
Fig 30



TINMAN'S HORSE

SM20N11053U

Fig 31

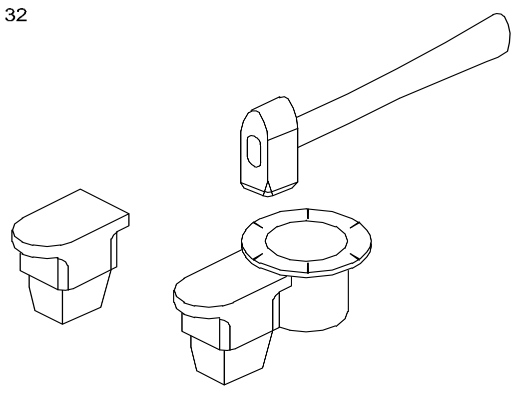


A - ROUND BOTTOM
B - ANVIL
C - ANVIL
D - HALF MOON
E - ROUND HEAD

HEADS

SM20N11053V

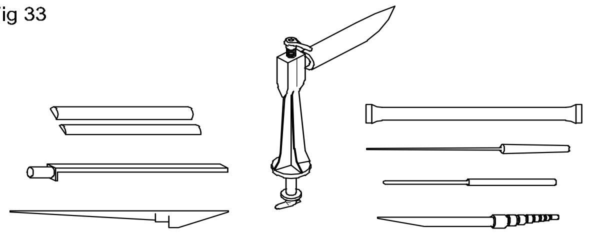
Fig 32



TINMAN'S ANVIL

SM20N11053W

Fig 33



UNIVERSAL STAKE HOLDER

Fig 34

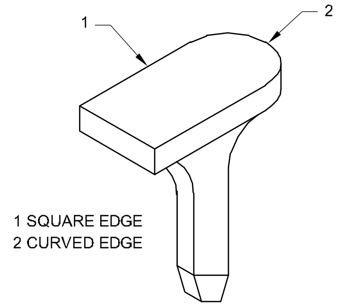
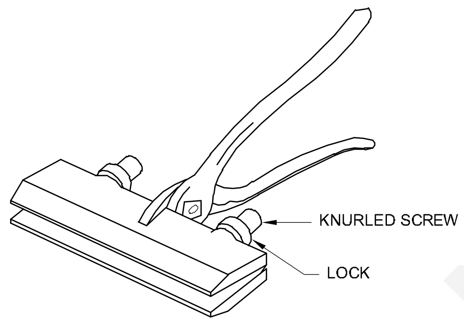
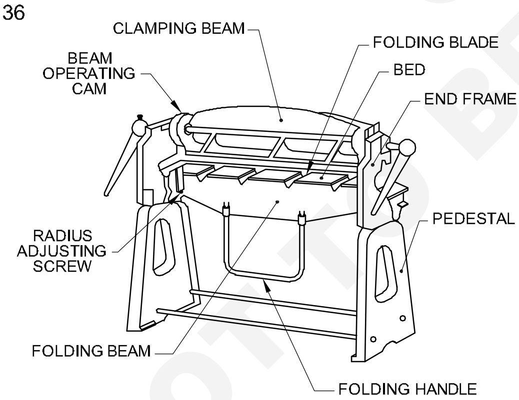


Fig 35



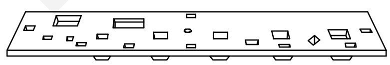
HAND SEAMER

Fig 36



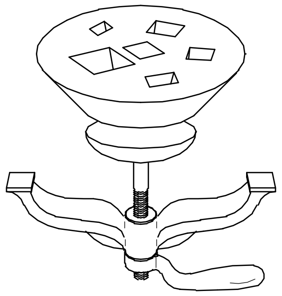
BAR FOLDER

Fig 37



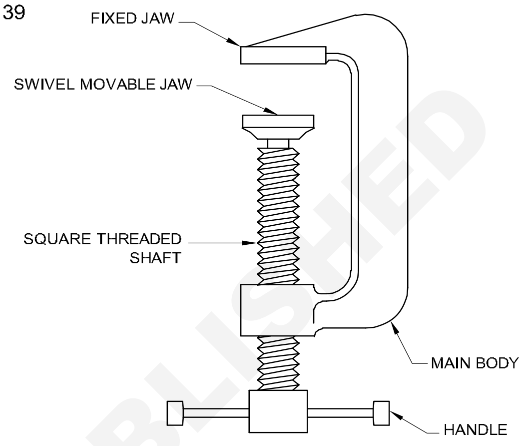
BENCH PLATE

Fig 38



REVOLVING BENCH PLATE

Fig 39



'C' CLAMP

Fig 40

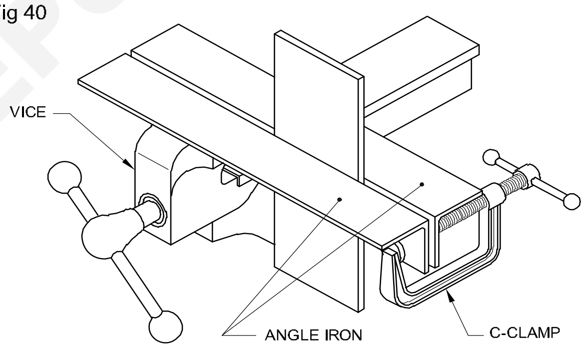
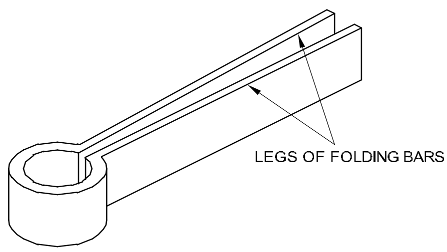
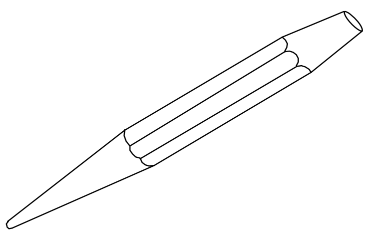


Fig 41



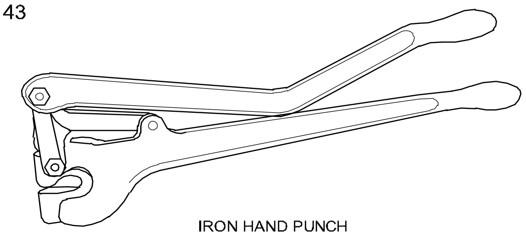
FOLDING BARS

Fig 42



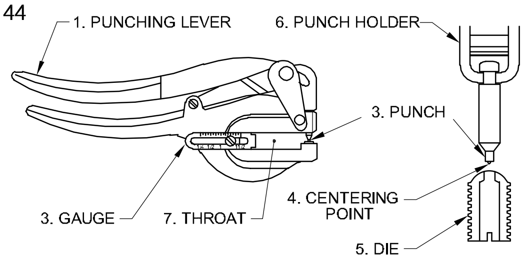
SOLID PUNCH

Fig 43



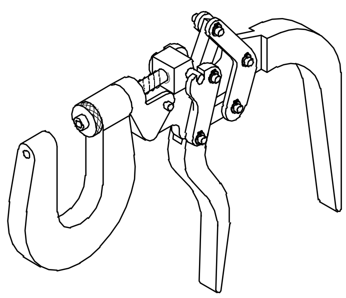
IRON HAND PUNCH

Fig 44



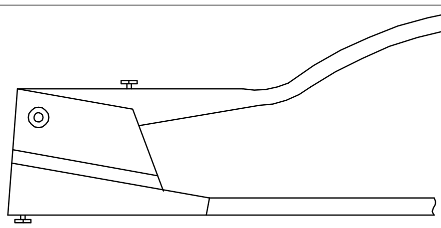
THE HAND LEVER PUNCH

Fig 45



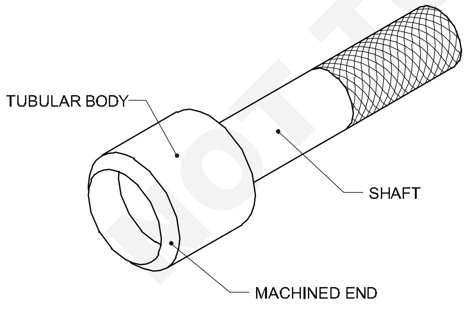
C CLAMP

Fig 46



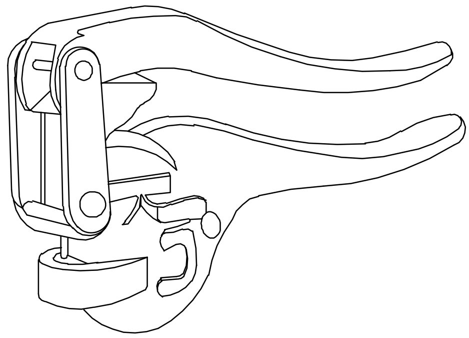
SOLID PUNCH

Fig 47



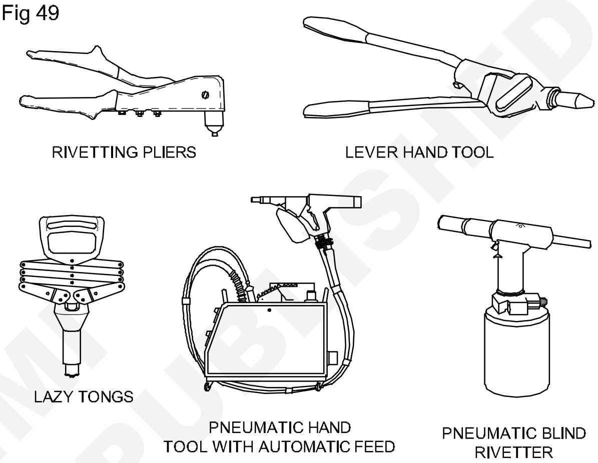
HOLLOW PUNCH

Fig 48



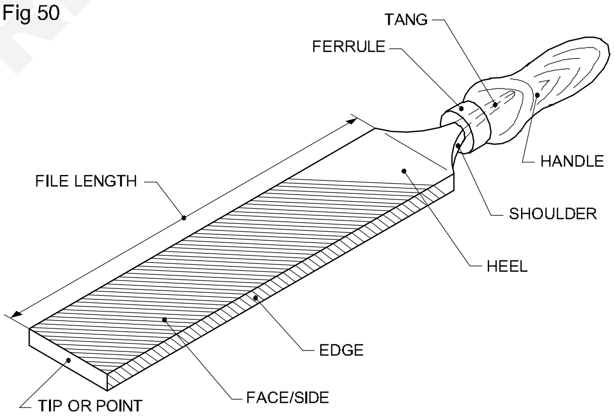
TINNER'S HAND PUNCH

Fig 49



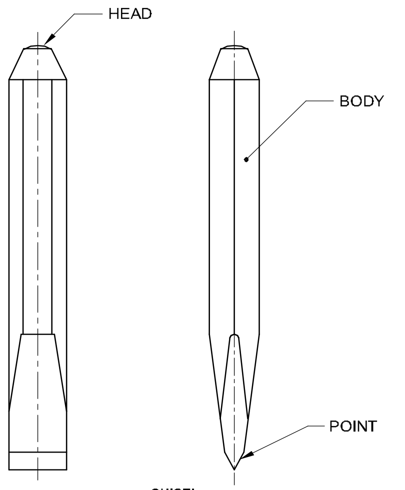
BLIND RIVETTING EQUIPMENT

Fig 50



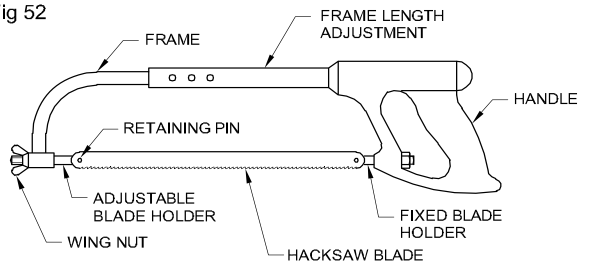
FILE

Fig 51



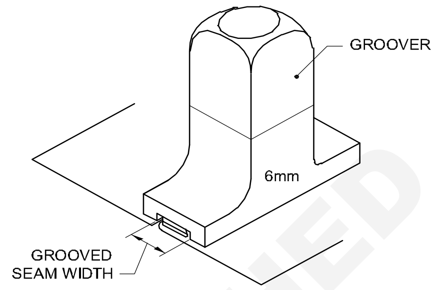
CHISEL

Fig 52



HACK - SAW FRAME UNIT BLADE

Fig 53



SIZE OF GROOVE & SEAM

TOOLS & EQUIPMENT

FOR SHEET METAL WORKER

MACHINES AND APPLIANCES TOOLS

Fig 1

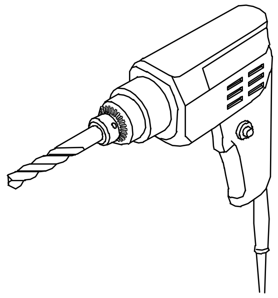
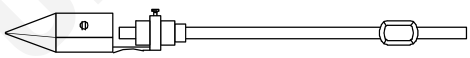
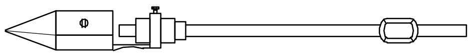


Fig 4



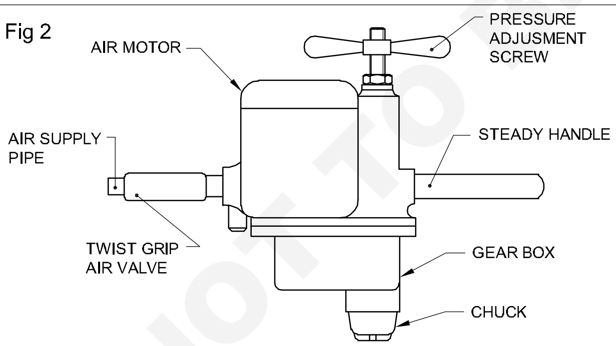
GAS HEATED SOLDERING COPPER BIT

Fig 4



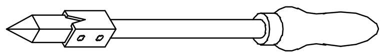
GAS HEATED SOLDERING COPPER BIT

Fig 2



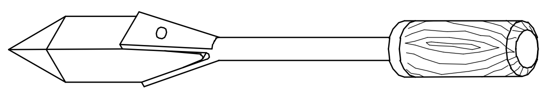
DRILLING MACHINE

Fig 5



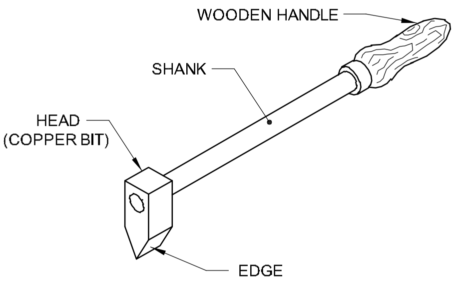
STRAIGHT SOLDERING COPPER WITH HANDLE

Fig 6



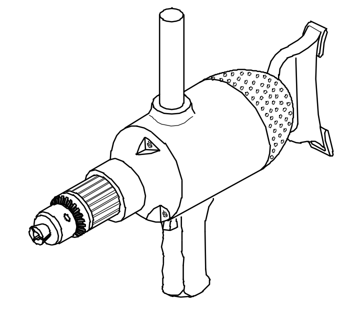
ADJUSTABLE SOLDERING BIT

Fig 3



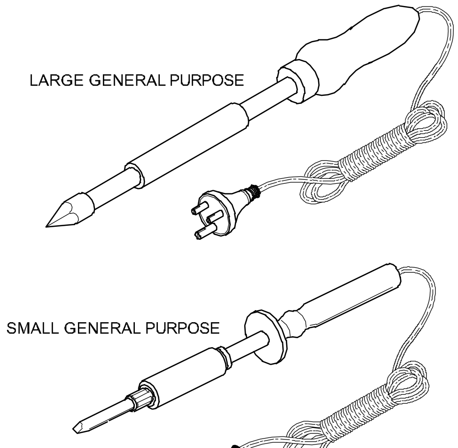
SOLDERING IRON (HATCHET TYPE)

Fig 8



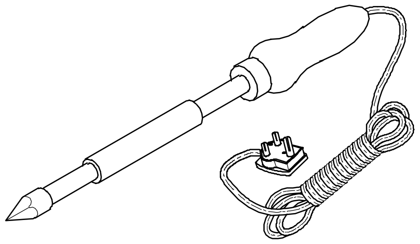
HAND DRILLING MACHINE

Fig 9



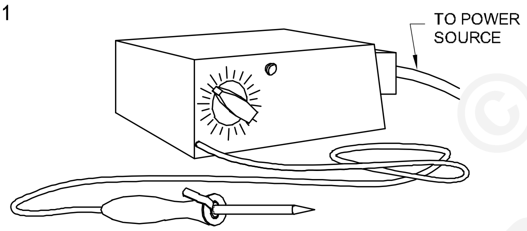
SELECT THE APPROPRIATE SOLDERING IRON

Fig 10



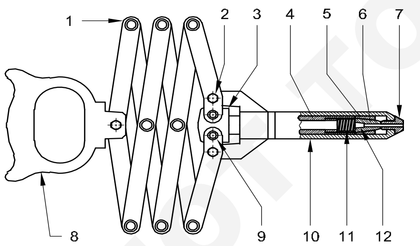
ELECTRIC COPPER SOLDERING

Fig 11



TRANSFORMER TYPE ELECTRIC SOLDERING IRON

Fig 12



PARTS LIST OF LAZY TONG

NO.	DESCRIPTION	QTY.
1	LINKAGES	1 SET
2	LOCK NUT	2
3	YOKE	1
4	POWER COUPLING	1
5	JAW CASE	1
6	JAWS	1 SET
7	NOSE PIECE	1
8	HANDLE	1
9	FULCRUM PINS	2
10	BODY	1
11	JAW PUSHER SPRING	1
12	JAW PUSHER	1

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Fig 13

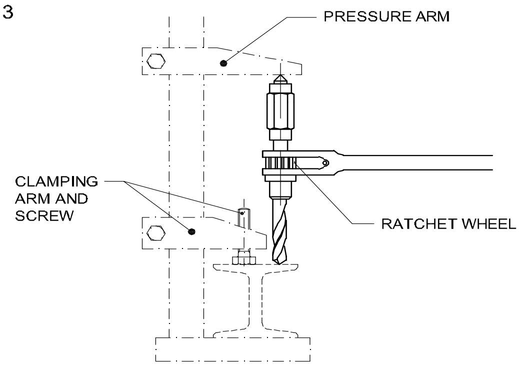
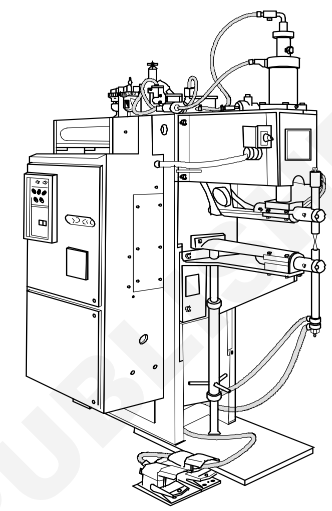
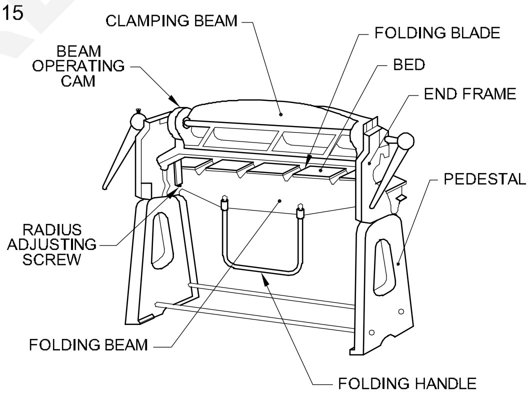


Fig 14



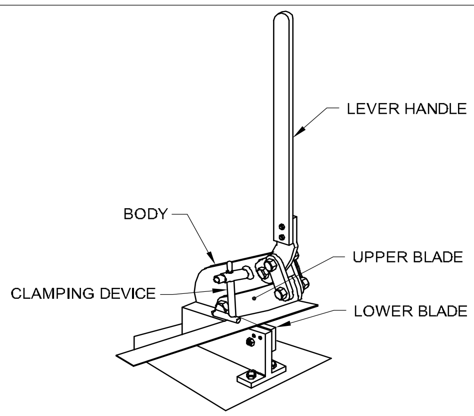
PEDESTAL TYPE SPOT WELDER

Fig 15



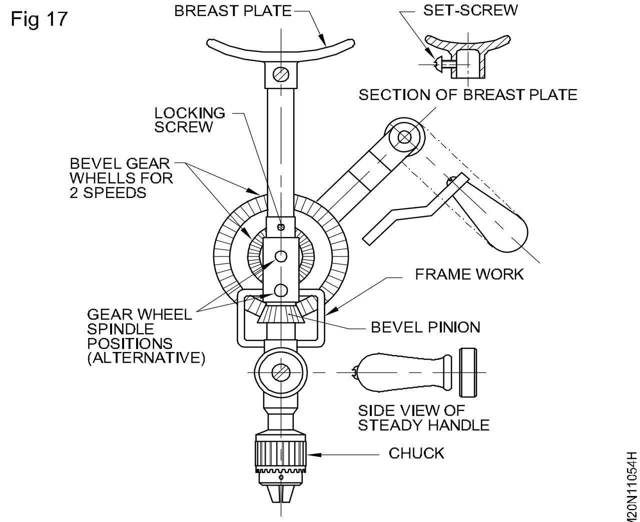
SHEARING MACHINE

Fig 16



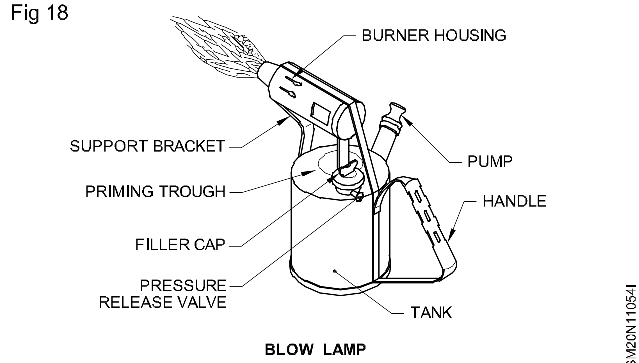
HAND SHEARING MACHINE

Fig 17



MANUAL HAND DRILLING MACHINE

Fig 18



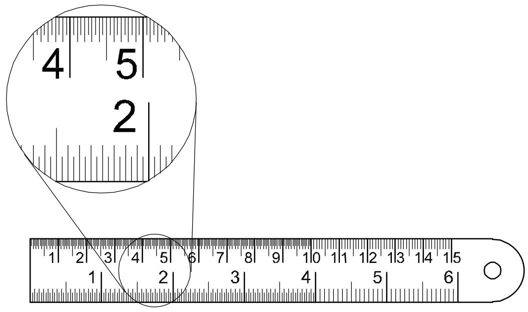
BLOW LAMP

Measuring and Marking Tool

Objectives: At the end of this lesson you shall be able to
- **state the purpose of a steel rule**
- **state the precautions to be followed while using a steel rule.**

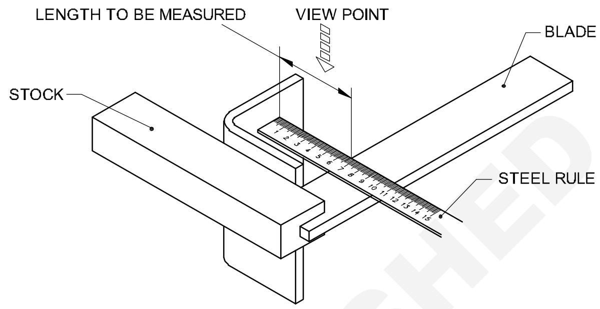
Engineer's steel rules (Fig 1) are used to measure the linear dimensions of workpieces. Steel rules are made of spring steel or stainless steel. These rules are available in lengths of 150 mm, 300 mm and 600 mm and 1000 mm. The reading accuracy of the steel rule is 0.5 mm.

Fig 1



For accurate reading it is necessary to read vertically to avoid errors arising out of parallax. (Fig 2)

Fig 2



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

Do not place a steel rule with other cutting tools.

Apply a thin film of oil when not in use.

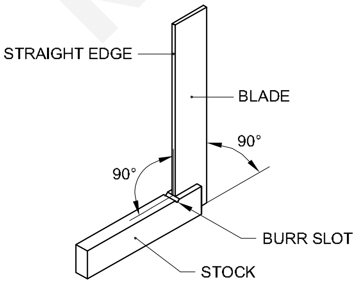
Try square

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 the squareness of a surface and the flatness of surfaces.

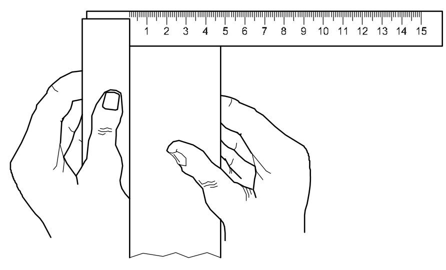
The accuracy of measurement by a try-square is about 0.002 mm per 10 mm length, which is accurate enough for most workshop purpose. The try-square has a blade with parallel surfaces. This blade is fixed to the stock at 90^0. Burr slot is provided on the stock at meeting point of blade to accommodate the burr, if present on the component, to avoid inaccuracy in measuring squareness.

Fig 1



Uses: The try square is used to check the squareness of a sheet. (Fig 2)

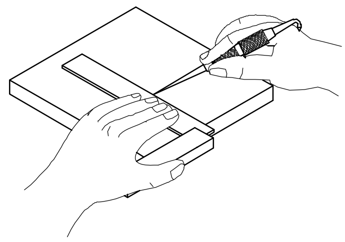
Fig 2



To mark lines at 90° to the edges of a workpiece. (Fig 3)

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

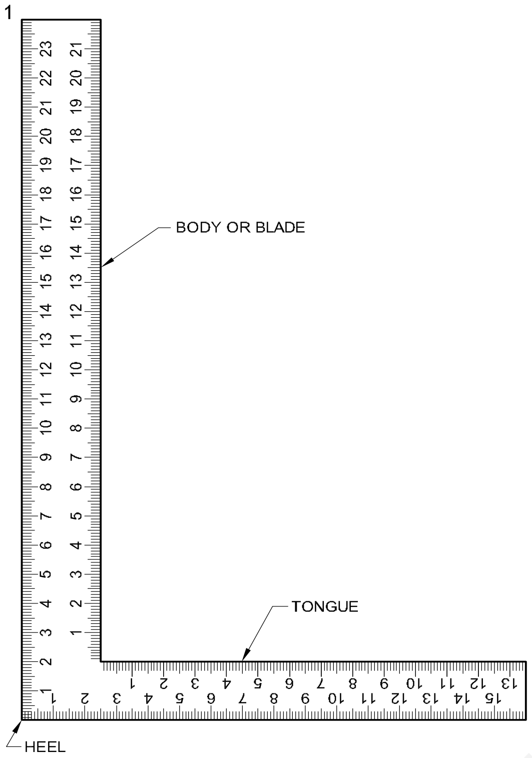
Fig 3



Tinman's "L" square

Objectives: At the end of this lesson you shall be able to
- **state the use of the Tinman's "L" square.**

Fig 1



A Tinman's "L" square is an "L" shaped piece of hardened steel with graduation marks on the edges of the Tongue and Body or blade (Fig.1). It is used for marking in the perpendicular direction to any base line and to check the perpendicularity.

The short arm of the "L" square is called the tongue and the long arm is called the body or blade and the corner is called the heel. The angle between the tongue and the body of the "L" square is 90°.

The size of the "L" square is specified by the length of the body and the tongue.

It is also called as Tinman's square.

Straight edge

Objectives: At the end of this lesson you shall be able to
- **state the use of straight edge**
- **list the types of straight edge.**

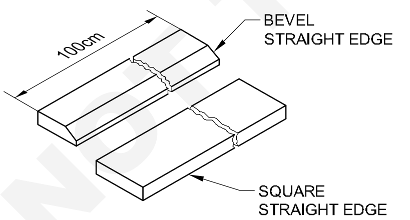
Straight edge: Straight edge is a flat bar of steel.

It is used to mark straight lines on a sheet metal surface.

Types (Fig.1):

Straight edges are available in two types.

Fig 1



1 Square straight edges

2 Bevel straight edge.

Straight edges are available in 600 mm, 1 to 3 mtrs in length. While marking with the help of a straight edge, place the straight edge on the sheet and hold it by your left hand.

Calipers

Objectives: At the end of this lesson you shall be able to
- **state the commonly used calipers**
- **compare the features of firm joint and spring joint calipers**
- **state the advantage of spring joint calipers over firm joint calipers.**

Calipers are simple indirect measuring instruments used to transfer measurements from steel rule to object and vice versa.

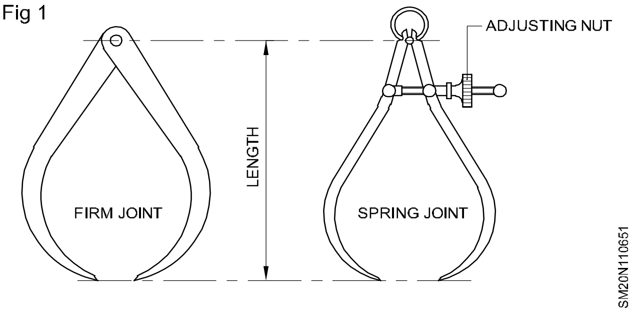
Calipers are of different types depending on the type of joint and the shape of leg.

TYPES OF JOINTS

– Firm joint calipers (Fig 1a)

– Spring joint calipers (Fig 1b)

Fig 1



Firm joint calipers : 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.

Spring joint calipers : 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 or touch". While measuring the job you should get the feel when the legs are just touching the surfaces.

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. (Fig 2) The calipers used for internal measurements are known as inside calipers. (Fig 3). Calipers are used along with steel rules, and the accuracy is limited to 0.5 mm. The parallelism of jobs can also be checked using calipers.

Fig 2

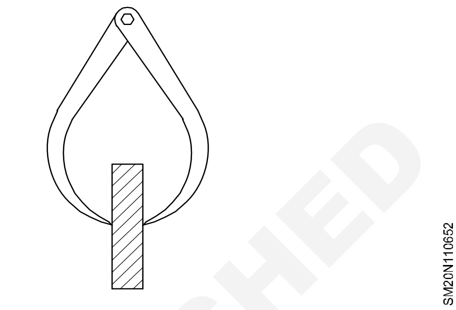
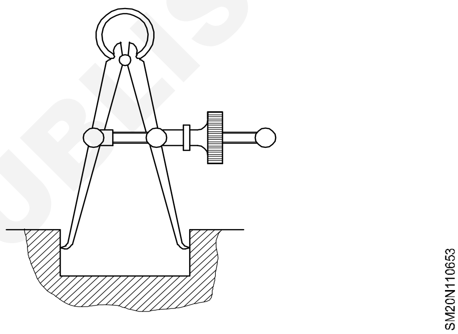


Fig 3



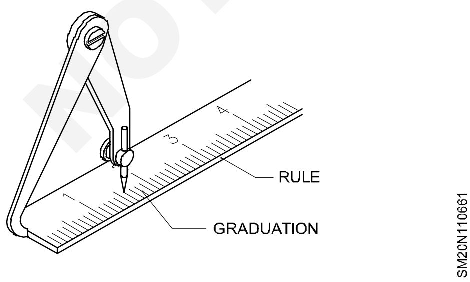
Jenny Calipers

Objectives: At the end of this lesson you shall be able to
- **identify a jenny caliper**
- **state the constructional features of a jenny caliper**
- **state the uses of a jenny caliper**
- **state safety, care and maintenance while using a jenny caliper.**

Jenny calipers are non-precision indirect marking tools.

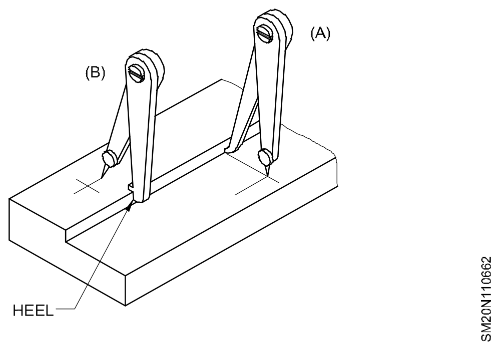
They are also known as odd leg calipers, leg and point calipers and Hermo prodite calipers. (Fig 1)

Fig 1



Constructions: These calipers are available with the usual bent leg or with a heel. (Fig 2)

Fig 2



These calipers have one leg bent and the other with an adjustable scriber point. In some calipers, other leg is fixed and pointed. These legs are joined together by means of a rivet to make the joint firm. These calipers are available in sizes of 150 mm, 200 mm, 250 mm and 300 mm.

Uses: These calipers are used for

1 Marking lines parallel to the inside and outside edges. (Fig 2)

2 Locating the centre of round bars. (Fig 3)

3 Scribing lines parallel to the curved edges. (Fig 4)

Fig 3

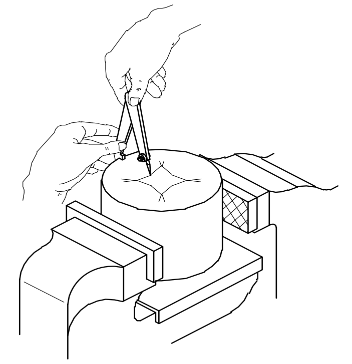


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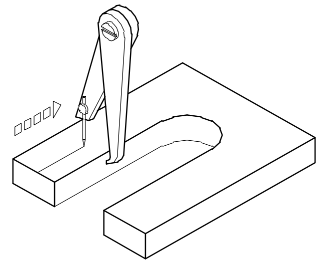
Fig 4



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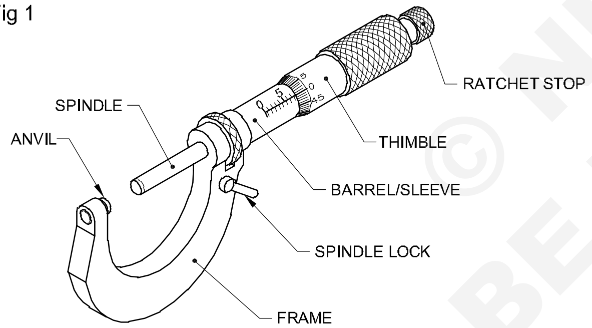
Outside Micrometers

Objectives: At the end of this lesson you shall be able to
- **identify the parts of an outside micrometer**
- **state the functions of the main parts of an outside micrometer.**

A micrometer is a precision instrument used to measure a job, generally within an accuracy of 0.01 mm.

Fig 1



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Micrometers used to take the outside measurements are known as outside micrometers. (Fig 1)

The parts of a micrometer are listed here.

Frame: The frame is made of drop-forged steel or malleable cast iron. All other parts of he micrometer are attached to this.

Barrel/Sleeve: The barrel or sleeve is fixed to the frame. The datum line and graduations are marked on this.

Thimble: On the bevelled surface of the thimble also, the graduation is marked. The spindle is attached to this.

Spindle: One end of the spindle is the measuring face. The other end is threaded and passed through a nut. The threaded mechanism allows for the forward and backward movement of the spindle.

Anvil: The anvil is one of the measuring faces which is fitted on the micrometer frame. It is made of alloy steel and finished to a perfectly flat surface.

Spindle lock nut: The spindle lock nut is used to lock the spindle at a desired position.

Ratchet stop: The ratchet stop ensures a uniform pressure between the measuring surfaces.

Graduations of metric outside micrometer

Objectives: At the end of this lesson you shall be able to
- **state the principle of a micrometer**
- **determine the least count of an outside micrometer.**

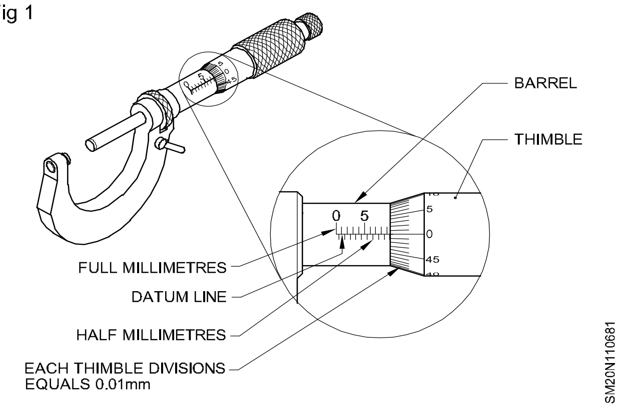
Working principle: The micrometer works on the principle of screw and nut. The longitudinal movement of the spindle during one rotation is equal to the pitch of the screw. The movement of the spindle to the distance of he pitch or its fractions can be accurately measured on the barrel and thimble.

Graduations: In metric micrometers the pitch of the spindle thread is 0.5 mm.

Thereby, in one rotation of the thimble, the spindle advances by 0.5 mm.

On the barrel a 25 mm long datum line is marked. This line is further graduated to millimetres and half millimeters (i.e

Fig 1



1 mm & 0.5 mm). The graduations are numbered as 0,5,10,15,20 & 25 mm.

The circumference of the bevel edge of the thimble is graduated into 50 divisions and marked 0-5-10-15....45-50 in a clockwise direction.

The distance moved by the spindle during one rotation of the thimble is 0.5 mm.

Movement of one division of the thimble = 0.5 x 1/50 = 0.01 mm.

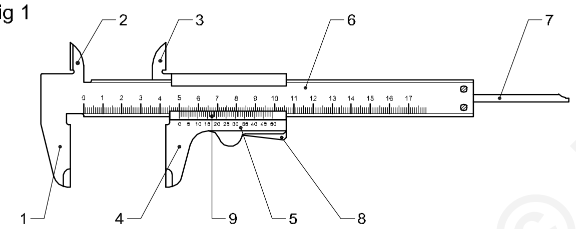
Accuracy or least count of a metric outside micrometer is 0.01 mm.

Vernier calipers

Objectives: At the end of this lesson you shall be able to
- **identify the parts of a vernier caliper**
- **state the constructional features of a vernier caliper**
- **state the uses of vernier calipers.**

A vernier caliper is a precision measuring instrument. It is used to measure up to an accuracy of 0.02 mm. (Fig 1)

Fig 1



The following are the parts of a vernier caliper. (Number as per Fig 1)

Fixed jaw (Part 1 and 2) **:** Fixed jaws are part of the main scale. One jaw is used for taking external measurements and the other for internal measurements.

Movable jaw (Part 3 & 4) **:** Movable jaws are part of the vernier slide. Two jaws No. 1 and 4 are used for external measurements (Fig 2) and the other jaws 2 & 3 are for internal measurements. (Fig 3)

Vernier slide (Part 5) **:** A vernier slide moves over the beam and can be set in any position by means of a spring- loaded **thumb lever** (Part 8).

Fig 2

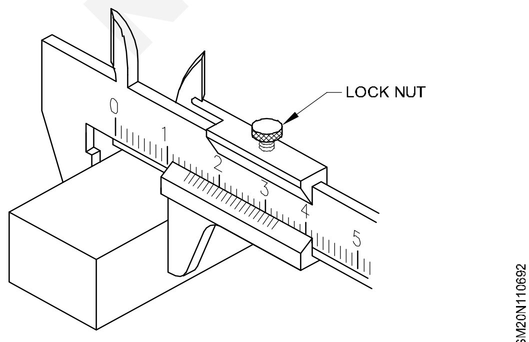
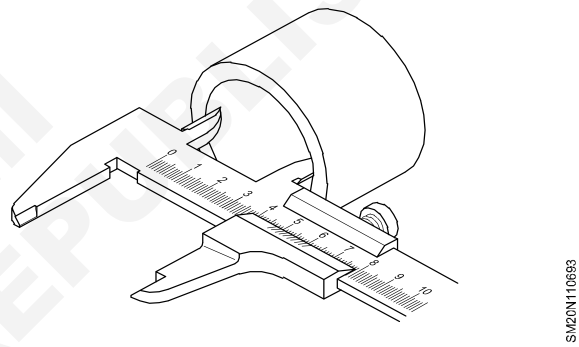


Fig 3



Beam (Part 6)**:** The vernier slide, and the depth bar attached to it, slide over the beam. The graduations on the beam are called the **main scale divisions.**

Depth bar (Part 7) **:** The depth bar is attached to the vernier slide and is used for depth measurements.

Vernier scale (Part 9) **:** The vernier scale is the graduation marked on the vernier slide. The divisions of this scale are called vernier divisions.

Lock nut : After taking the measurement of a job the lock nut will be tightened. So that the vernier slide will not move and the dimension will not be changed.

Vernier calipers are available in different sizes 150 mm, 225 mm, 900 mm, and 1200 mm. The selection of the size depends on the measurements to be taken. Vernier calipers are precision instruments and extreme care should be taken while handling them.

Avoid parallax error while reading. Right method is shown for external measurement (Fig 4) and internal measurement. (Fig 5)

Never use a vernier caliper for any purpose other than measuring. Vernier calipers should be used only to measure machined or filed surfaces.

They should never be mixed with any other tools.

Clean the instrument after use. Apply oil or grease and store it in a box.

Fig 4

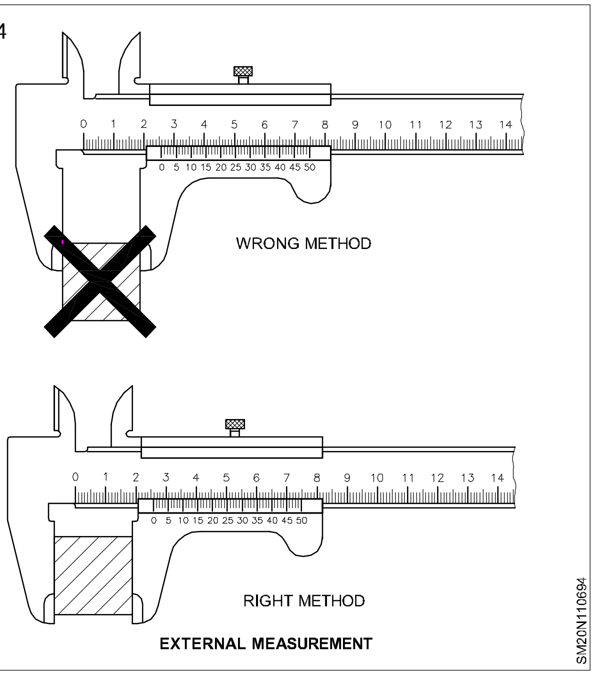
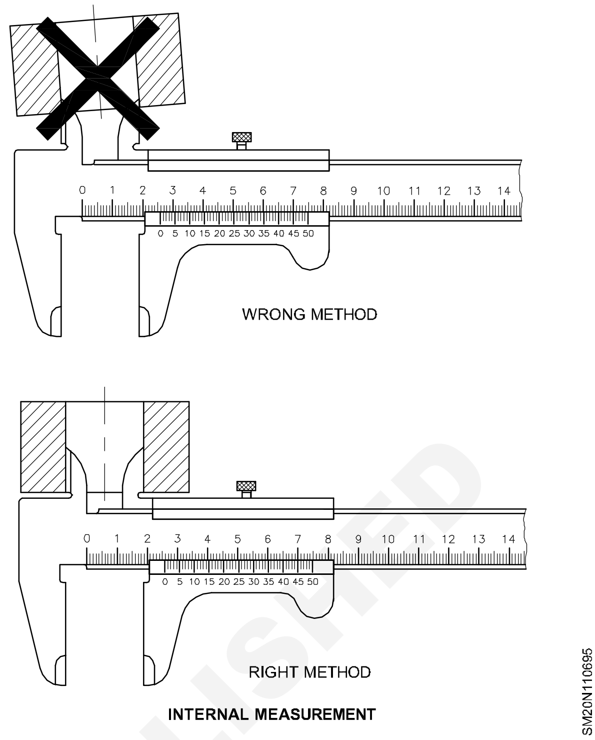


Fig 5



Vernier Height Gauge

Objectives: At the end of this lesson you shall be able to
- **identify the parts of a vernier height gauge**
- **state the functions of each part**
- **list out the specific uses of a vernier height gauge.**

Specific uses of a vernier height gauge: Accurate measurements are important in the layout (marking off) and in the inspection work. (Fig 1&2)

Fig 1

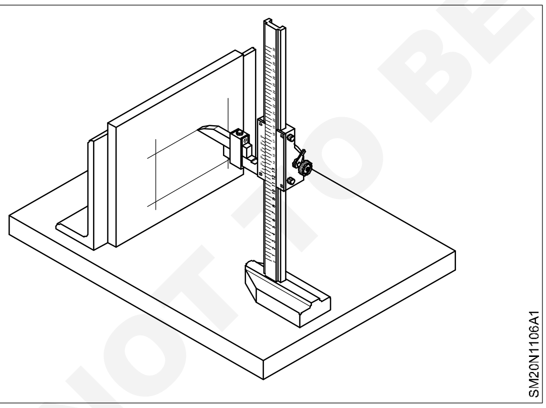
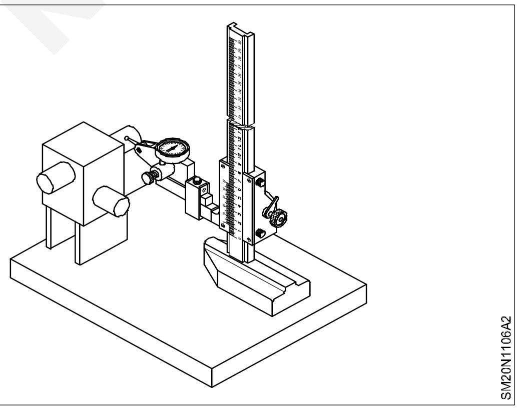


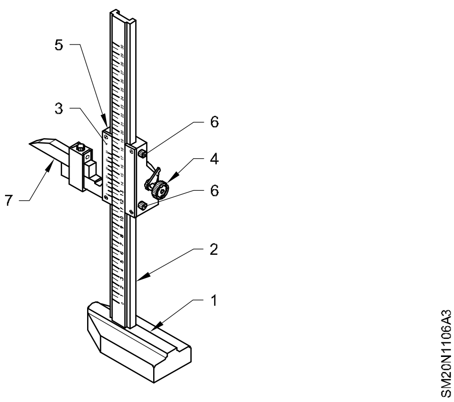
Fig 2



Vernier height gauges are particularly suitable for marking off accurate distances, and centre locations. The graduations and the readings are the same as those of a vernier caliper.

Parts and their function: Parts of a vernier height gauges and their functions are given here. (Fig 3)

Fig 3



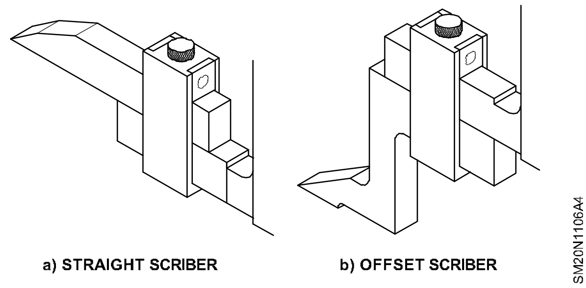
Base (1:) This is the datum from which measurements and settings are made. The underside of the base is hardened, ground and lapped.

Beam (2): This is similar to the beam scale of a vernier caliper and is attached to the base.

Vernier slide (3): This unit slides on the beam and carries the vernier plate (5) Locking screws (6), fine setting device (4) and scriber (7). Some vernier height gauges are provided with a rack and pinion arrangement for moving the slide along the beam.

Vernier height gauges are provided with both straight and offside scribers. (Fig 4)

Fig 4

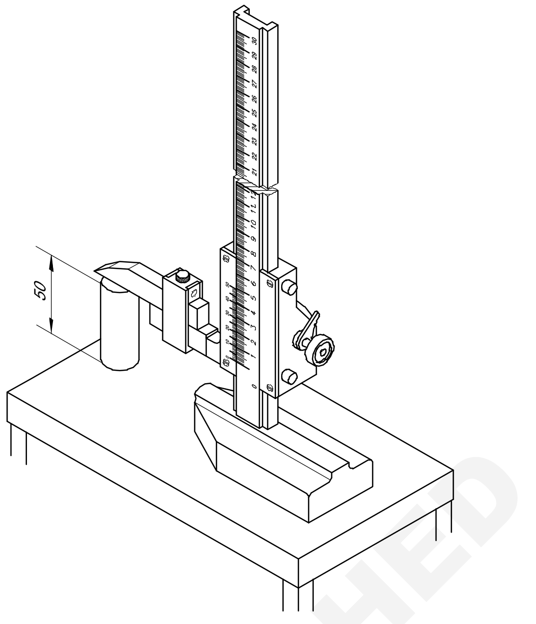


Zero setting of the vernier height gauge: The offset scriber permits the zero setting of the instrument from the datum surface.

While using a straight scriber, the zero setting of the instrument is at a level above the datum surface. In this case the zero setting is to be checked using the precision round block, supplied along with the instrument.

Vernier height gauges with which we can measure from the datum surface without the special off set scribers are also available. (Fig 5)

Fig 5



The size of the vernier height gauge is stated by the height of the beam. The most commonly used size has a beam of 300 mm height.

Vernier height gauges are used with the surface plates or other accurate flat surfaces.

Measurement of angles

Objectives: At the end of this lesson you shall be able to
- **state the units and fractional units of angles**
- **express degrees, minutes and seconds using symbols.**

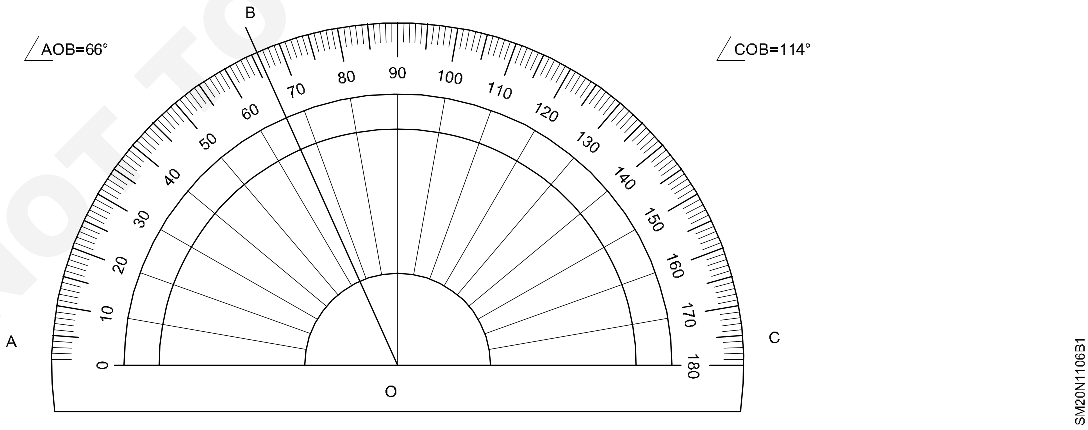
The unit of an angle

For angular measurements a complete circle is divided into 360 equal parts. Each division is called a degree (A half circle will have 180^0) (fig 1).

Subdivisions of an angle

For more precise angular measurements, one degree is further divided into 60 equal parts. This division is one MINUTE(‘). The minute is used to represent a fractional part of a degree and is written as 30^0 15’.

Fig 1



One minute is further divided into smaller units known as seconds (“). There are 60 seconds in a minute.

An angular measurement written in degrees, minutes and seconds would read as 30^0 15’20”.

Examples for angular divisions

1 complete circle 3600

1/2 circle 1800

1/4 of a circle (right angle) 900

Sub divisions 1 degree or 10 = 60 mts or 60’

1 min or 1’ = 60 secs or 60^0

Vernier Bevel Protractor

Objectives: At the end of this lesson you shall be able to
- **Identify the parts of a universal bevel protractor**
- **state the functions of each part**
- **list out the uses of a Vernier bevel protractor.**

The Vernier bevel protractor is a precision instrument meant for measuring angles precisely to an accuracy of 5 minutes. (5')

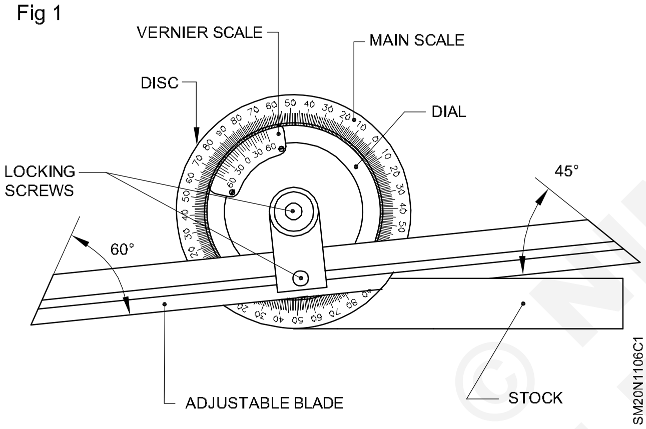
Parts of a vernier bevel protractor

The following are the parts of a vernier bevel protractor. (fig 1)

Stock

This is one of the contacting surfaces during the measurement of an angle. Preferably it should be kept in contact with the surface from which the inclination is measured.

Fig 1



Disc

The disk is an integrated part of the stock. It is circular in shape, and the edge is graduated in degrees.

Dial

It is pivoted to the disc and can be rotated through 360^0. The vernier scale of the instrument is attached to the dial. The dial is locked to the disc during reading the measurement.

Blade

This is the other contacting surface of the instrument that contacts the work during measurement, preferably the inclined surface. It is fixed to the dial with the help of the clamping lever. A parallel groove is provided in the centre of the blade to enable it to be longitudinally positioned whenever necessary.

Locking screws

Two knurled locking screws are provided, one to lock the dial to the disc. and the other to lock the blade to the dial.

All parts are made of good quality alloy steel, properly heat-treated and highly finished. A magnifying glass is sometimes fitted for clear reading of the graduations.

Uses of a vernier bevel protractor

The vernier bevel protractor is used to measure acute angles. i.e. less than 90^0 (fig 2) obtuse angles i.e. more than 90^0 (fig 3) for setting work-holding devices to angles on machine tools, work-tables etc. (fig 4 & 5).

Fig 2

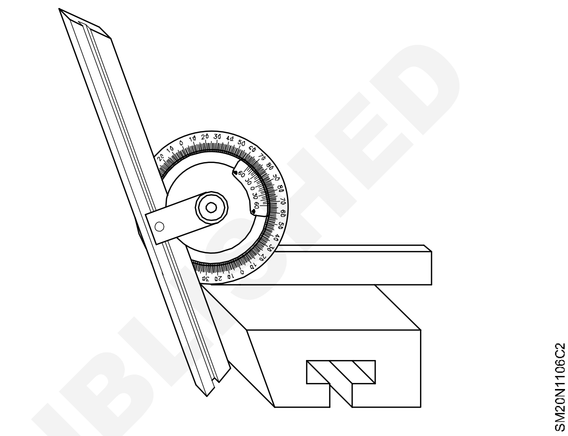


Fig 3

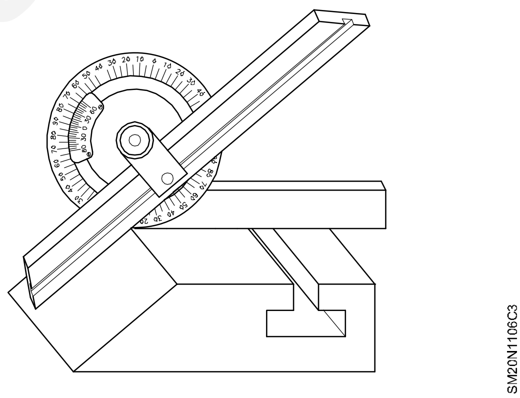


Fig 4

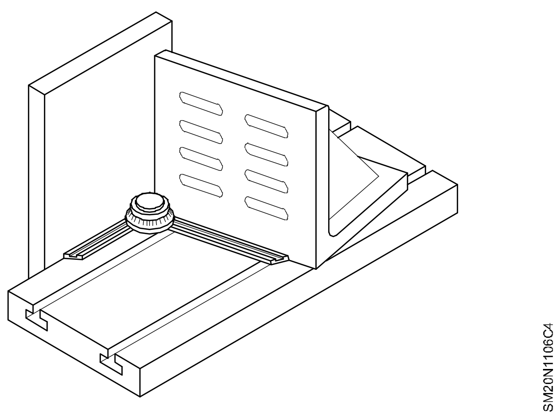
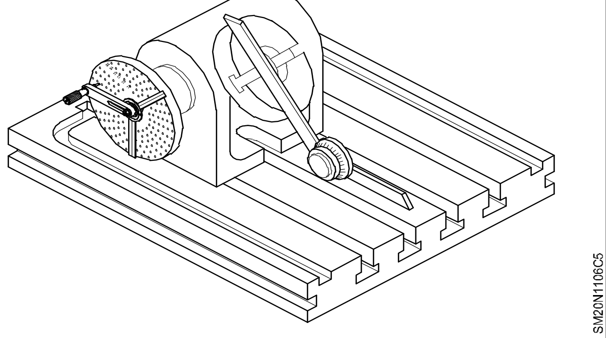


Fig 5



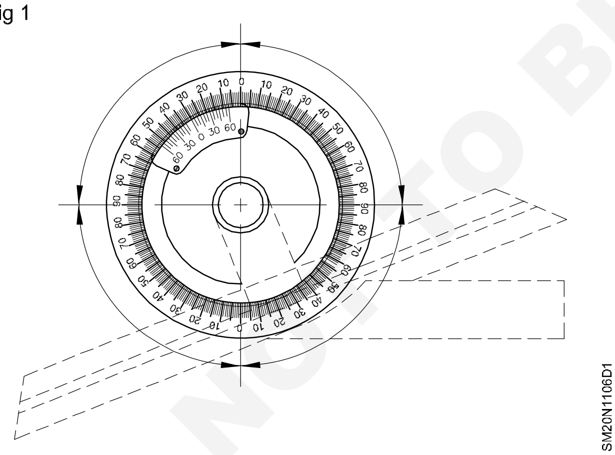
Graduations on universal bevel protractor

Objectives: At the end of this lesson you shall be able to
- **state the main scale graduations on the disc**
- **state the vernier scale graduations on the dial**
- **determine the least count of the vernier bevel protractor.**

The main scale graduations (fig 1 & 2)

For purposes of taking angular measurements, the full circumference of the disc is graduated in degrees. The 360^0 are equally divided and marked in four quardrants, from 0 degree to 90 degrees, 90 degrees to 0 degree, 0 to 90 degrees 90 degrees to 0 degreee, 0 to 90 degrees and 90 degrees to 0 degrees. Every tenth division is marked longer and numbered. Each division represents 1 degree. The graduations on the disc are known as the main scale divisions. On the dial, 23 divisions spacing of the main scale is equally divided into 12 equal parts on the vernier. Each 3rd line is marked longer and numbered as 0,15,30,45,60. This constitutes the vernier scale. Similar graduations are marked to the left of 0 also (Fig 1)

Fig 1



One vernier scale division (VSD) (Fig 2)

$$\frac{23^o}{12} = 1\frac{11^o}{12} = 1^o55'$$

The least count of the vernier bevel protractor

When the zero of the vernier scale coincides with the zero of the main scale, the first division of the vernier scale will be very close to the 2nd main scale division. (fig 2).

Hence, the least count is

2 MSD - 1 VSD

i.e. the Least count = $2^o - \frac{23^o}{12}$

$= \frac{1^o}{12} = 5'$

For any setting of the blade and stock, the reading of the acute angle and the supplementary obtuse angle is possible, and the two sets of the vernier scale graduations on the dial assist to achieve this (fig 3).

Fig 2

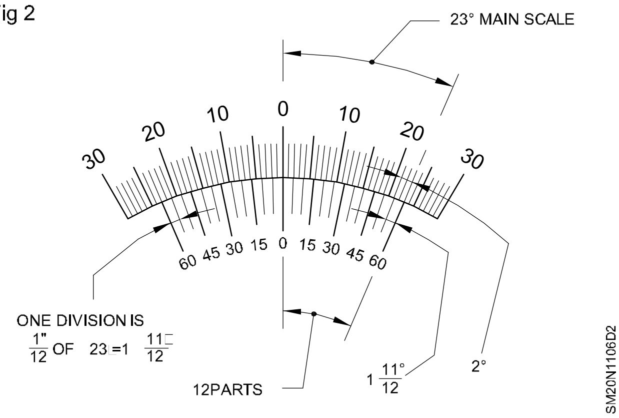
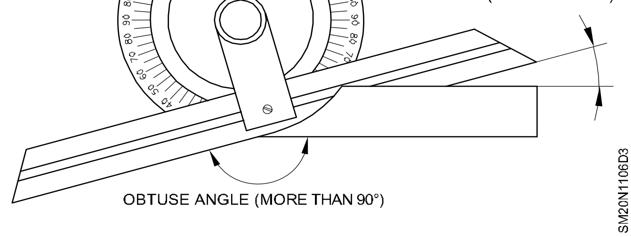


Fig 3



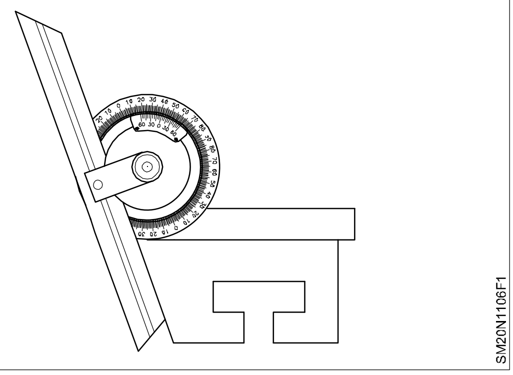
Reading of universal bevel protractor

Objectives: **At the end this lesson you shall be able to**
- **read vernier bevel protractor for acute angle setting**
- **read vernier bevel protractor for obtuse angle setting.**

For reading acute angle set up (fig 1)

First read the number of whole degrees between zero of the main scale and zero of the vernier scale (fig 2)

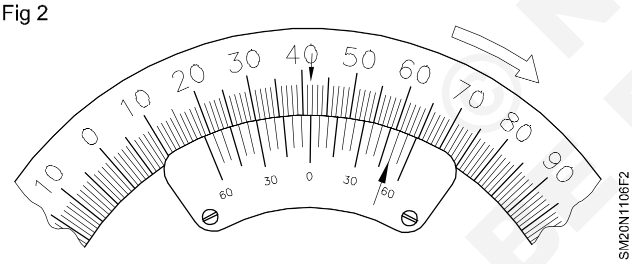
Fig 1



> **Note : the line on the vernier scale that exactly coincides with any one of the main scale divisions and determine its value in minutes.**

To take the vernier scale reading, multiply the coinciding divisions with the least count.

Fig 2



Example 10 x 5' = 50'

Total up both the readings to get the measurements = $41^0 50'$

If you read the main scale in an anticlockwise direction, read the vernier scale also in an anticlockwise direction from zero.

If you read the main scale in a clockwise direction, read the vernier scale also in a clockwise direction from zero.

For obtuse angle set up (fig 3)

The vernier scale reading is taken on the left side as indicated by the arrow (fig4) The reading value is subtracted from 180^0 to get the obtuse angle value.

Reading $22^0 30'$

Measurement

$180^0 - 22^0\ 30' = 157^0 30'$

Fig 3

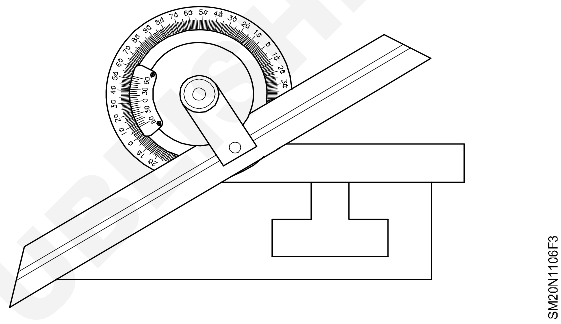
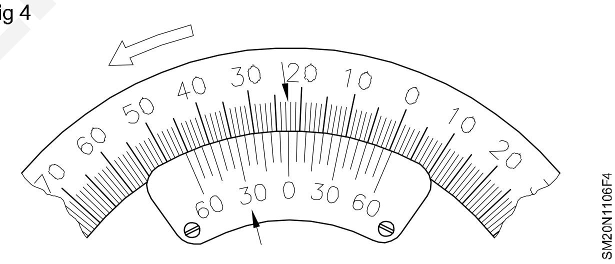


Fig 4



Combination set

Objectives: At the end of this lesson you shall be able to
- **identify the parts of a combination set**
- **state the uses of each attachment in a combination set.**

Combination sets can be used for different types of works like layout, measurement and checking of angles.

The combination set (Fig 1) has a

– protractor head

– square head

– centre head

– rule.

Protractor head (Fig 2) **:** The protractor head can be rotated and set to any required angle.

The protractor head is used for marking and measuring angles within an accuracy of 1°. The spirit level attached to this is useful for setting jobs in a horizontal plane.

Fig 1

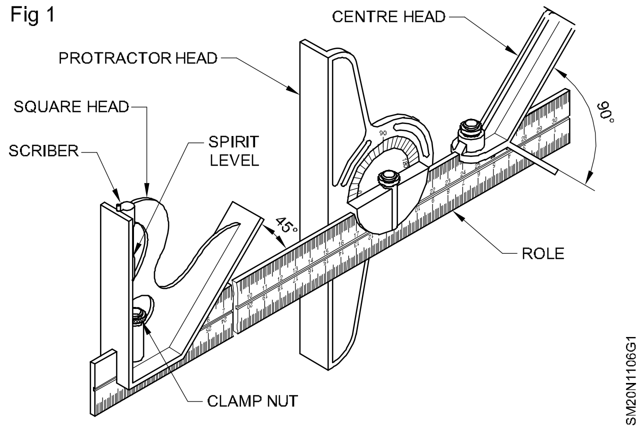
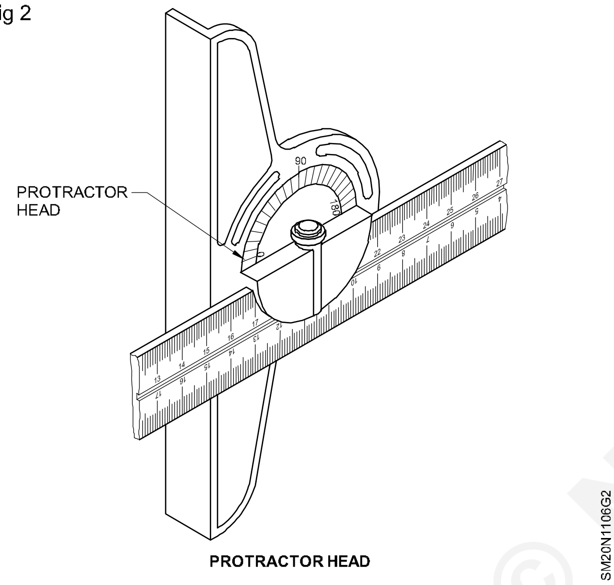
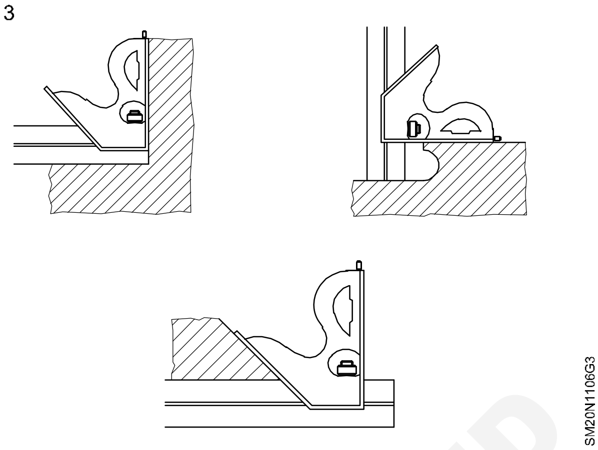


Fig 2



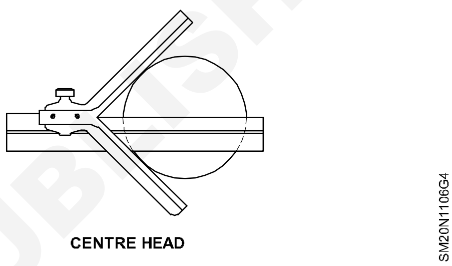
Square head (Fig 3) **:** The square head has one measuring face at 90^0 and another at 45^0 to the rule. It is used to mark and check 90^0 and 45^0 angles. It can also be used to set workpieces on machines and measure the depth of slots.

Fig 3



Centre head (Fig 4) **:** This along with the rule is used for locating the centre of cylindrical jobs.

Fig 4



For ensuring accurate results, the combination set should be cleaned well after use and should not be mixed with cutting tools, either while using or storing.

Radius gauges

Objectives: At the end of this lesson you shall be able to
- **state the uses of radius gauges**
- **state the features of a radius gauge.**

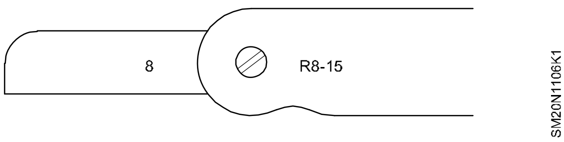
Radius gauges are used to check the internal and external radius of workpieces.

These gauges are made of high quality steel sheets and are finished to accurate radius. Radii of parts are checked by comparing the radius of the gauges.

Radius gauges are available in sets of several blades held in a holder. Each blade can be separately pulled out of the holder when in use.

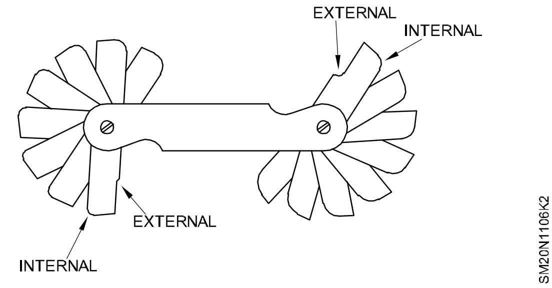
The size of the radius is marked on the individual blades of the gauges. (Fig 1)

Fig 1



These gauges are available in different combinations with internal and external radius. (Fig 2 & 3)

Fig 2



Individual gauges are also available for different radii. (Fig 4)

Fig 3

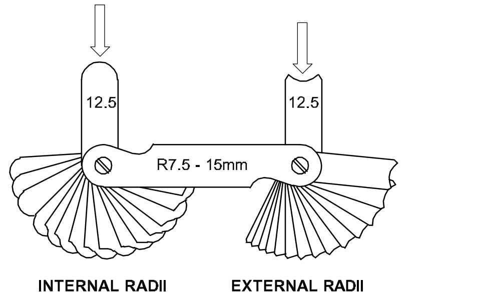
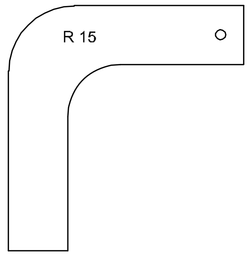


Fig 4



Screw Pitch gauge

Objectives: At the end of this lesson you shall be able to
- **state the purpose of a screw pitch gauge**
- **state the constructional features of a screw pitch gauge.**

Purpose: A screw pitch gauge is used to determine the pitch of a thread.

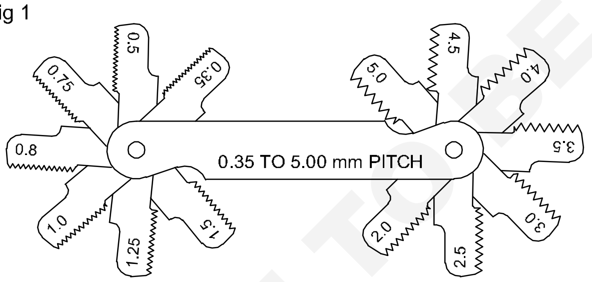
It is also used to compare the profile of threads.

Constructional features: Pitch gauges are available with a number of blades assembled as set. Each blade is meant for checking a particular standard thread pitch. The blades are made of thin spring steel sheets and are hardened.

Some screw pitch gauge sets will have blades provided for checking British Standards threads (BSW, BSF etc) at one end the Metric standard at the other end.

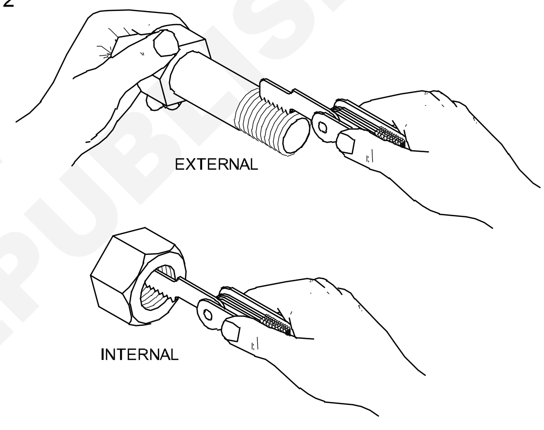
The thread profile on each b lade is cut for about 25 mm to 30 mm length. The pitch of the blade is stamped on each blade. The standard and range of the pitches are marked on the case. (Fig 1)

Fig 1



For obtaining accurate results while using the screw pitch gauge, the full length of the blade should be placed on the threads. (Fig 2)

Fig 2



USING SCREW PITCH GAUGE

Standard wire gauge

Objectives: At the end of this lesson you shall be able to
- **state the use of the standard wire gauge**
- **state some important hints in using standard wire gauge**
- **state the metal thickness in mm for the given gauge numbers.**

The job drawing indicate only gauge or thickness of the sheet to be used. Before starting the work identify the correct thickness of the sheet. The thickness of the sheet is measured with the help of the standard wire gauge.

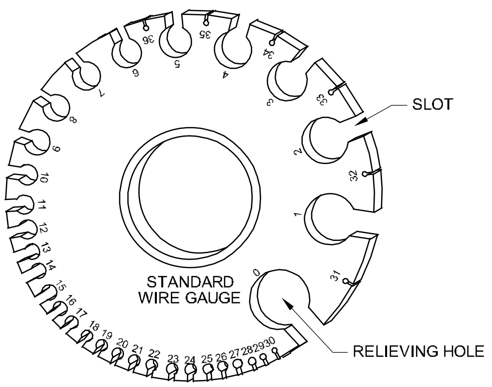
The gauge consist of a disc shape smoothened steel metal piece with numerous slots around the outside edge. These slots are of various width and correspond to certain gauge number. (Fig 1)

Gauge number is stamped on one side of each slot and on the other side, the decimal part of an inch is stamped to show the thickness of the sheet and the diameter of the wire.

Thickness of the sheet is checked by inserting the edge of the sheet in the appropriate slot of the standard wire guage.

Wire diameter is checked by inserting the wire only in the slot, and not in the circle. (Fig 2)

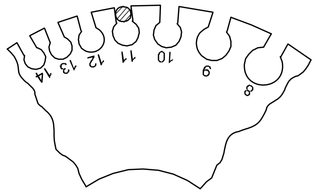
Fig 1



STANDARD WIRE GAUGE

SM20N1106N1

Fig 2



SM20N1106N2

Table 1

SWG TO INCHES AND MM

SWG NO	INCHES	MM	SWG NO	INCHES	MM
00	.3437	8.729	18	.0480	1.257
0	.3125	7.937	19	.0418	1.118
1	.2812	7.142	20	.0359	.996
2	.2656	6.846	21	.0329	.886
3	.2391	6.073	22	.299	.794
4	.2321	5.895	23	.0269	.707
5	.2092	5.321	24	.0230	.629
6	.1943	4.935	25	.0209	.560
7	.1793	4.770	26	.0179	.498
8	.1644	3.988	27	.0164	.443
9	.1495	3.551	28	.0149	.396
10	.1280	3.175	29	.0135	.353
11	.1196	2.827	30	.0120	.315
12	.1046	2.517	31	.0109	.276
13	.0897	2.240	32	.0101	.256
14	.0747	1.994	33	.0093	236
15	.0673	1.775	34	.0085	.251
16	.0640	1.587	35	.0073	.185
17	.0538	1.412	36	.0079	.177

Scriber/Scratch awl

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

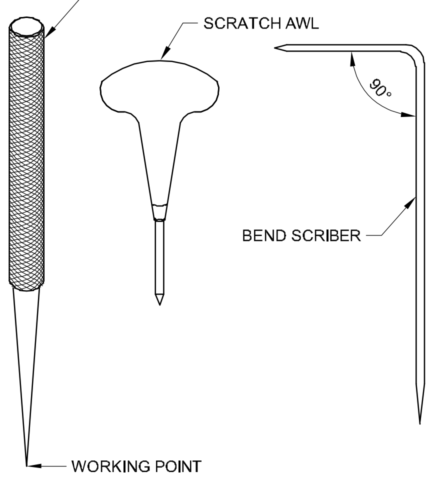
In layout work, it is necessary to scribe lines to indicate the dimensions of the workpiece to be cut or folded.

It is made out of high carbon steel about 3 to 5 mm dia. for drawing clear lines on sheet metal, working point is ground at one end angle of 10° to 20°. Scriber working point is hardened and tempered.

Scribers are available in different types and sizes.

Types of scribers (Fig 1)

Fig 1

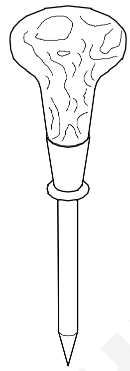


STRAIGHT SCRIBER

– Straight scriber
– Bend scriber
– Scratch AWL

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.

Fig 2



Dividers

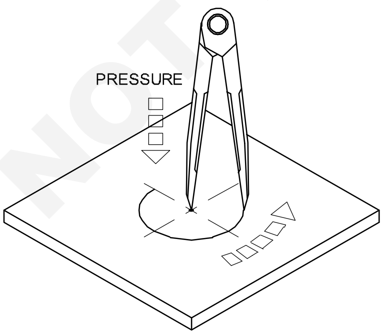
Objectives: At the end of this lesson you shall be able to
- **state the uses of dividers**
- **state the specification of dividers**
- **state the important aspects to be considered in respect of divider points.**

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

Dividers are available with firm joints and spring joints. (Fig 1 & 4) The measurements are set on the dividers with a steel rule.

Constructional features : Spring dividers are made of two steel, sharp pointed legs. The points are hardened and tempered. The legs are joined by a fulcrum roller and bow spring. The distance should be adjusted between the points with a ball headed screw and knurled nut. A peg is provided on the top of the bow spring for easy handling.

Fig 1



FIRM JOINT DIVIDER

Fig 2

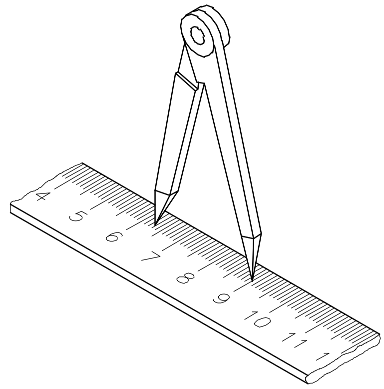
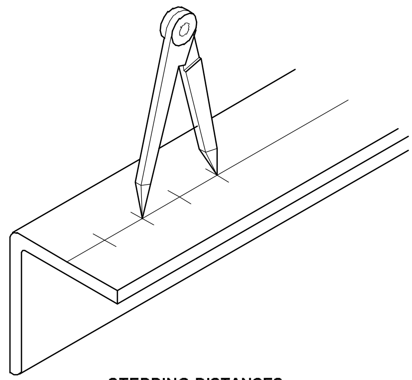


Fig 3



STEPPING DISTANCES

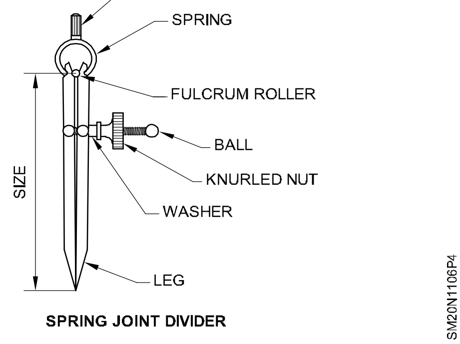
The size of dividers ranges from 50 mm to 200 mm. The distance from the point to the centre of the fulcrum roller (pivot) is the size of the divider. (Fig 4)

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

The two legs of the divider should always be of equal length. (Fig 5)

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

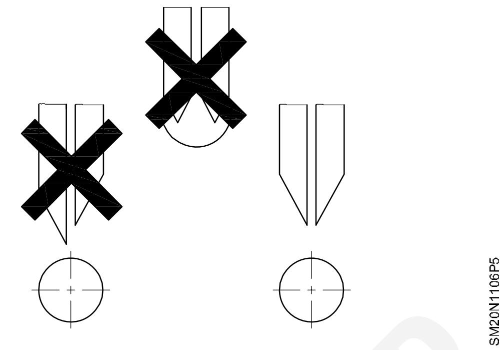
Fig 4



The divider point should be kept sharp in order to produce fine lines. Frequent sharpening with an oilstone is better than sharpening by grinding.

Sharpening by grinding will make the points soft.

Fig 5



Wing compass

Objectives: At the end of this lesson you shall be able to
- **identify the part of a wing compass**
- **state the use of the wing compass**
- **state the specification of the wing compass**
- **state some important hints on the wing compass**
- **state the use of a trammel beam.**

Wing compass is used for scribing circles, arcs and for transforming and stepping off distances. (Fig 1,2 and 3)

Fig 1

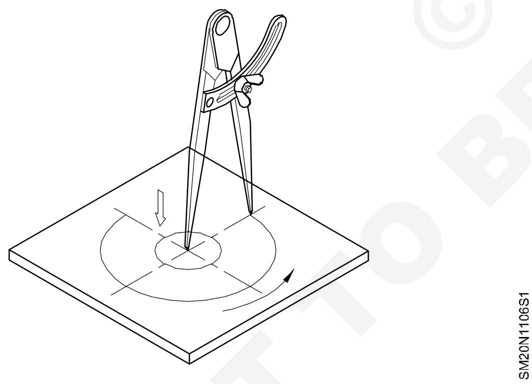


Fig 2

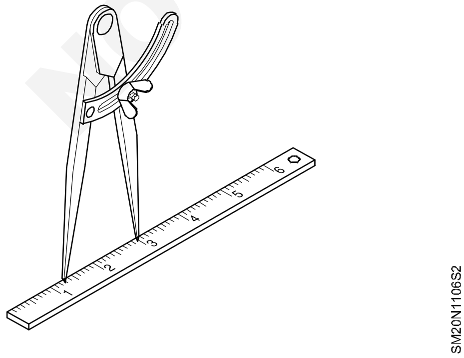
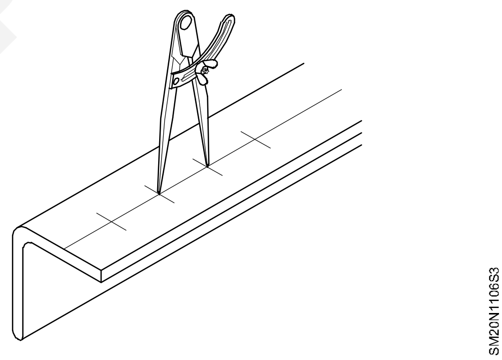


Fig 3



Compasses are available with (A) Firm joints (B) Wing (C) Spring joints and (D) Beam Compass or Trammel. (Fig 4)

The measurements are set on the wing compass with a steel rule.

The sizes of a wing compass range between 50 mm to 200 mm. The distance from the point to the centre of the rivet is the size of the wing compass. (Fig 5)

For the correct location and seating of the wing compass legs, 60^0 dot punch mark is indented.(Fig 6)

The beam compass (or) Trammel is used to scribe a circle or an arc with a large diameter which cannot be scribed by a wing compass. (Fig 7)

Parts of the wing compass are shown in Fig 8.

Fig 4

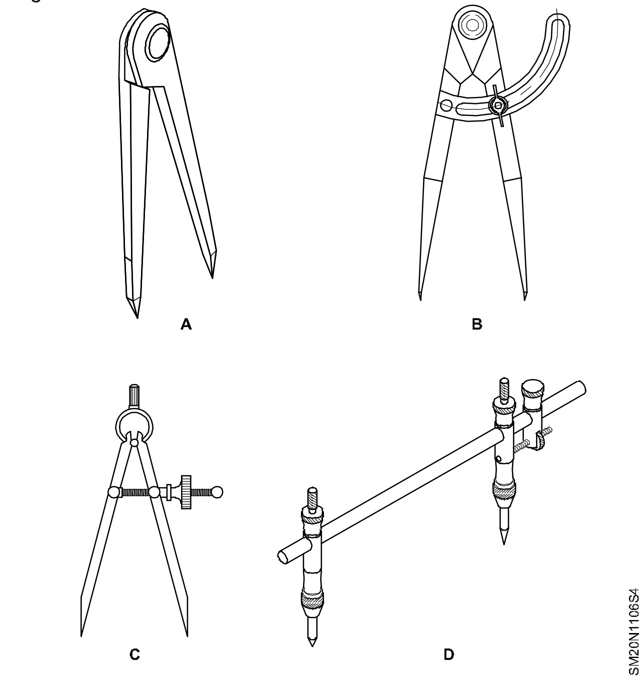


Fig 5

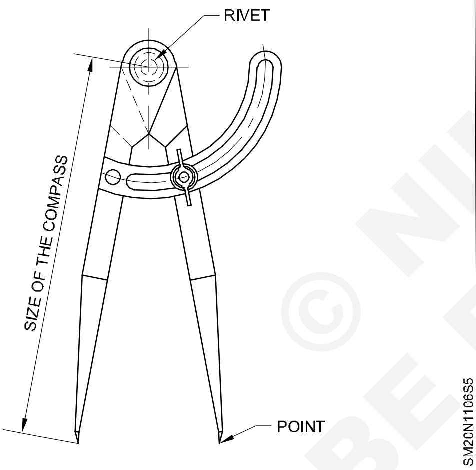


Fig 6

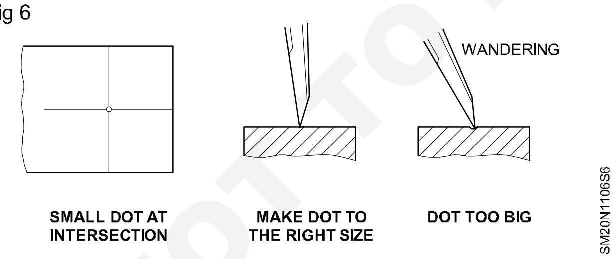


Fig 7

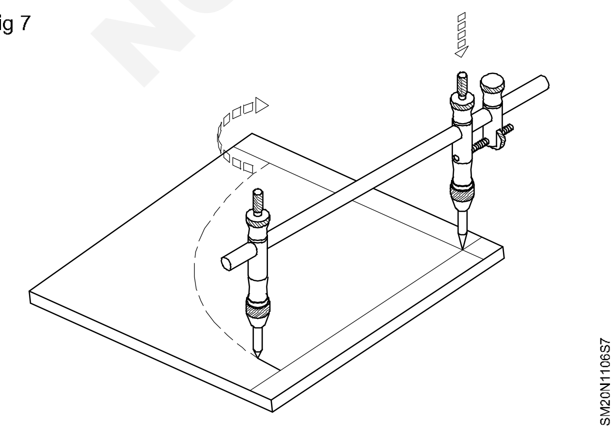
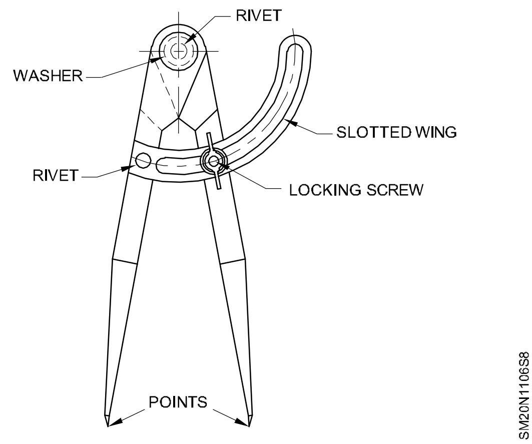
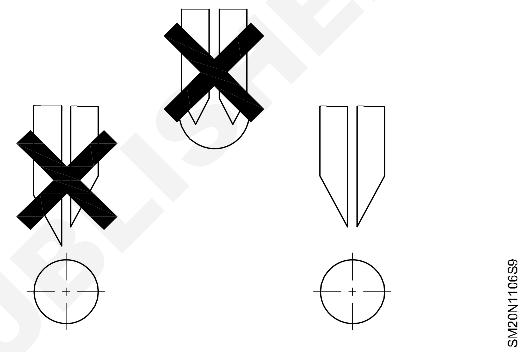


Fig 8



The two legs of the compass should always be equal in length. (Fig 9)

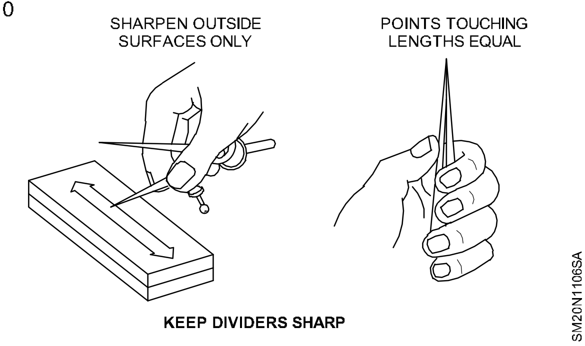
Fig 9



Compass are specified by the type of the joints and length. When using spring type wing compass the measurement once taken will not vary while marking.

The compass point should be kept sharp, in order to produce fine lines. Frequent sharpening with an oilstone is better than sharpening by grinding. (Fig 10) Sharpening by grinding will make the points soft.

Fig 10

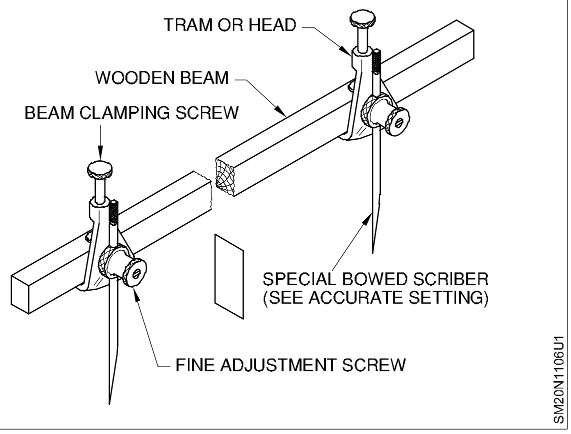


Trammels

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

Beam Trammels and taper measures: Trammel set is used for striking lines at 90° to each other, and also for measuring the distances accurately. It is a usual practice for the craftsman to use a pair of trammel heads or 'trams' and any convenient beam such as a length of wooden batten. The arrangement of the trammel for fine adjustment for accurate marking out is shown in Fig 1.

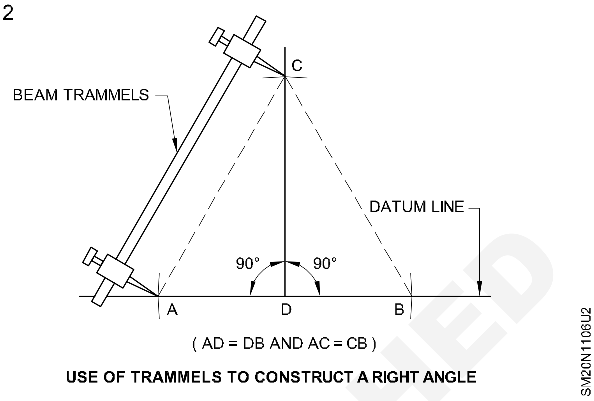
Fig 1



The 90^0 angle lines i.e lines square with each other, may be set out, with the aid of the beam trammel set or steel tape as shown in Fig 2.

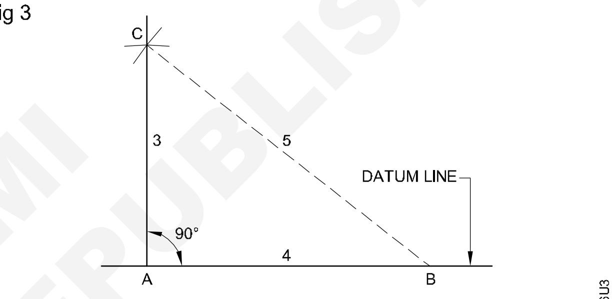
The normal accuracy obtainable when marking out with the dividers, and the trammels is within 0.15 mm of the true dimension. Fig 3 show how the properties of a right angled triangle can be used to set out a perpendicular line by using trammel set.

Fig 2



USE OF TRAMMELS TO CONSTRUCT A RIGHT ANGLE

Fig 3



USE OF TRAMMELS AND STEEL TAPE TO CONSTRUCT A RIGHT ANGLE.

APPLICATIONS OF BEAM TRAMMELS AND STEEL TAPE (MAKING OUT)

Punch

Objectives: At the end of this lesson you shall be able to
- **state the constructional features of a punch**
- **state the use of a punch**
- **state the care and maintenance of a punch.**

Punches are hand tools, used to make indentation marks, make holes and to remove pins from holes in sheet metal working.

The punches are available in different types. (Fig 1)

Almost all punches are having the following features.

They are made from high carbon steel, the forging angle (tapered portion) and the head are annealed. (Fig 2)

The round knurled stem is to give a good grip. The working point is hardened and tempered.

Dot punch (Fig 3): The angle of the dot punch is 60^0 used for marking light punch mark needed to position compass. Dot punch mark is used to locate the point of the compass for scribing circles as shown in Fig 4.

Fig 1

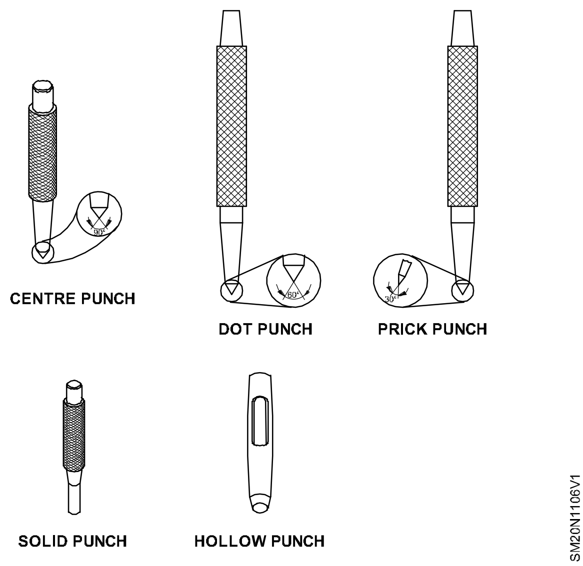


Fig 2

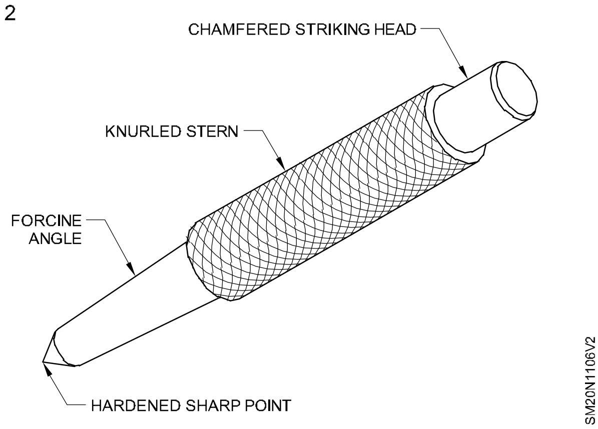


Fig 3

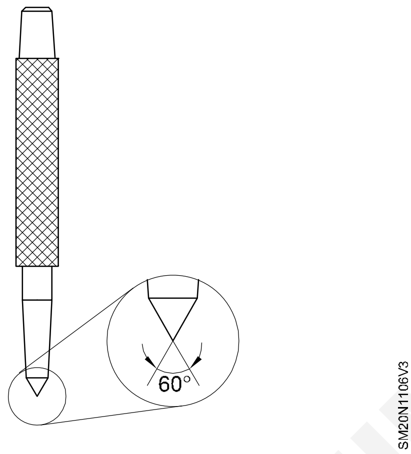
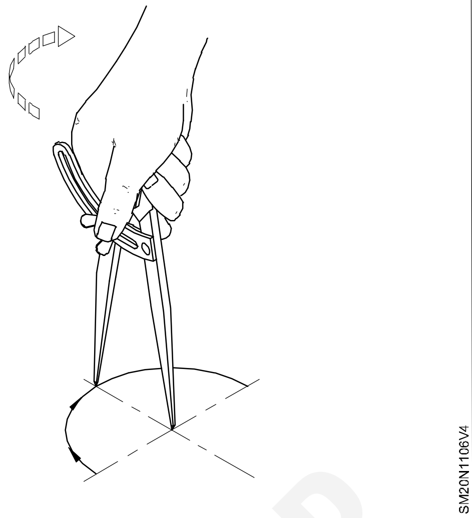


Fig 4



SPECIFICATION

Dot punch is specified by the length and the diameter of the punch.

Care and maintenance: Keep the head free of burrs if not, it will lead to mushroom head.

Types of marking punches

Objectives: At the end of this lesson you shall be able to
- **state the different punches used in marking**
- **state the feature of each punch and its uses.**

Punches are used in order to make certain dimensional features of the layout permanent. There are three types of punches. They are

– Centre punch

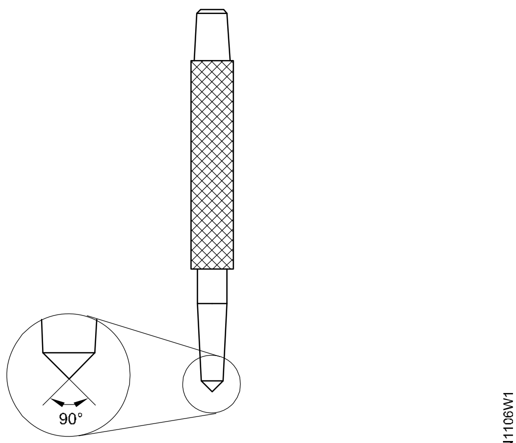
– Prick punch

– Dot punch.

Centre punch: The angle of the point is 90^0 in a centre punch. The punch mark made by this is wide and not very deep. This punch is used for locating holes. The wide punch mark give a good seating for starting the drill. (Fig 1)

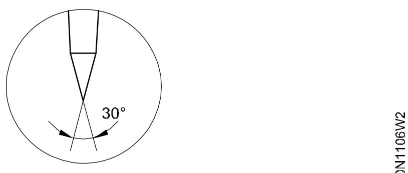
Prick punch: The angle of the prick punch is 30^0. This punch is used for making light punch marks needed to position dividers and trammels. The divider leg will get a proper seating in the punch mark. (Fig 2)

Fig 1



CENTRE PUNCH

Fig 2



PRICK PUNCH

Cutting Tool

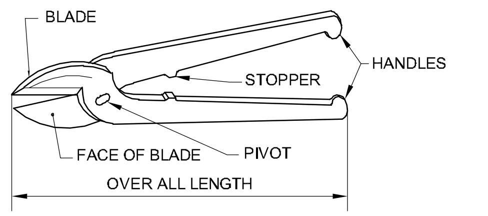
Objectives: At the end of this lesson you shall be able to
- **state the uses of straight snips**
- **state the parts of straight snips**
- **state care and maintenance.**

A snip is also called a hand shear. It is used like a pair of scissors to cut thin soft metal sheets. Snips are used to cut sheet metal upto 20 S.W.G.

Uses of straight snips: The straight snips are used to cut sheet metal along straight lines and outer sides of curves.

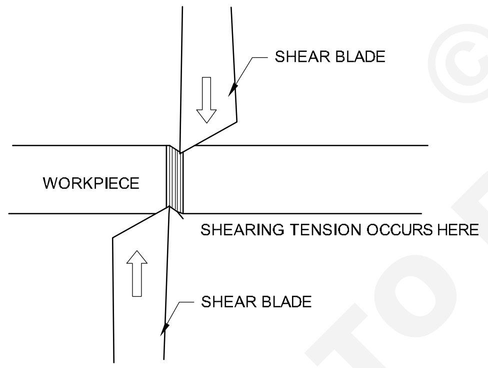
Parts of straight snips are shown in Fig 1.

Fig 1



While cutting a sheet metal, blades are pressed against the sheet, which causes shearing tension from both sides as shown in Fig 2 and the cutting action takes place.

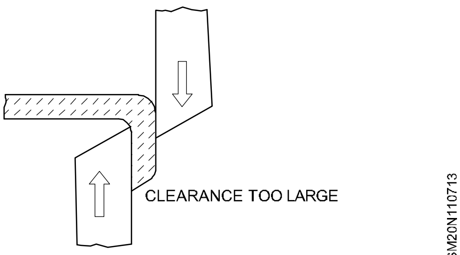
Fig 2



Cutting edge of the blade and clearance: Clearance between the blades should be free but without gap. For straight snips, cutting angle is 87°.

If the clearance is too large it cause unclean cut, chamfered and jamming of work piece as shown in Fig 3.

Fig 3



Types: There are two types of snips

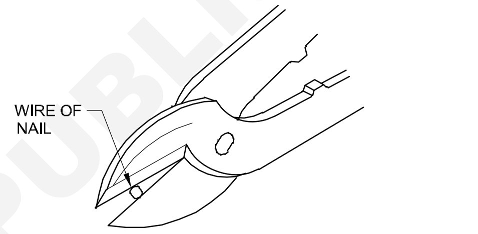
1 Straight snip

2 Bent snip

Specification: Snips are specified by its overall length and the shape of the blade. (snips are available in 150 mm, 200 mm, 300 and 400 mm overall length) Ex.200 mm, straight snips.

Safety: Avoid cutting wires and nails, if so the cutting edge of the blade becomes damaged (Fig 4).

Fig 4



Avoid cutting hard sheet metal, if so the blade becomes blunt.

Due to wear and tear, the cutting edge of the blades becomes blunt. To resharpen the blade, the cutting angle alone should be ground to an angle of 87° (Fig 5) and should not grind the face of the cutting side of the blade. (Fig 6)

Fig 5

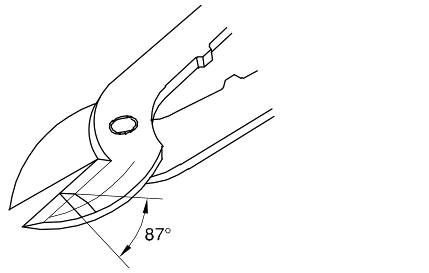
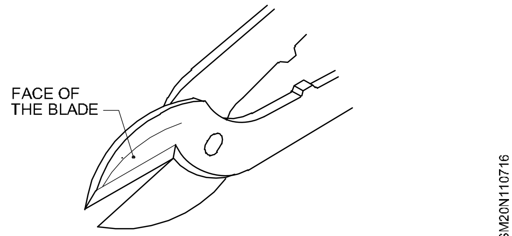


Fig 6

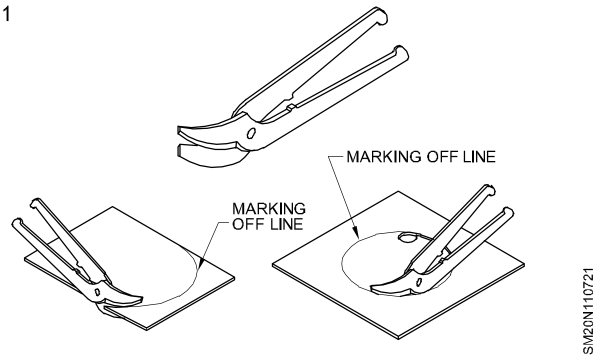


Bend snips

Objectives: At the end of this lesson you shall be able to
- **state the use of the bend snips**
- **state the parts of the bend snips**
- **state the specification of the bend snips.**

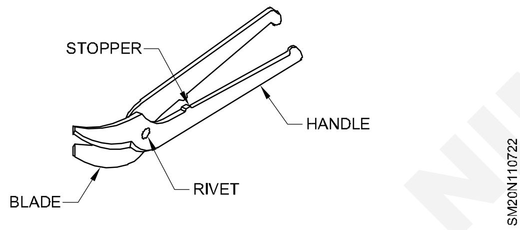
The bend snips are used to cut the inside curved lines and for trimming curved edges as shown in (Fig 1).

Fig 1



Parts of the bend snips are shown in fig 2. The blades of the bend snips are curved. (Fig 2)

Fig 2



Specification: Bend snips are specified by their overall length. Bend snips are available in 150, 200, 300 and 400 mm length.

Type of shears

1 Tinman's shears is sometimes called straight shears.

2 Universal combination shears or Gilbow shears.

3 Pipe shears

4 Scotch shears

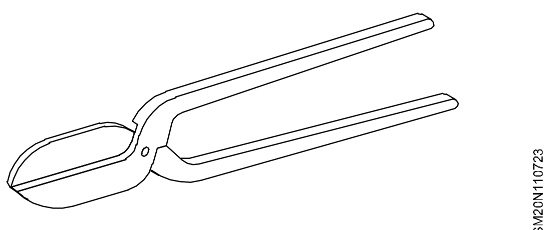
5 Block shears

6 Rohdes shears

USES

Tinmans shears (Fig 3): It is used for making straight cuts and large external curves upto the thickness of 18 SWG. Cutting angle of a shears is 87^0. The cross sectional view of the cutting blades is shown in Fig 3.

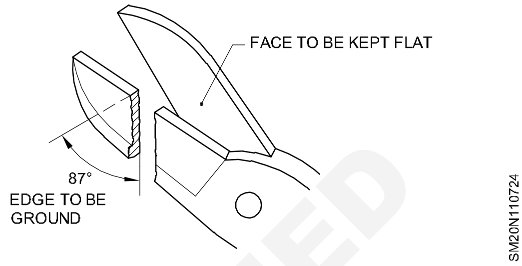
Fig 3



Never grind the face of the blade.

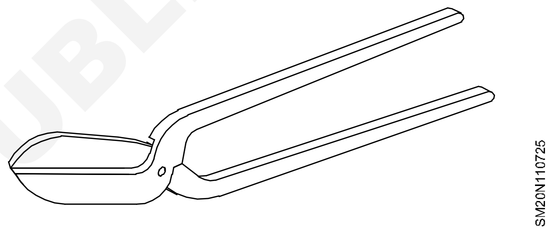
Universal combination shears or Gillow shears (Fig 4)

Fig 4



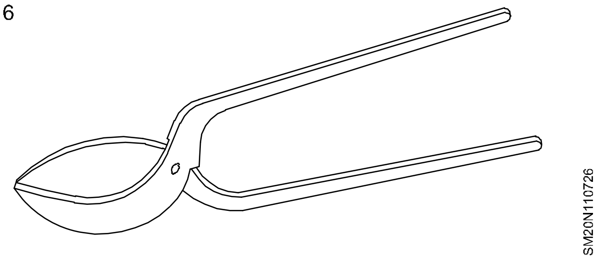
Its blades are designed for universal cutting, straight line or internal and external cutting of curves may be right hand or left hand, easily identifiable as the top blade is either on the right or the left.(Fig 5)

Fig 5



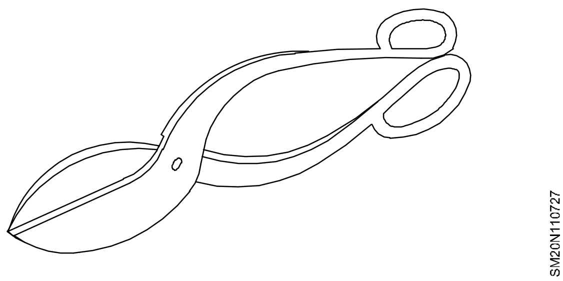
Pipes shears (Fig 6): It is applied as bend shears in all cases, particularly it is used to trim the edges of the pipes.

Fig 6



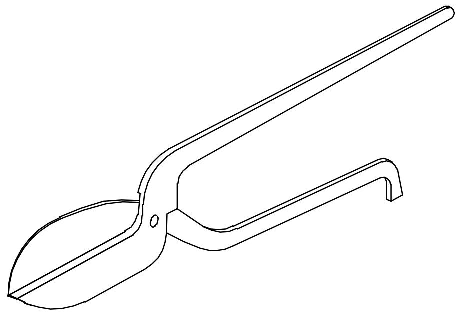
Scotch shears (Fig 7): It is a shape as shown in the Fig 9. Its handles are formed as eye holes to give extra grip to the hands. It is also used as Tinman's shears.

Fig 7



Block shears (Fig 8): One of the handle of the shear is bent downwards as shown in the fig. The bending portion should be fixed on the iron plates hole and the upper handle will be held by the worker. It is used in mass production purposes.

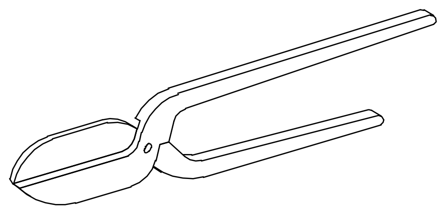
Fig 8



SM20N110728

Rohdes shears: Its one handle is shorter in length as compared with the other handle as shown in (Fig 9).

Fig 9



SM20N110729

The short handle is to be pressed by the right leg of the worker and the other handle should be held by the right hand. It is used to cut lengthy sheets.

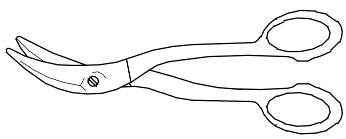
Shearing force: To produce the maximum cutting force, the hand must be kept far from the rivet and the metal being cut must be kept close to the rivet.

Types of Shears

Objectives: At the end of this lesson you shall be able to
- **state the types of shears and their application.**

Hawk Billed shears (Fig 1): It is used for the inside cutting of an intricate work. The snips have narrow curved blades that allow you to make sharp turns without bending the metal.

Fig 1

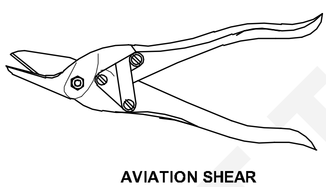


HAWK-BILLED SHEAR

SM20N110731

Aviation shears (Fig 2): It can be used for all kinds of cutting. These are made with left, right or universal cutting blades.

Fig 2

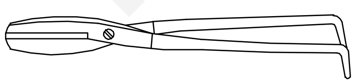


AVIATION SHEAR

SM20N110732

Bench shears (Fig 3): These are designed to have one handle held in a vice or bench plate, while the other handle is moved up and down.

Fig 3



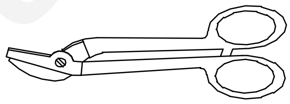
BENCH SHEAR

SM20N110733

They can cut 16 gauge to 18 gauge thickness sheet metal.

Double cutting shears (Fig 4): These shears have three blades used to cut around cylindrical objects, such as cans and pipes. A single blade is pushed through the metal to sheet to cut.

Fig 4



DOUBLE CUTTING SHEAR

SM20N110734

Electric Portable Shear (Fig 5): Electric shears are used to cut corrugated metal sheets or a sheet metal of 18 gauge thickness or lighter sheet metals.

Fig 5

SM20N110735

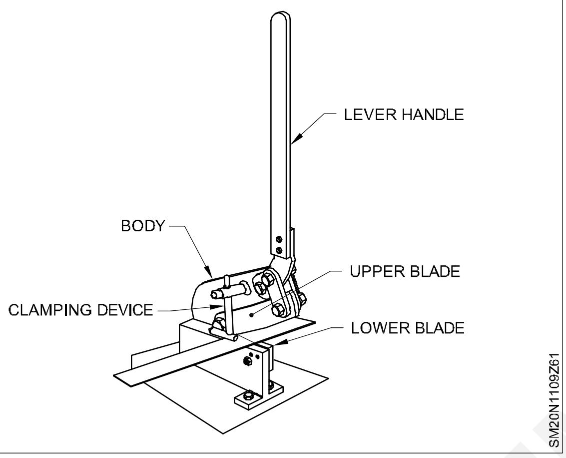
The shear point can be inserted with a light hammer blow. Successive blows will drive the shear on a scribed line for almost any shape like inner circles,zig zag, curvature line easily. A strip of metal about 3"/32 (2.5 mm) wide is removed in this shearing operations.

Hand lever shears

Objectives: At the end of this lesson you shall be able to
- **identify the hand lever shear**
- **state the principle of working**
- **state the constructional feature parts and their functions.**

Hand lever shear is a hand operated machine used to cut sheet metal upto a thickness of 3 mm (10 SWG). When the machine is mounted on the bench, it is called a hand lever bench shear. It may also be mounted on the flood, over a small platform. It is used for cutting along straight lines and convex cutting of sheet metal.

Fig 1



The lower blade of the hand lever shear is fixed (bottom blade) and the upper blade is pivoted at an angle.

The sheet being cut is prevented from tilting by a clamping device, which can be adjusted to the thickness of the sheet.

The knife cutting edge of the upper blade is curved so that the opening angle at the point of cut remains constant.

As the upper blade moves down on the sheet metal, the metal is subjected to shearing force, which causes deformation of the metal. (Fig 2&3)

After a certain amount of plastic deformation, the cutting member begin to penetrate. The uncut metal work, harden at the edge (Fig 4).

Fracture begins to run into the work hardened metal from the point of contact of the cutting members. When these fractures meet, the cutting members penetrate the whole of the metal thickness. (Fig 5)

Fig 2

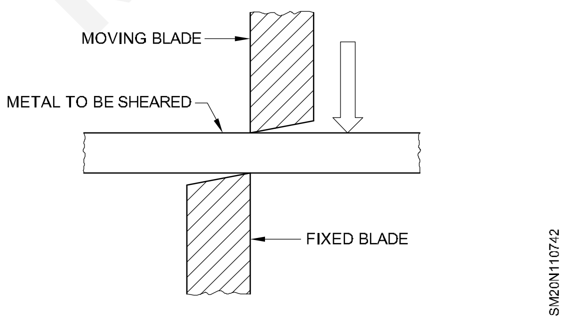


Fig 3

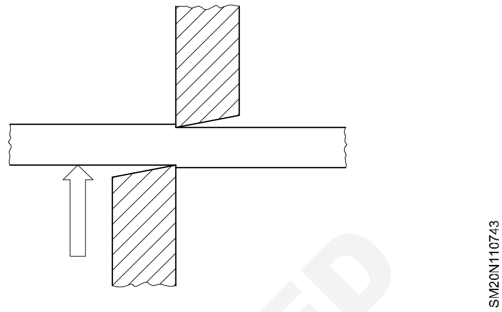


Fig 4

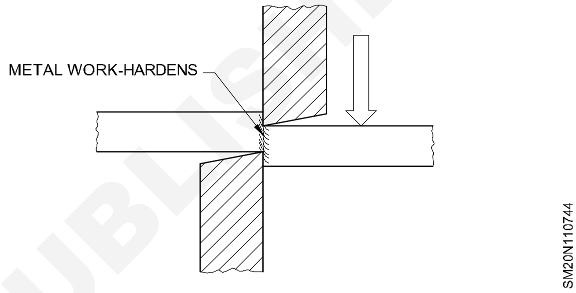
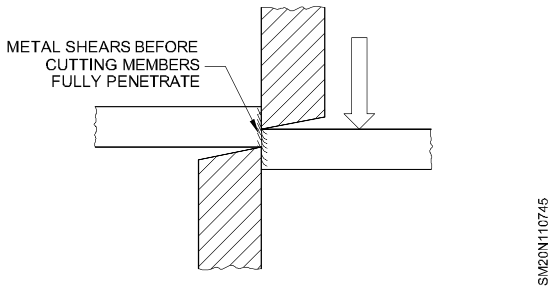


Fig 5



Blade clearance is very important and should not exceed 10 percent of the thickness to be cut and should suit the particular material.

Results of incorrect and correct setting of shear blade are as follows.

1 Excessive clearance causes a burr to form on the underside of the sheet as shown in the (Fig 6).

2 With no clearance, over strain is caused, the edge of the sheet becomes flattened on the under sides as shown in (Fig 7).

3 With the correct clearance, optimum shearing results are obtained as shown in (Fig 8).

Fig 6

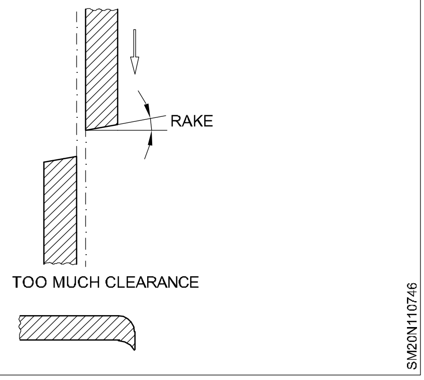


Fig 7

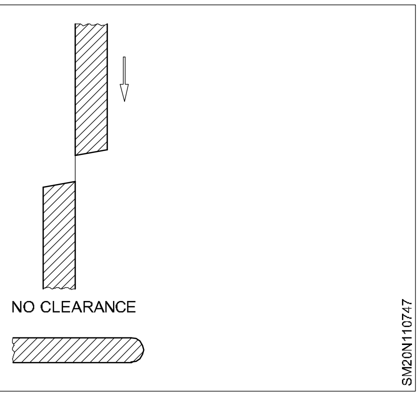
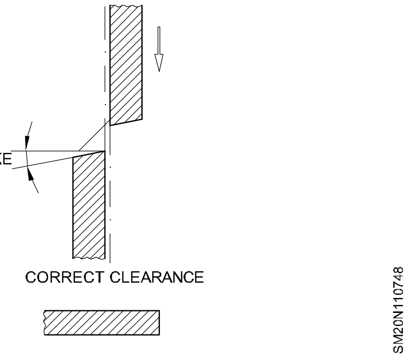


Fig 8



Hacksaw frame and blade

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

The hand hacksaw frame 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 Fig 1.

TYPES OF HACKSAW FRAMES

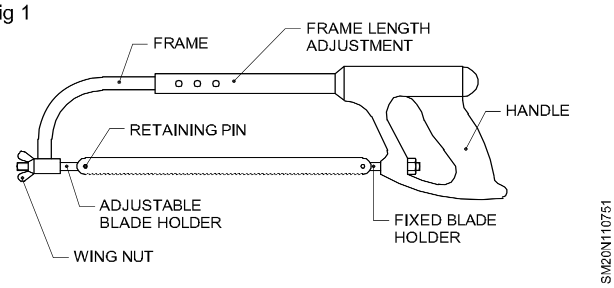
The two different types of hacksaw frames are, solid frames and adjustable frames.

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) (Fig 1) **:** This is the most commonly used type. It gives a better grip and control, while sawing.

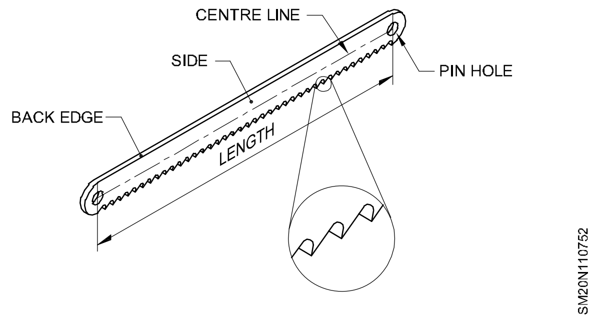
Fig 1



For proper working, it is necessary to have frames of rigid construction.

Hacksaw blades (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 carbon steel (LA) or high speed steel (HSS) and in standard lengths of 250 mm and 300 mm.

Fig 2



TYPES OF HACKSAW BLADES

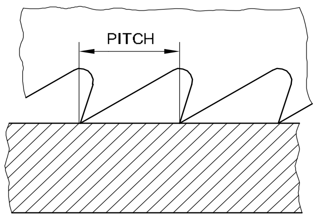
Two types of hacksaw blades are available - hard blades and flexible blades.

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) **:** The distance between adjacent teeth is known as the 'pitch' of the blade

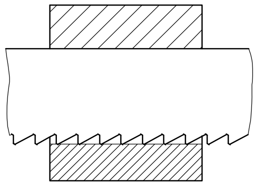
Fig 3



Classification	Pitch
Coarse	1.8 mm
Medium	1.4 mm & 1.0 mm
Fine	0.8 mm

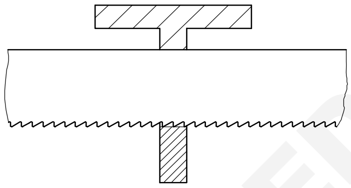
Pitch selection : For soft materials such as bronze, brass, soft steel, cast iron, heavy angles etc use a 1.8 mm pitch blade. (Fig 4)

Fig 4



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

Fig 5



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

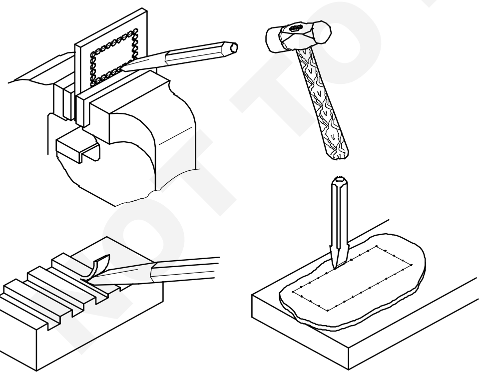
Cold chisel

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 chisels and its uses.**

A cold chisel is a hand cutting tool used by fitters for chipping and cutting off operations.

Chipping is an operation of removing excess metal, layer by layer with the help of a chisel and hammer. Chipped surfaces being rough, they should be finished by filing. (Fig 1)

Fig 1

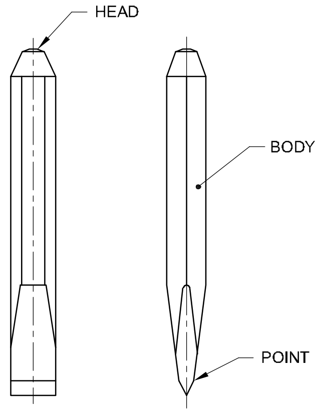


Parts of a chisel (Fig 2) **:** A chisel has the following parts.

- Head
- 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.

Fig 2



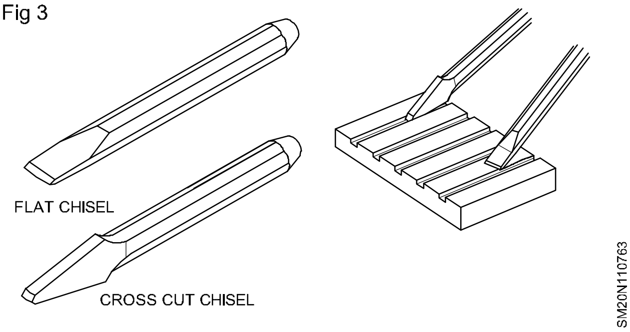
Types of chisels and its uses: The commonly used chisels are

- Flat chisel
- Cross-cut chisel
- Half round nose chisel
- Diamond point chisel
- Web chisel/Punching chisel.

Flat chisels (Fig 3) **:** To cut sheet metals, remove metal from large flat surfaces and chip excess metal in welded joints and castings.

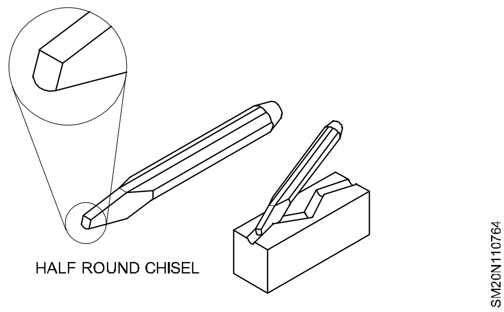
Cross-cut or cape chisels (Fig 3) **:** To cut keyways, grooves and slots.

Fig 3



Half round nose chisels (Fig 4) **:** To cut curved grooves (oil grooves)

Fig 4



Diamond point chisels (Fig 5) **:** To square the jobs at the corners.

Web chisels/punching chisels (Fig 6) **:** To seperate metals after chain drilling.

Fig 5

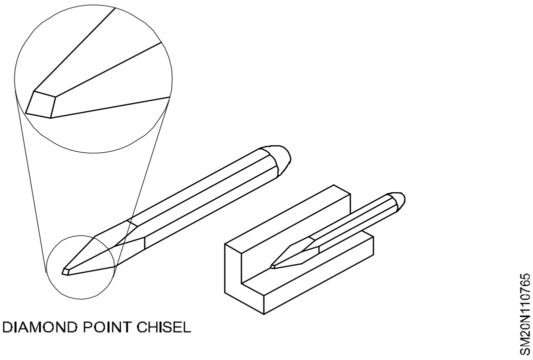
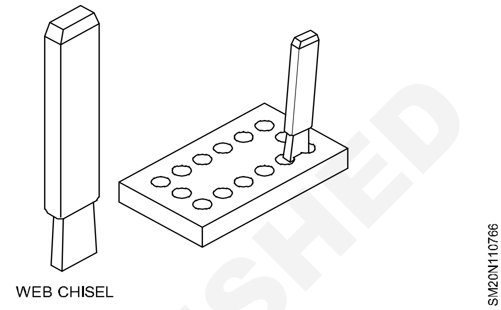


Fig 6



Chisels are specified according to their

- length
- width of cutting edge
- type/shape of the cutting edge
- cross-section of body.

The length of chisels ranges from 150 mm to 400 mm. The width of the cutting edge varies according to the type of chisels.

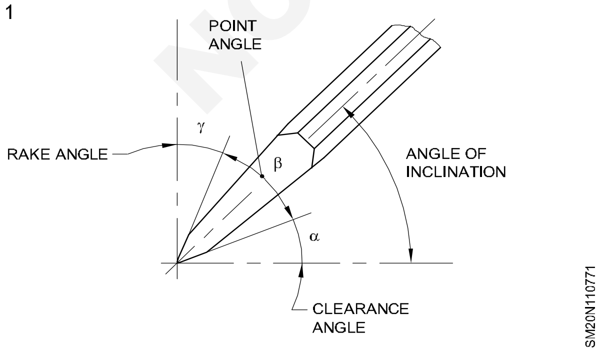
Angles of chisels

Objectives: At the end of this lesson you shall be able to
- **select the point angles of chisels for different materials**
- **state the different cutting angles of a chisel**
- **state the effect of rake and clearance angles.**

Point angles and materials: Point/cutting angle of a chisel depends on the material to be chipped. Sharp angles are given for soft materials, and wide angles for hard materials.

The correct point angle and angle of inclination generate the correct rake and clearance angles. (Fig 1)

Fig 1



Rake angle: Rake angle 'γ' is the angle between the top face of the cutting point, and normal to the work-surface at the cutting edge.

Clearance angle : Clearance angle 'α' is the angle between the bottom face of the point and tangent to the work-surface originating at the cutting edge.

If the clearance angle is too low or zero, the rake angle increases. The cutting edge cannot penetrate into the work. The chisel will slip. (Fig 2)

If the clearance angle is too much, the rake angle reduces. The cutting edge digs in, and the cut progressively increases. (Fig 3)

Fig 2

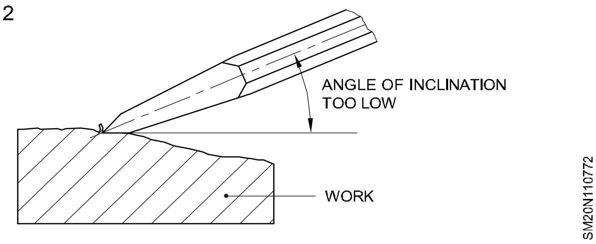
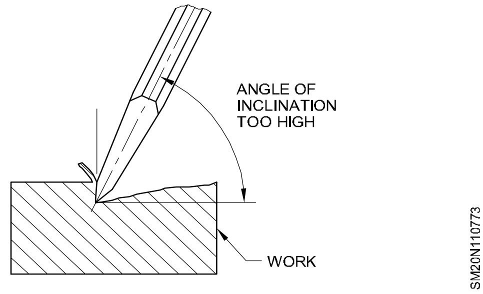


Fig 3



Material to be cut	Point (β) angle	Angle inclination
High carbon steel	65^0	39.5^0
Cast iron	60^0	37^0
Mild steel	55^0	34.5^0
Brass	50^0	32^0
Copper	45^0	29.5^0
Aluminium	30^0	22^0

Pliers

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)

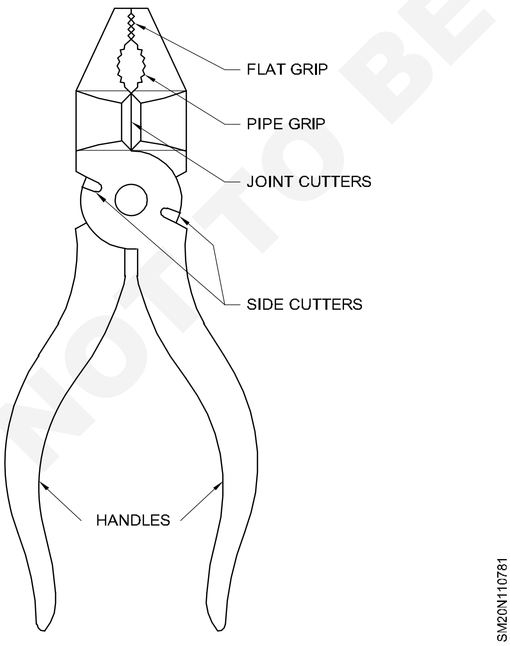
(Combination pliers)

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

Features (Fig 1)

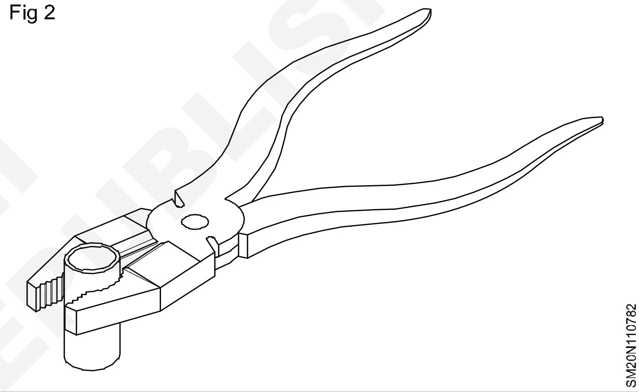
Flat jaw tips are serrated for general gripping.

Fig 1



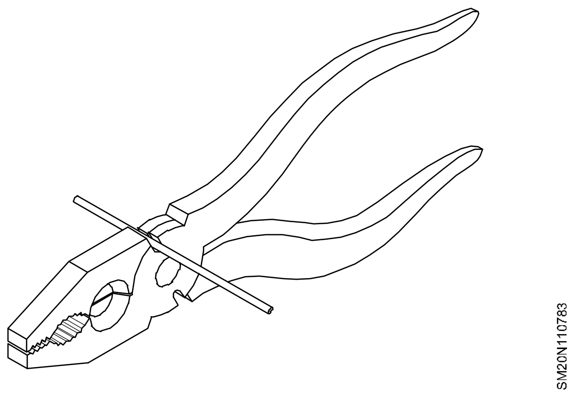
Pipe grip is serrated for gripping cylindrical objects. (Fig 2)

Fig 2



Side 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)

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 4

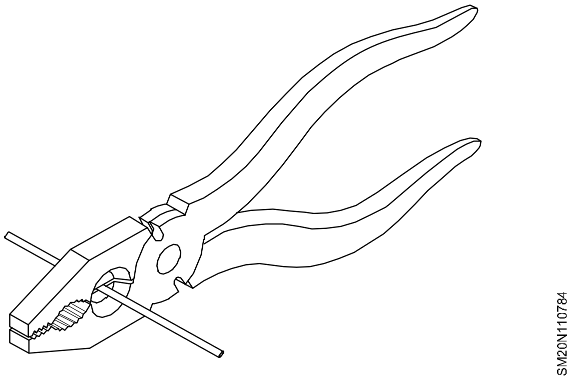
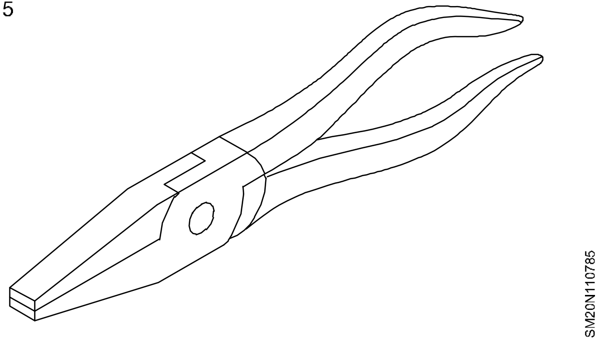
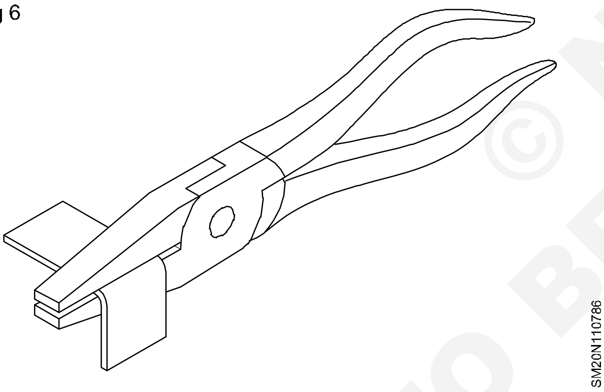


Fig 5



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

Fig 6



Round nose pliers

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

Fig 7

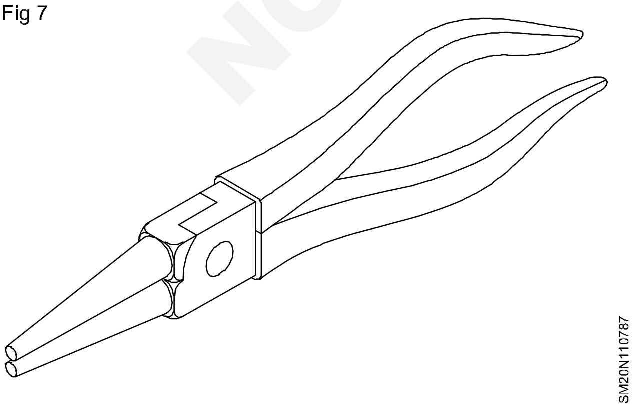
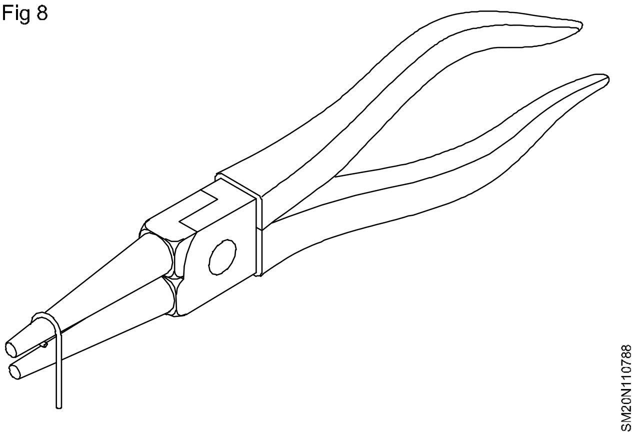


Fig 8



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 openings.

Mainly used for gripping. (Fig 9)

End cutting pliers

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

Fig 9

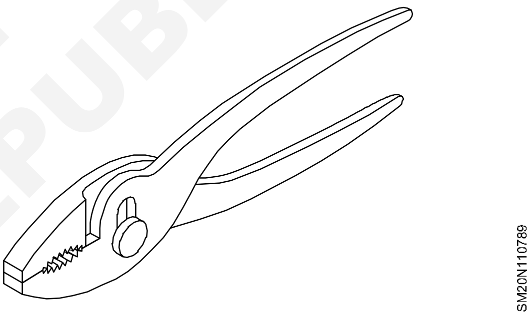
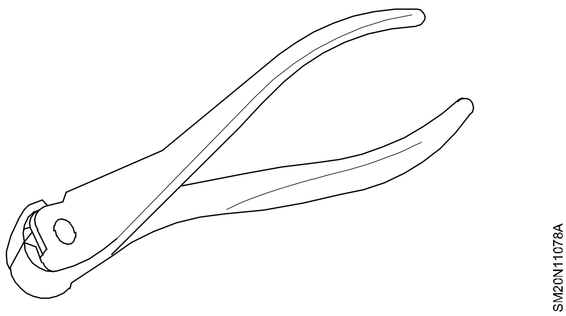


Fig 10



Circlip pliers

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

External circlip pliers

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

Internal circlip plier

It is used to fit and remove the internal circlip in the groove of the bore. (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 11

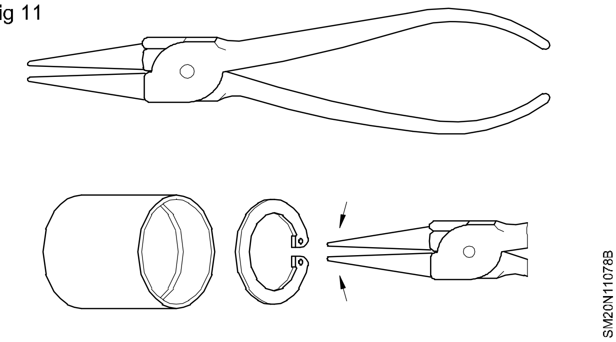
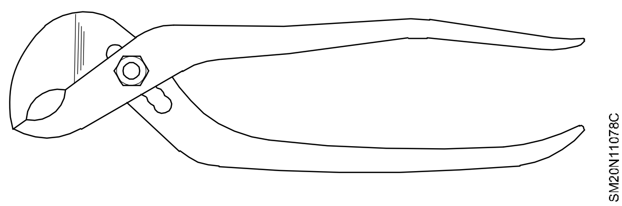
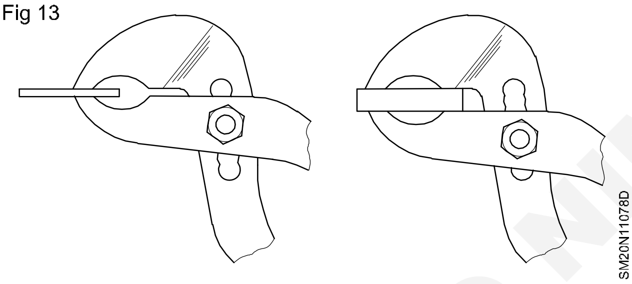


Fig 12



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

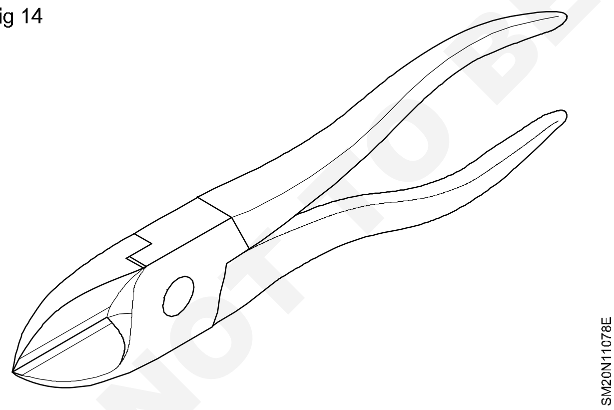
Fig 13



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) They are also used for spreading the cotter pin. (Fig 16)

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. (Fig 17)

Fig 15

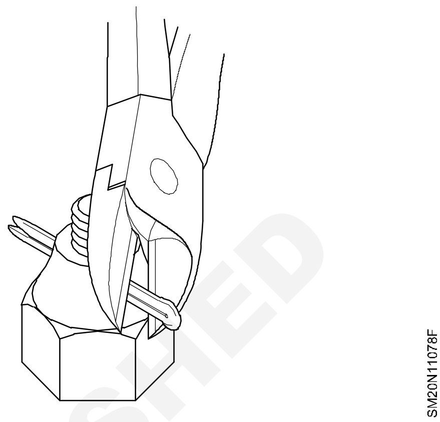
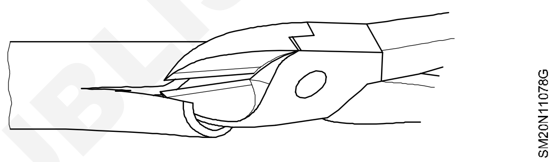


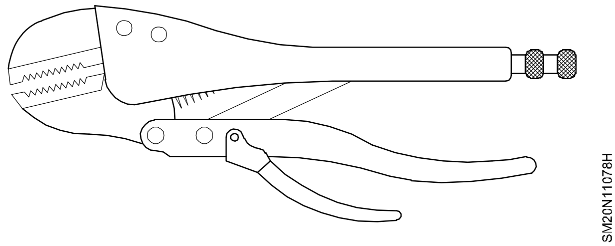
Fig 16



It has high gripping power.

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

Fig 17



Elements of a file

Objectives: At the end of this lesson you shall be able to
- **identify the elements of a file.**

Methods of material cutting : Filing is a method for removing excess material from a workpiece by using a file which acts as a cutting tool. Figure shows how to hold a file. Files are available in many shapes and sizes.

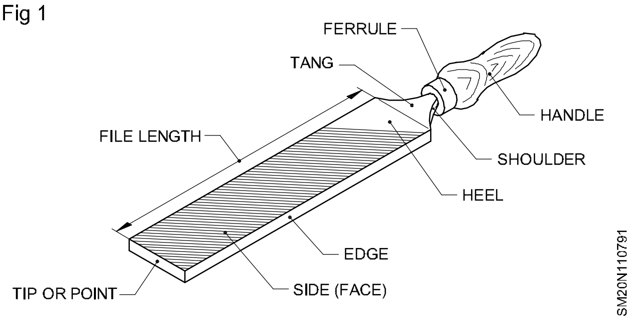
Materials : Generally files are made of high carbon or high grade cast steel. The body portion is hardened and tempered. The tang is however, not hardened.

Tip or point – the end opposite to tang

Face or side – the broad part of the file with teeth cut on its surface

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
Ferrule	–	a protective metal ring to prevent cracking of the handle.

Fig 1



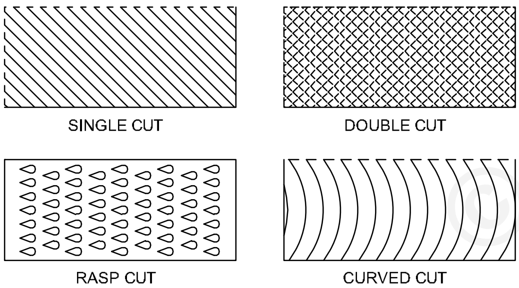
Cuts of file

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. Different cuts have different uses.

Types of cuts (Fig 1) **:** Basically there are four types of cuts.

Fig 1



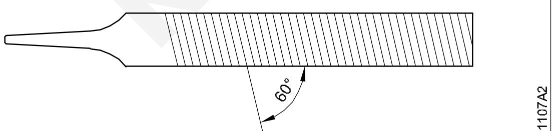
TYPES OF FILE CUT

Single cut, double cut, rasp cut and curved cut.

Single cut file (Fig 2) **:** 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 cut 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.

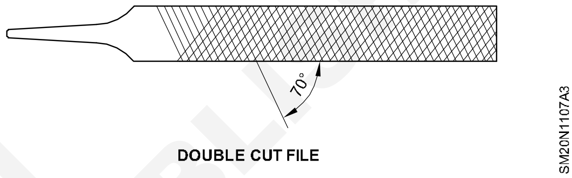
Fig 2



SINGLE CUT FILE

Double cut file (Fig 3) **:** A double cut file has two rows of teeth cut diagonal to each other. The first row of the teeth is known as OVERCUT and they are cut at an angle of 70^0. The other cut, made diagonal to this, is known as UPCUT, and is at an angle of 51^0. This file removes stock faster than the single cut file.

Fig 3

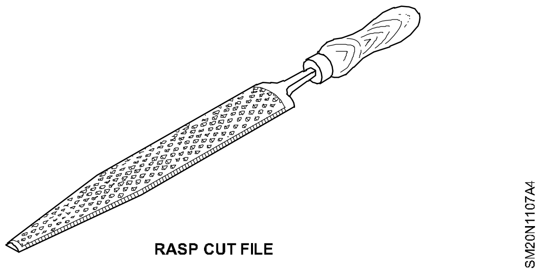


DOUBLE CUT FILE

Rasp cut file (Fig 4) **:** 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.

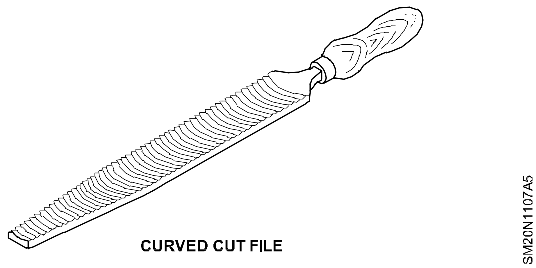
Curved cut file (Fig 5) **:** These files have deeper cutting action and are useful for filing soft materials like - aluminium, tin, copper and plastic. The curved cut files are available only in a flat shape.

Fig 4



RASP CUT FILE

Fig 5



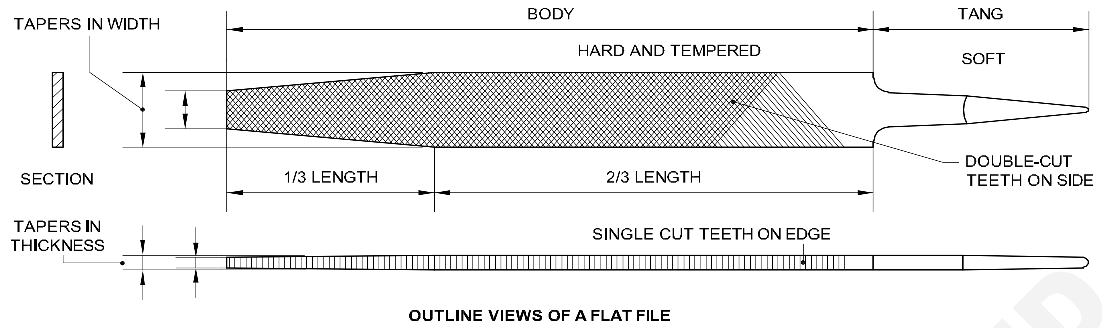
CURVED CUT FILE

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. There are certain special single cut files also, used for sharpening hand saws.

File shapes

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.**

Fig 1



OUTLINE VIEWS OF A FLAT FILE

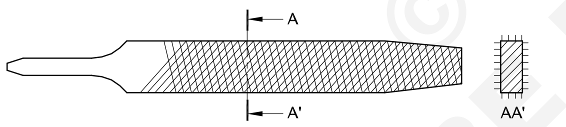
Files are made in different shapes so as to enable to file and finish components to different shapes.

The shape of files is usually specified by their cross section.

The files useful for this exercise are flat files and hand files.

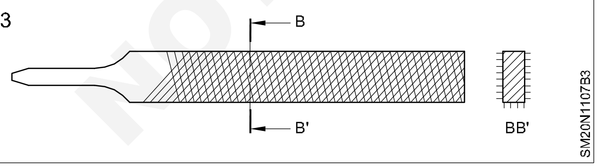
Flat files (Figs 1 & 2) **:** These files are of a rectangular cross-section. The edges along the width of these files are parallel up to two-thirds of the length, and then they taper towards the point. The faces are double cut and the edges single cut. These files are used for general purpose work. They are useful for filing and finishing external and internal surfaces.

Fig 2



Hand files (Fig 3) **:** These files are similar to the flat files in their cross-section. The edges along the width are parallel throughout the length. The faces are double cut. One edge is single cut whereas the other is the safe edge. Because of the safe edge, they are useful for filing surfaces which are at right angles to surfaces already finished.

Fig 3



Flat files are general purpose files. They are available in all grades. Hand files are particularly useful for filing at right angles to a finished surface.

or filing and finishing different profiles, files of different shapes are used.

The shape of files is stated by its cross-section.

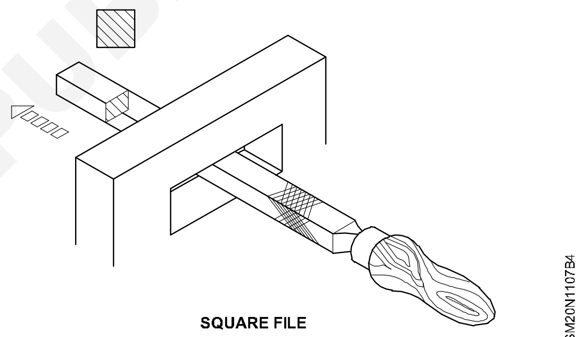
Common files of different shapes

– Flat file, hand file, square file, round file

– Half-round file, triangular file and knife-edge file (Flat and hand files have already been discussed.)

Square file : A square file is used for filing square holes, internal square corners, rectangular openings, keyways and splines. (Fig 4)

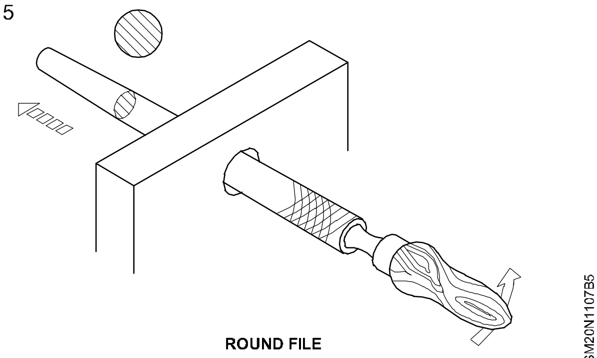
Fig 4



SQUARE FILE

Round file : A round file is used for enlarging circular holes and filing profiles with fillets. (Fig 5)

Fig 5

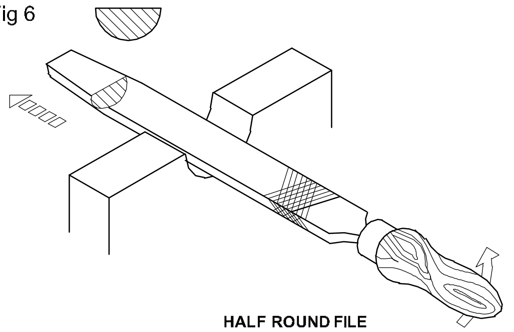


ROUND FILE

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 6)

Triangular file : A triangular file is used for filing corners and angles which are more than 60^0. (Fig 7)

Fig 6



HALF ROUND FILE

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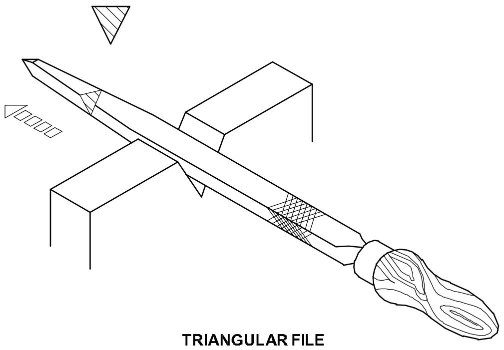
Fig 7



TRIANGULAR FILE

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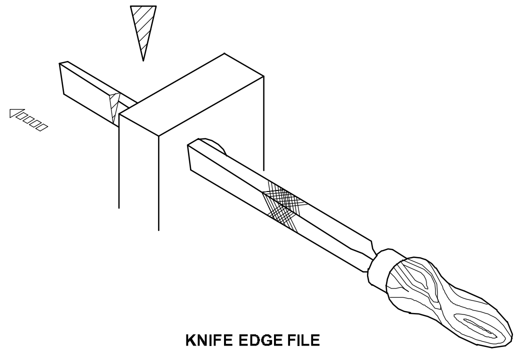
Knife-edge file : A knife-edge file has the cross-section of a sharp triangle. It is used for filing narrow grooves and angles above 10^0. (Fig 8)

Fig 8



KNIFE EDGE FILE

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The above files have one third of their lengths tapered. They are available both in single and double cuts.

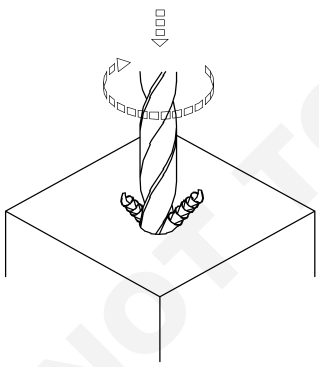
These files are available in lengths of 100, 150, 200, 250, 300 and 400 mm and are made in bastard, second cut and smooth grades.

Drill (Parts and function)

Objectives: At the end of this lesson you shall be able to
- **state the function of drills**
- **identify the parts of a drill**
- **state the function of each part of the drill.**

Drilling is a process of making holes on workpieces. The tool used is drill. For drilling, the drill is rotated in clockwise direction with a downward pressure causing the tool to penetrate into the material. (Fig 1)

Fig 1



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Parts of a drill

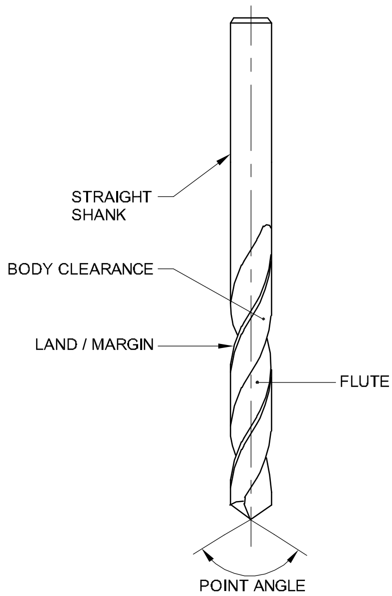
The various parts of a drill can be identified from the figure. (Fig 2)

Point: The cone shaped end which does the cutting is called the 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 the machine. (Fig 3) Shanks are of two types. Taper shank is used for larger diameter drills, and straight shank is used for smaller diameter drills.

LIP : LIP is the cutting edge which penetrates into metal while drilling.

Fig 2



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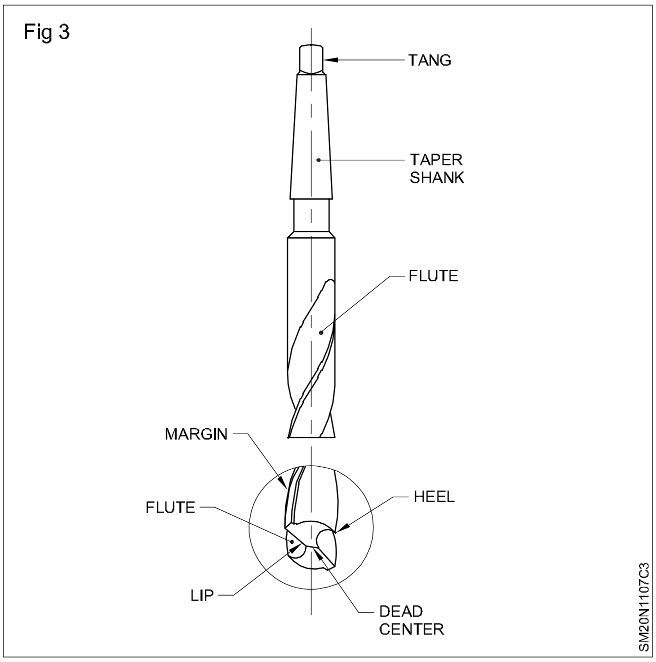


Tang: This is a part of the taper shank drill which fits into the slot of the drilling machine spindle.

Body: The portion between the point and the shank is the body of the 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

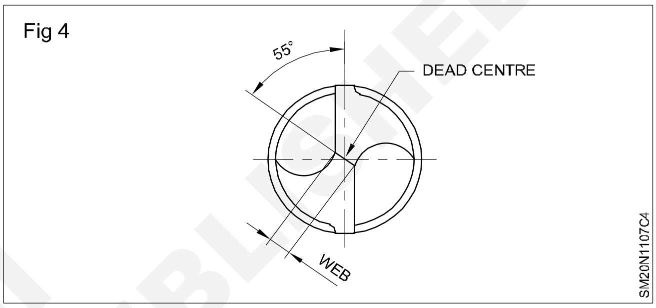
- to form the cutting edges
- to cut the chips and
- allow them to come out
- the coolant to flow to the cutting edge.

Land/margin: The land/margin is the narrow strip which extends to the entire length of the flutes.

The diameter of the drill is measured across the land/margin.

Body clearance: Body clearance is the part of the body which is reduced in diameter to cut down the friction 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.(Fig 4)



Sheet Metal Mallets & Hammers

Objectives: At the end of this lesson you shall be able to
- **state the different types of mallets**
- **state the uses of mallets**
- **state the care and maintenance.**

Mallet is a shaping tool used for general purpose work like flattening, bending and forming to required shape of sheet metal.

These are made of hard wood

When using any metal hammer for flattening the sheet metal, the face of the hammer may damage or leave impression on the sheet more than what is required for the job. To avoid such damage and a impression, mallets are used.

Types (Fig 1)

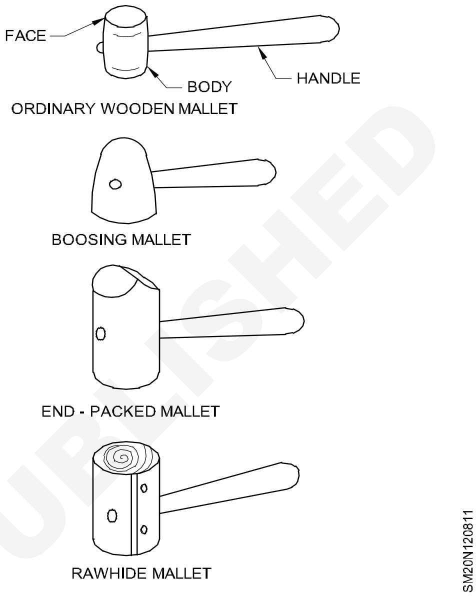
- Ordinary mallet
- Bossing mallet
- End-faked mallet
- Raw hide mallet.

Ordinary mallet: Both the faces of the mallets are provided the little convexity. If the face is not in convex shape the edges of the mallet face will get frozen while beating the job.

Mallets are specified by the dia and the shape of the face. Mallets are available in 50 mm, 75 mm and 100 mm dia.

Avoid using the mallet as hammer for doing chipping and to drive nails and work on the sharp corners.

Fig 1



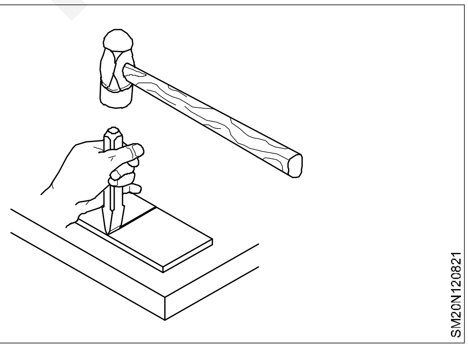
If so the face will get damaged and the mallet is liable to break.

Hammers

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

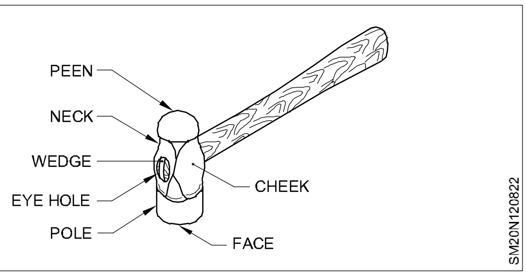
An engineers hammer is a hand tool used for striking purpose while punching, bending, straightening, chipping, forging and riveting. (Fig 1)

Fig 1



Parts of a hammer: The hammer's 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, pein, check, eyehole, pole and neck. (Fig 2)

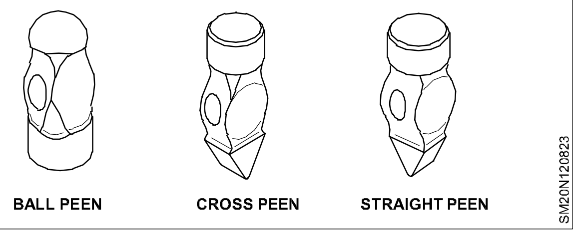
Fig 2



Face: The face is the striking portion and slight convexity is given to it to avoid digging of the edge. It is used for striking while chipping, bending, punching, hollowing etc.

Peen: The pein is the other end of the head. It is used for shaping and forming work like riveting, forming, bending, hollowing etc. The pein is of different shapes such as ball pein, cross pein and straight pein. The face and the pein are hardened. (Fig 3)

Fig 3



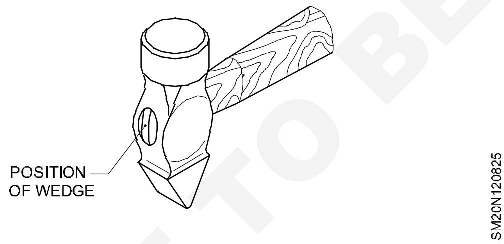
Cheek: The cheek is the middle portion of the hammer head. The weight of the hammer is stamped here.

This portion of the hammer head is left soft.

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

Fig 4

Fig 5

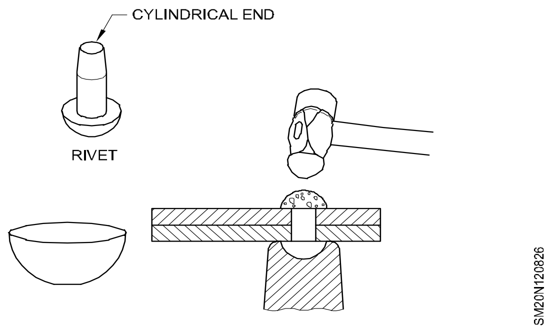


Specification : An engineer's hammer is specified by its weight and the shape of the pein. The weight varies from 125 grams to 1500 grams.

The weight of an engineer's hammer, normally used for marking purposes is 250 grams.

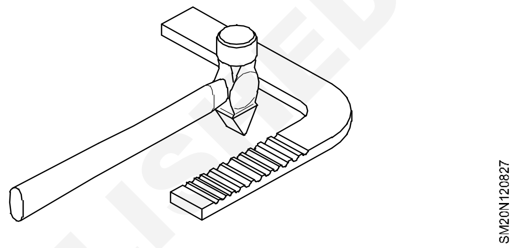
Application of hammer pein : The ball pein is used for riveting. (Fig 6)

Fig 6



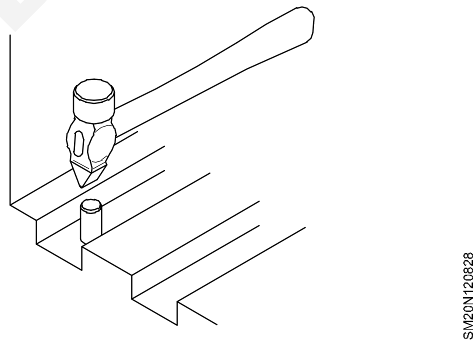
The cross pein is used for spreading the metal in one direction. (Fig 7)

Fig 7



The straight pein is used at the corners. (Fig 8)

Fig 8



Before using a hammer

- Make sure that the handle is properly fitted
- Select a hammer with the correct weight, suitable for the job.
- Check the head and the handle for any cracks.
- Ensure that the face of the hammer is free from oil or grease.

Sheet Metal Hammers

Objectives: At the end of this lesson you shall be able to
- **state the names of sheet metal hammers**
- **state the constructional features of sheet metal hammers**
- **state safety precautions while using the hammers.**

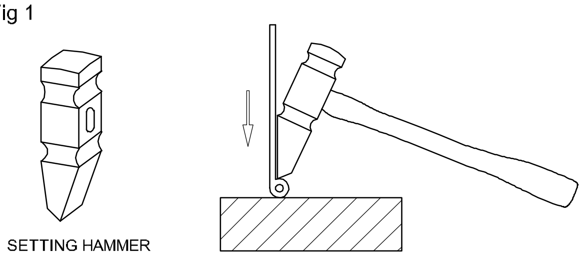
In the previous lessons, you learned about the Engineering hammers such as Ball pane hammer, cross pane hammer and straight pane hammer. Apart from these, there are some special type of hammers used in sheet metal trade, which are called sheet metal hammers.

They are

1 Setting hammer
2 Riveting hammer
3 Creasing hammer
4 Stretching hammer
5 Hollowing hammer
6 Bullet hammer
7 Planishing hammer
8 Peening hammer

Setting hammer: Its face is either round or square in shape. Its pane is tapered from the eye hole and the other side is straight to the handle. The tip of the pane is rectangular in shape, and slightly convexed. It is used to set up the seams, flaring the edge of the cylindrical jobs and to set up the long channel also. Its face is used for general purposes. (Fig 1)

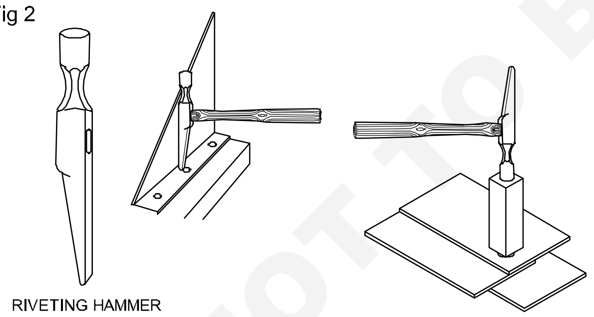
Fig 1



Riveting hammer: Riveting hammer's face is round in shape and the face is slightly convex. Its pane is long tapered and straight to the handle vertically. The tip of the pane is blended.

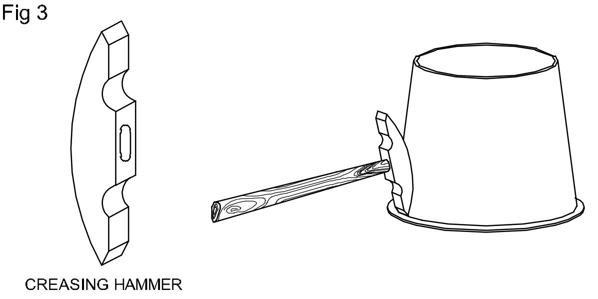
Riveting hammer is used to jump the rivet shanks and finish the rivet heads. (Fig 2)

Fig 2



Creasing hammer: Its both ends are sharpened and cross to the handle. It is used to finish the wired edges, false wiring edge and make corners of the sheet with the help of a creasing stake. (Fig 3)

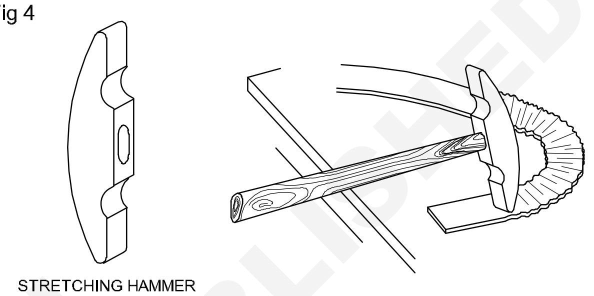
Fig 3



Stretching hammer: Its shape is like a creasing hammer but its pane ends are blended.

It is used to stretch the sheets to increase the length of the sheet. It is mostly used in raising operation. (Fig 4)

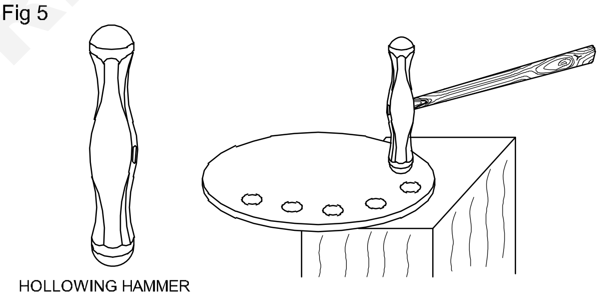
Fig 4



Hollowing hammer: Its both ends are shaped like ball and well polished.

t is used to make hollowing operation on the metal sheet and to remove the dents from the hollowed articles. This hammer is mostly used for panel beating work. (Fig 5)

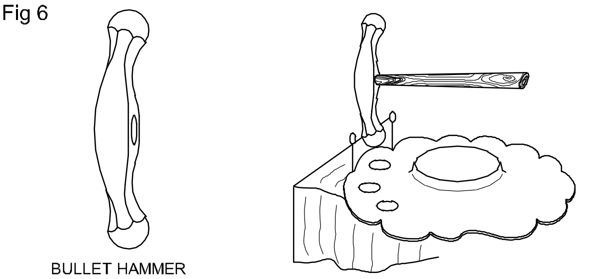
Fig 5



Bullet hammer: Its panes look like the hollowing hammer but the body is longer than the hollowing hammer and slightly bent. The pane ends are well polished and suitable to work on deep portion.

It is used to draw deep hollowing where the hollowing hammer cannot be used and also it is used to remove the dents from the deep hollow portion. (Fig 6)

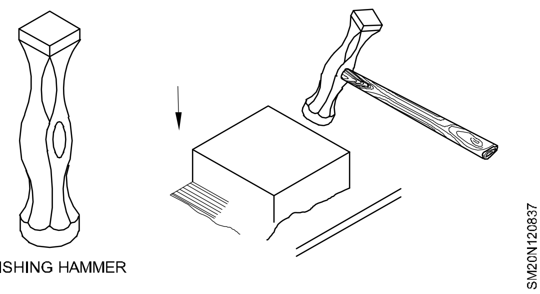
Fig 6



Planishing hammer: It's one face is square and other is round in shape and well polished. Its pane is slightly convex. This hammer is heavy in weight.

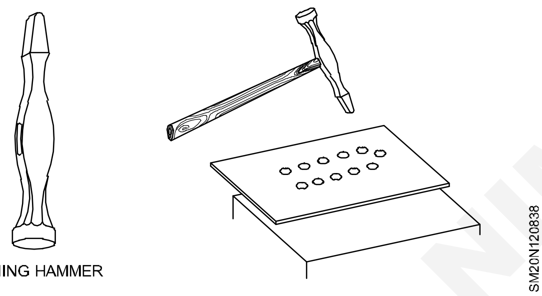
It is used to give smooth surface finish to the jobs which are hollowed and raised, and to planish the surface of the plain sheets. (Fig 7)

Fig 7



Peening hammer: It's face is round and slightly convex and a pane is just like stretching hammer. This hammer is used to peen polished impressions on the spinned aluminium job and hollowed copper, brass house hold vessels. (Fig 8)

Fig 8



Specification: The sheet metal hammers are specified by the Type of pane and the weight of the hammer.

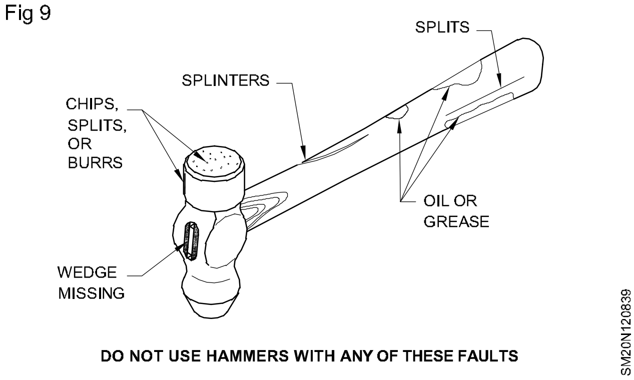
Example

1 lb Planishing hammer

Safety precautions (Fig 9)

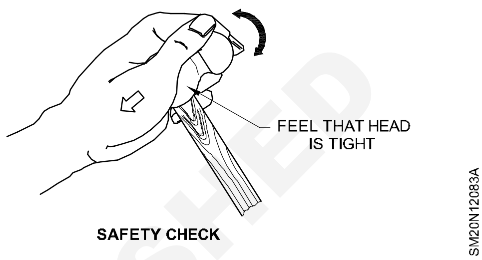
- Always handle and face of the hammers should be free from oil and grease.
- Face of the hammers should be free from scratches, dents, splits, burrs, chips etc.
- The handle should be securely fitted to the head. The wedge should be tight. (Fig 10)

Fig 9



DO NOT USE HAMMERS WITH ANY OF THESE FAULTS

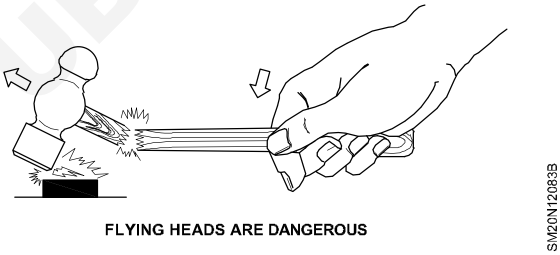
Fig 10



SAFETY CHECK

- Hammers fitted with broken, cracked, splinted handles should not be used. Replace the handles immediately. (Fig 11)

Fig 11



FLYING HEADS ARE DANGEROUS

- Heads flying from poorly fitted or broken handle can cause serious injuries.
- Always use a piece of soft metal between the hammer and the hard steel.
- Never hit two hammer faces together because the faces would split and the chips would fly dangerously.
- Select the right hammer for that particular job.

Groover

Objectives: At the end of this lesson you shall be able to
- **state the use of the groover**

Hand Groover

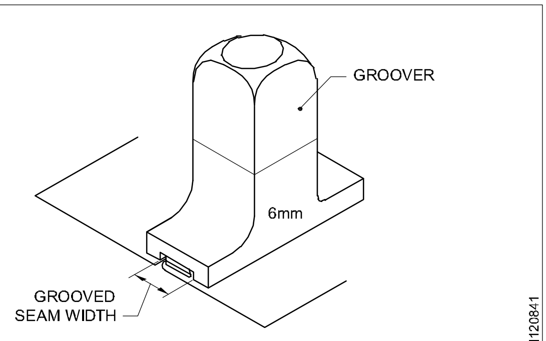
A groove is made at the bottom of this tool to the required width and depth.

This has a handle in square or hexagonal shape like chisel to hold. This whole part is hardened and tempered. (Fig 1)

The hand groover is specified according to the size of the groove of the groover.

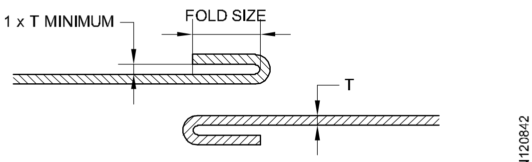
To arrive the size (width) of the fold to suit a particular groover, subtract the thickness by 3 times from the width of the groove (Fig 2)

Fig 1



SIZE OF GROOVE & SEAM

Fig 2



EDGE FOLDS

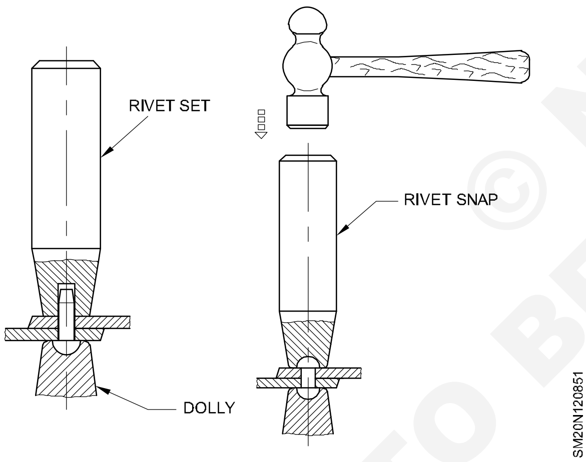
Tools for hand riveting

Objectives: At the end of this lesson you shall be able to
- **name the different tools used for hand riveting**
- **state the uses of different hand riveting tools.**

The following tools are used for making efficient riveted joints.

Rivet set: A rivet set is used for bringing the sheet metal closely together after inserting the rivet in the hole. This is required while riveting thin plates or sheets with small rivets.(Fig 1)

Fig 1

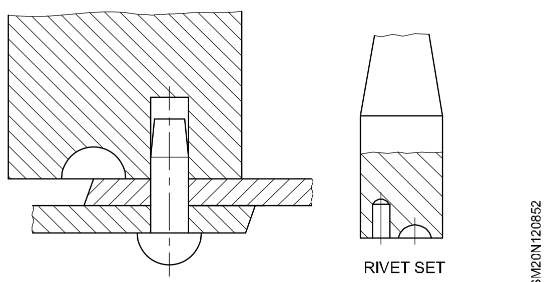


Dolly: This is used to support the head of the rivet which is already formed and also to prevent damage to the shape of the rivet head.

Snap: The rivet shape is used to form the final shape of the rivet during riveting. Snaps are available to match the different shapes of rivet heads.

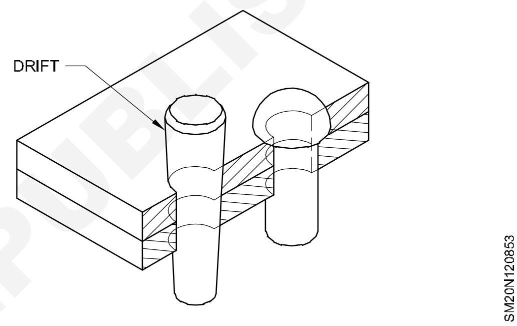
Combined rivet set: This is a tool which can be used for setting and forming the head.(Fig 2)

Fig 2



Drift: This is used to align the holes to be riveted.(Fig 3)

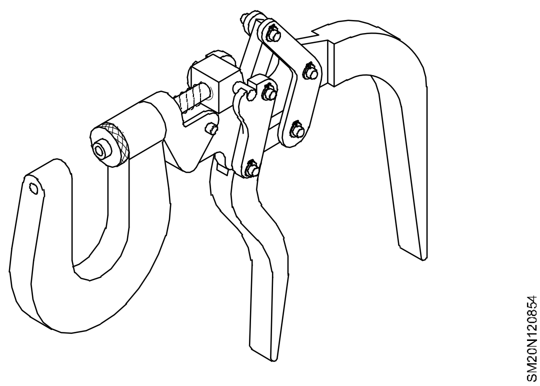
Fig 3



Hand riveter: This has a lever mechanism which exerts pressure between the jaws when the handle is pressed. (Fig 4)

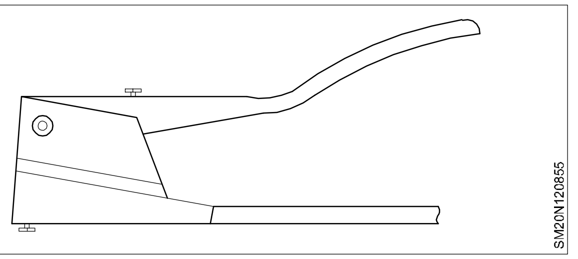
This is useful for riveting copper or aluminium rivets. Interchangeable anvils can be provided.

Fig 4



Pop riveter: This is used for riveting pop rivets by hand. The trigger mechanism squeezes the rivet and separates the mandrel of the rivet. In this method, as the mandrel is being separated from the rivet, the head is formed on the other end.(Fig 5)

Fig 5



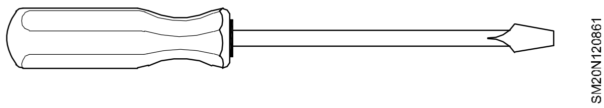
Screwdriver

Objectives: At the end of this lesson you shall be able to
- **state the different types of screwdrivers and their uses**

Screwdrivers are used to tighten or loosen screws and are available in various lengths.

Standard screwdriver (Light duty) (Fig 1)

Fig 1



It is made of a round shank/blade with metal, wood or moulded insulated material handle.

Standard screwdriver (Heavy duty) (Fig 2)

The shank is of square section for applying extra twisting force with the end of a spanner. (Fig 3)

Fig 2

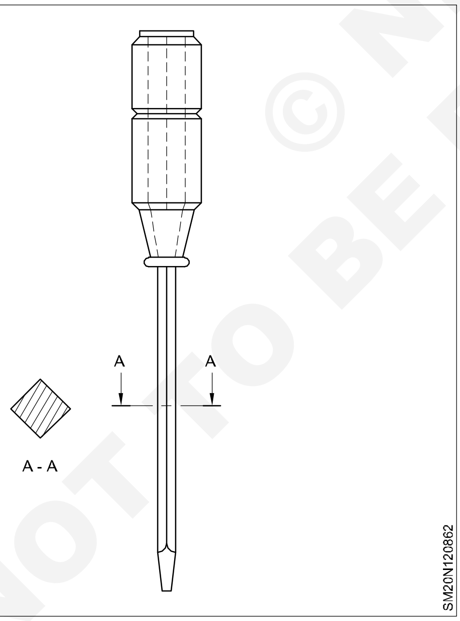
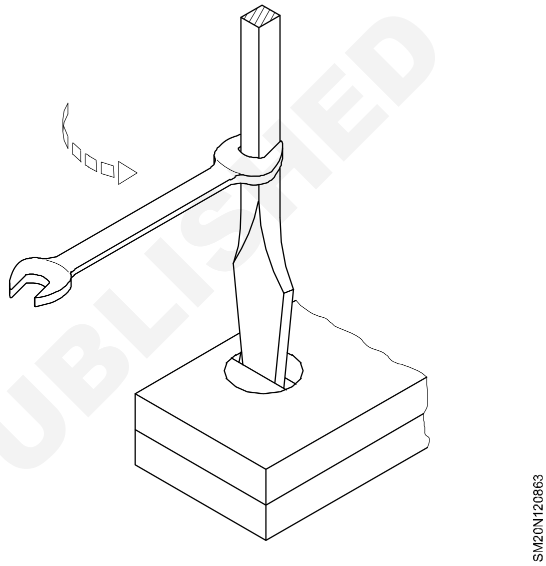
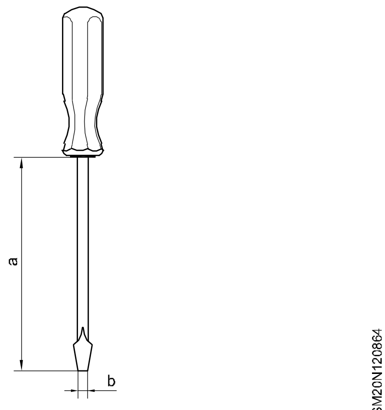


Fig 3



For quicker application ratchet offset screwdrivers are also available with renewable tips. (Fig 4)

Fig 4



Specification

Screwdrivers (Fig 5) are specified according to the

- length of the blade
- width of the tip.

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

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

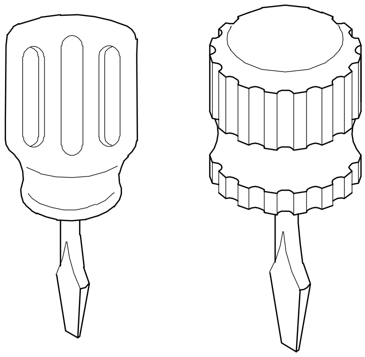


Fig 5

Screwdrivers for special uses

Small sturdy screwdrivers are available for use where there is limited space. (Fig 6)

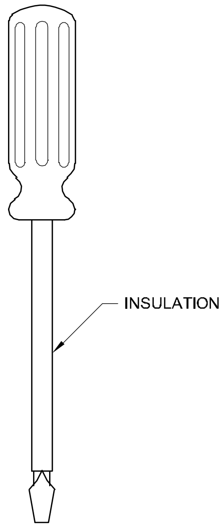


Fig 6

Screwdrivers with blades sheathed in insulation are available for the use of electricians. (Fig 7)

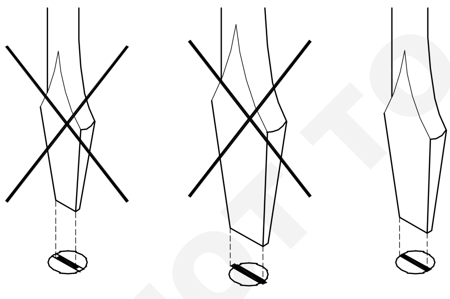


Fig 7

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

While using a Philips screwdriver apply more downward pressure.

Keep your hand away to avoid injury due to slipping of the screwdriver. (Fig 8)

Do not use screwdrivers with split or defective handles. (Fig 9)

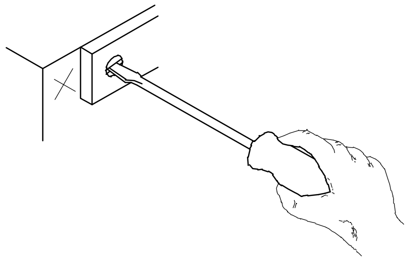


Fig 8

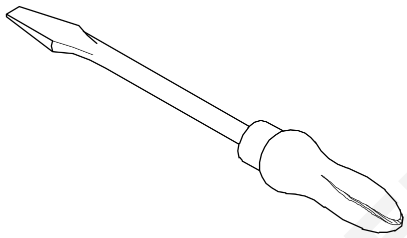


Fig 9

n 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.(Fig 10)

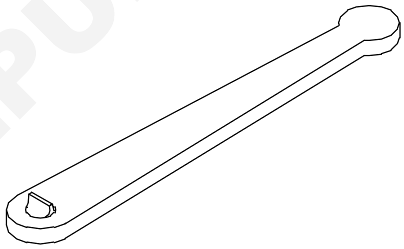


Fig 10

Heavy duty screwdriver (London pattern) (Fig 11)

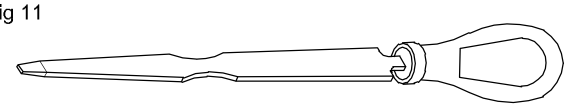
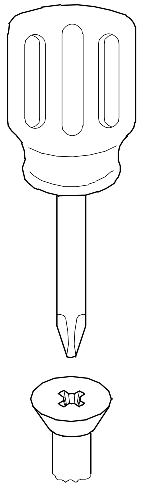


Fig 11

It has a flat blade and is mostly used by carpenters for fixing and removing wood screws.

Philips screwdriver (Fig 12)

Fig 12



These are made with cruciform (Fig 13) tips that are unlikely to slip from the matching slots. (Fig 14) Philips recess head screws are shown in (Fig 15).

Fig 13

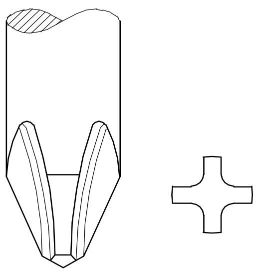


Fig 14

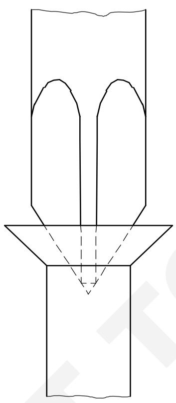
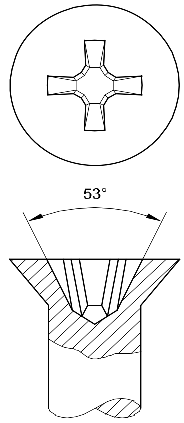


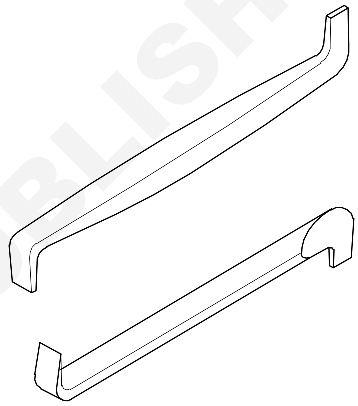
Fig 15



The sizes of Philips screwdrivers are specified by point size 1, 2, 3 and 4.

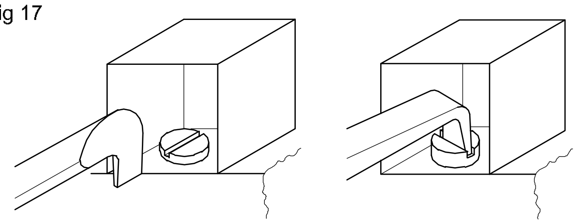
Offset screwdrivers (Fig 16)

Fig 16



These are useful in some situations (Fig 17) where the normal screwdriver cannot be used because of the length of the handle. They are also useful for applying greater turning force.

Fig 17



Spanners

Objectives: At the end of this lesson you shall be able to
- **state the uses of spanners of different sizes**
- **identify the size of a spanner.**

A spanner is a hand tool with jaws or opening or a ring at one end or at both ends for tightening or slackening nuts and bolts and screw heads. (Fig 1) It is made of drop-forged, high tensile or alloy steel and heat treated for strength.

Types of spanners

☐ Open end spanners

☐ Ring spanners

Open end spanners

They can be single-ended or double-ended.

Single-ended spanners (Fig 2)

These are general purpose spanners. Single-ended spanners are mostly supplied with machine tools for a specific purpose.

Fig 1

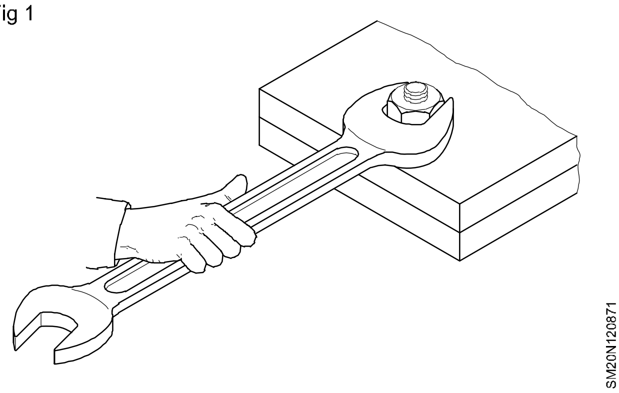
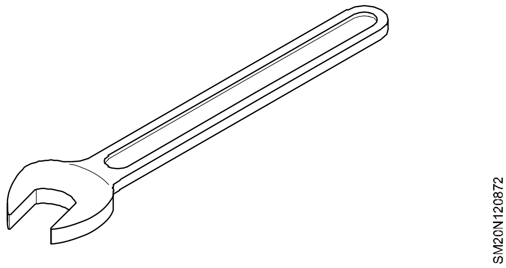


Fig 2



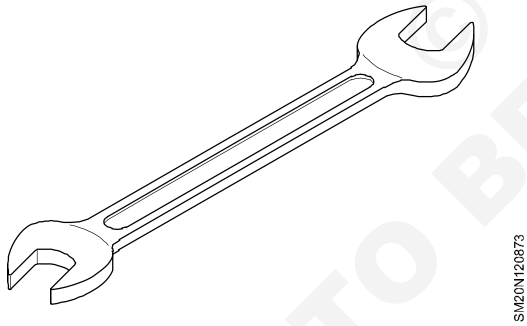
Double-ended spanners (Fig 3)

Double-ended spanners are standard spanners having two different size openings. Some spanners are made of chrome vanadium steel.

They are available in a set of 8, Nos 8 to 27 mm. (Fig 3)

8x10, 9x11, 12x13, 14x15, 16x17, 18x19, 20x22 and 24x27 mm.

Fig 3



Open end spanners bigger than 27 mm size are also available.

Ring spanners (Figs 4,5 & 6)

These types of spanners are used where obstruction close to the side of a nut prevails (Fig 4) and application of open-ended spanners is not possible.

Fig 4

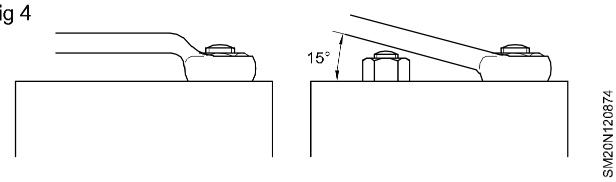


Fig 5

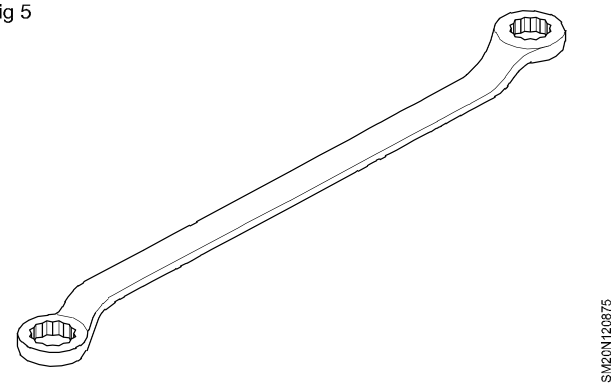
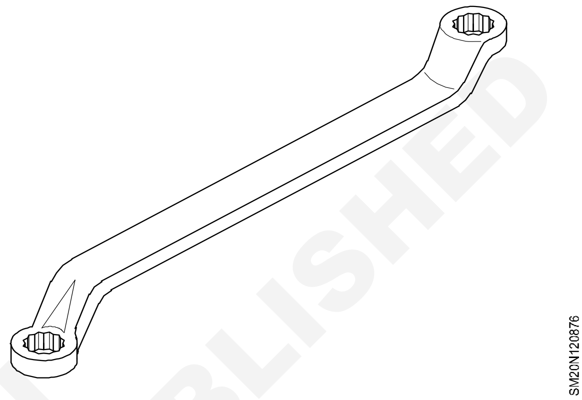


Fig 6



These are available in a set of 8 Nos. (8 to 27 mm)

8x9, 10x11, 12x13, 14x15, 16x17, 18x19, 20x22 and 24x27 mm.

Sizes and identification of spanners

Spanners for metric bolts, nuts and screws are marked with the size across the jaw opening in mm.

Special purpose spanners

- Tube or tubular box spanners (Figs 7 & 8)

Fig 7

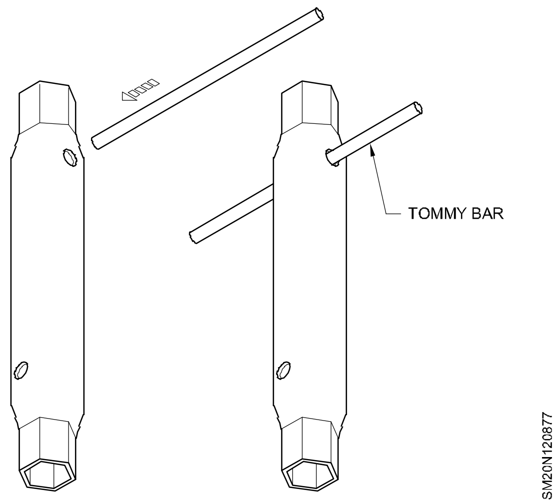
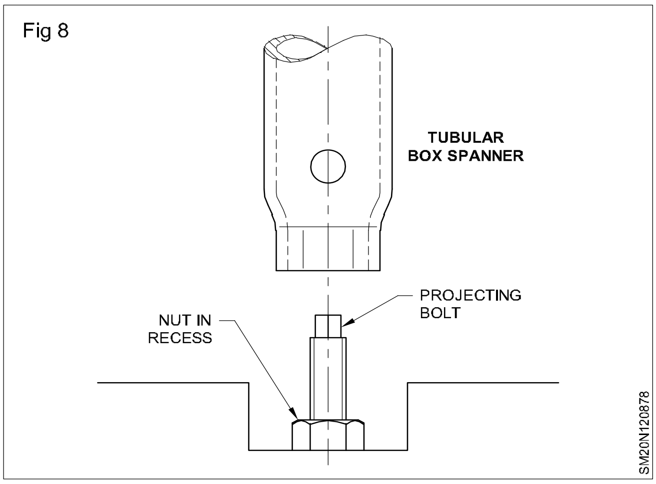
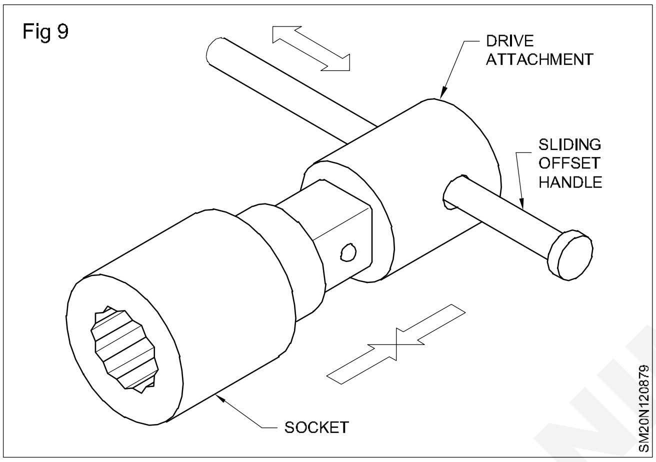


Fig 8



- Socket spanners (Fig 9)

Fig 9



- Adjustable spanners (Figs 10 &11)

Fig 10

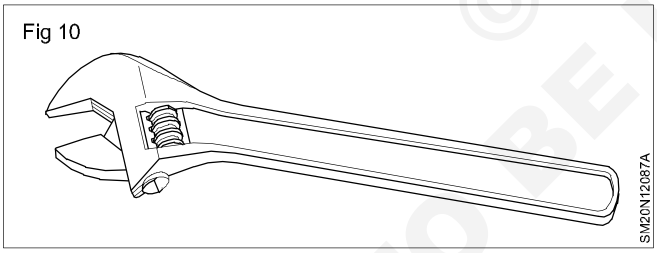
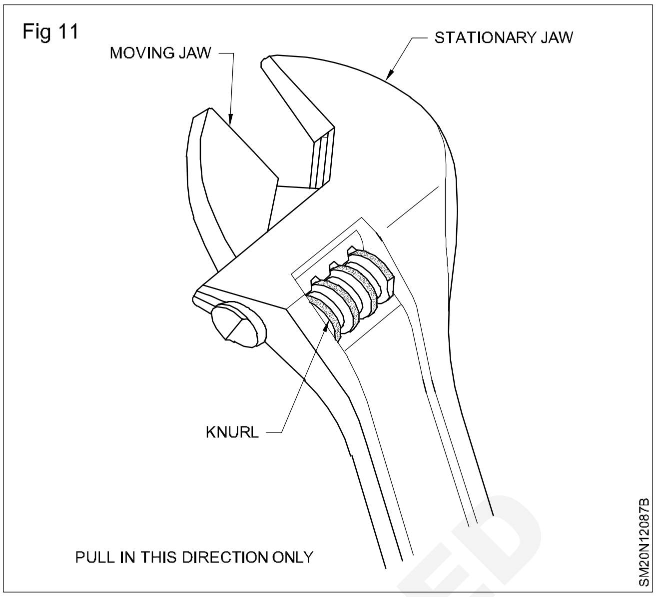


Fig 11



- Hook spanners (C-spanner) (Figs 12 & 13)

Fig 12

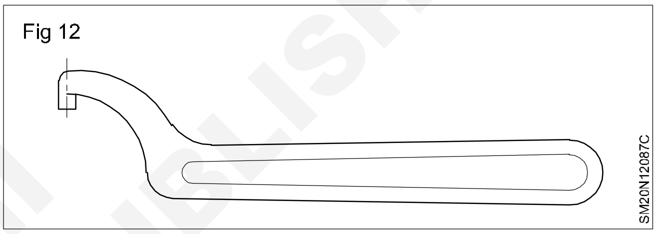
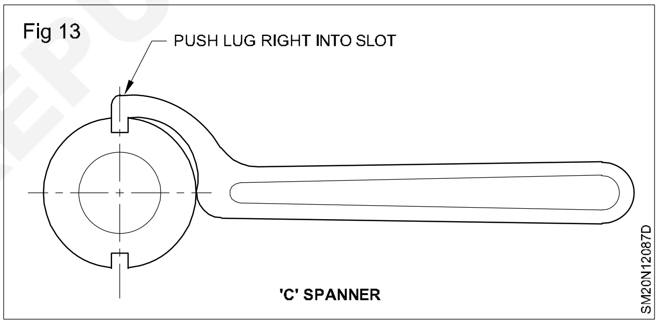


Fig 13



Holding Tools

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

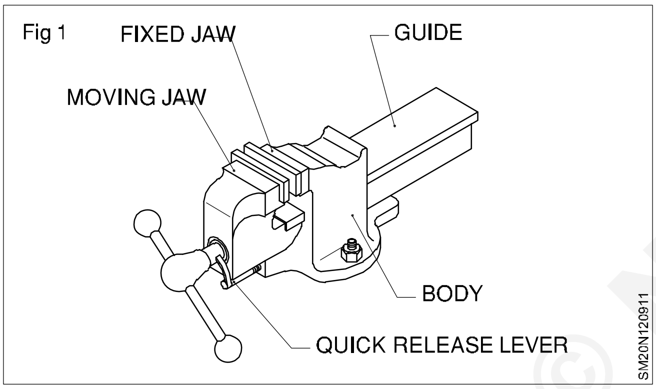
Vice

There are different types of vices used for holding work-pieces. They are quick releasing vice, pope vice, hand vice, pin vice and toolmaker's vice.

Quick releasing vice (Fig 1)/ Benchvice/Engineer's vice

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 screw and the movable jaw canbe set in any desired place quickly.

Fig 1

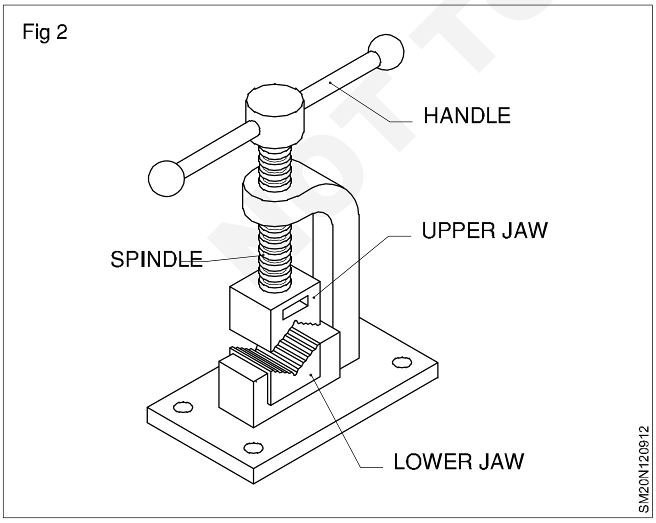


Pipe vice (Fig 2)

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

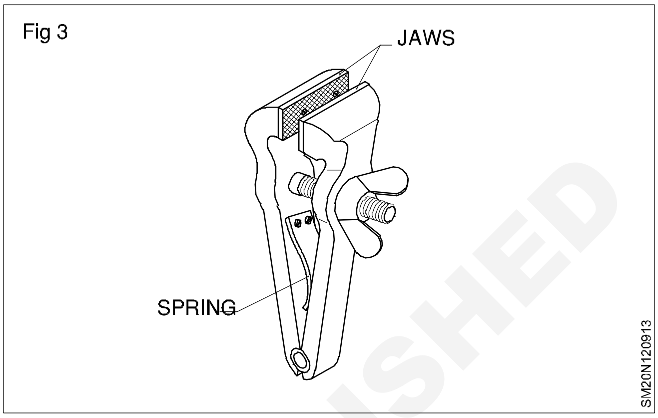
The pipe vice grips the work at four points on its surface. The parts of a pipe vice are shown in (Fig 2).

Fig 2



Hand vice (Fig 3 Hand vices are used for gripping screws, rivets, keys, small drills and others similar objects which are too small to be conveniently held in the bench vice. A

Fig 3

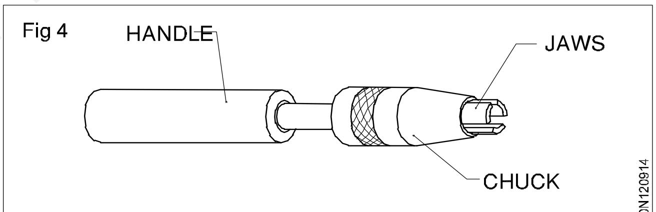


hand vice is made in various shapes and sizes. The length varies from 125 to 150 mm and the jaw width from 40 o 44 mm. The jaws can be opened and closed using the wing nut on the screw that is fastened to one leg, and passes through the other.

Pin vice (Fig 4)

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

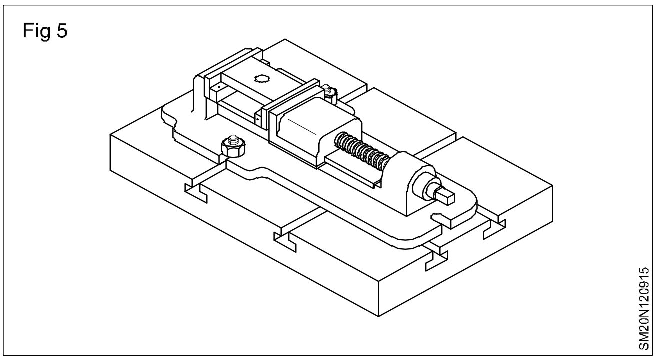
Fig 4



PIN VICE

Toolmaker's vice (Fig 5)
The toolmarker's vice is used for holding small work which requires filling 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.

Fig 5



Holding devices/Clamps

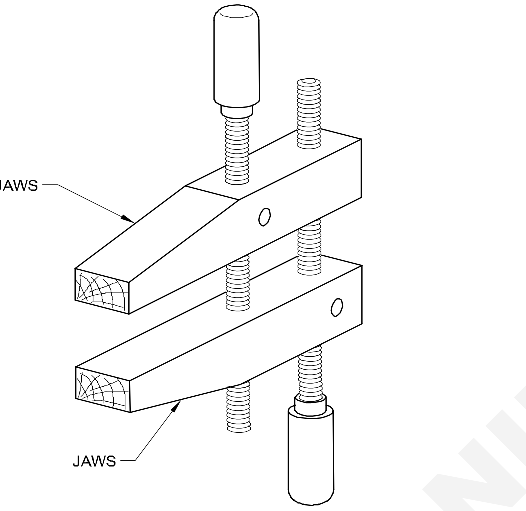
Objectives: At the end of this lesson you shall be able to
- **state the uses of Bar clamp and 'G' clamp**
- **state the uses of 'C' clamp and Hand screw.**

Hand screw (Fig 1)

The hand screw is a clamp consisting of a pair of chops. This is made of either in steel or wood.

It has two jaws one in left and the other in right side. Both the jaws are connected by two screwed thin rods, as shown in figure. Both the screws are to be screwed equally when clamping the job.

Fig 1



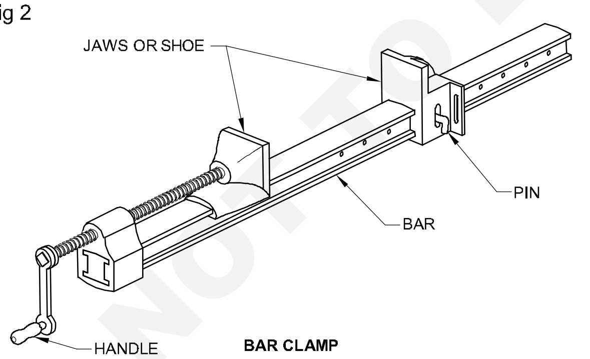
HAND SCREW

This is useful for small jobs and in gluing works.

Bar clamp (Fig 2)

Steel bar clamps are used generally in pairs for gluing purposes. The bar may be of rectangular or 'T' shape.

Fig 2



BAR CLAMP

T-bar clamps are heavier. Extra pressure can be applied to the job by this device. It has two sliding shoes. One shoe is attached to the screw and the other is pinned where it is necessary. The screw rod has a strong square thread. These are used for clamping up wide works and large frames.

'G' and 'C' clamp (Fig 3 & Fig 4)

These are frequently used for smaller jobs and where the two hands are employed. Both clamps have 'H' section iron and resists any tendency to distortion. The screw has a strong square thread and a round shoe on a ball which is socked joint. T-clamps are available in clamping capacity of 160mm to 2500mm.

In addition to the above there are several other clamps such as Corner clamp, Rope clamp, Flexible band clamps, Wooden gluing device etc.

Fig 3

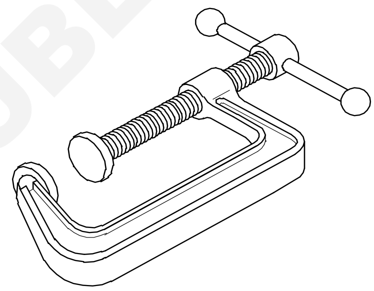
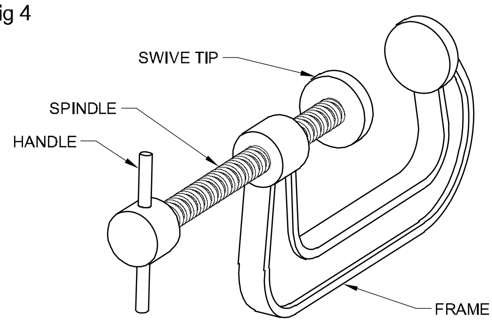


Fig 4



'G' CALAMP

Stakes and their uses

Objectives: At the end of this lesson you shall be able to
- **state what is a stake**
- **state the different types of stakes and their uses.**

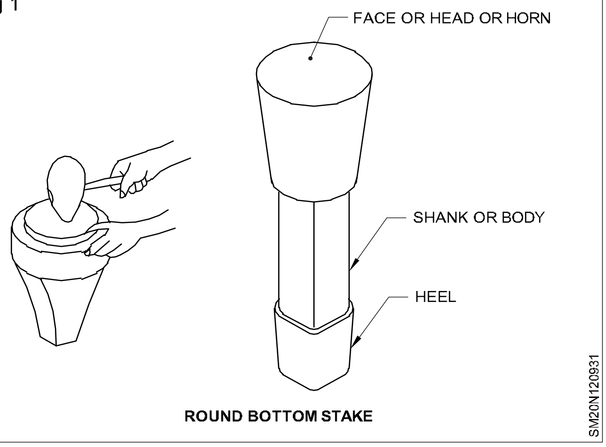
Stakes are the sheet metal workers anvils used for bending, seaming or forming. They actually work as supporting tools as well as forming tools.

Stakes are made in different shapes and sizes to suit the types of operations for which machines are not readily available or readily adaptable.

Some stakes are made of forged mild steel, faced with cast steel. The better class stakes are made either of forged steel or of cast steel.

A stake used in sheet metal working consists of a head (or) a horn. (shank or body and heel) The shanks are designed to fit into a tapered bench socket. (Fig 1)

Fig 1

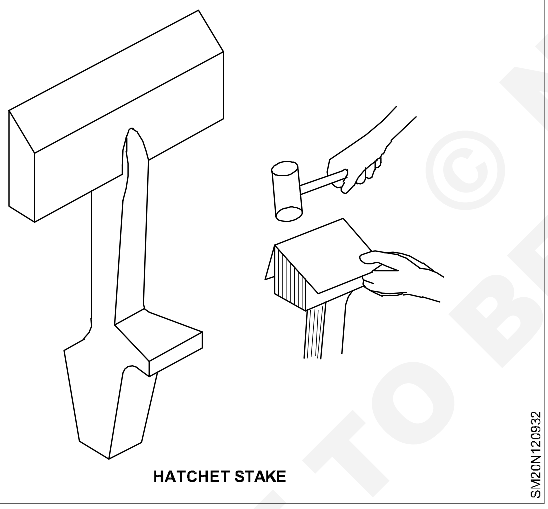


ROUND BOTTOM STAKE

Round bottom stake (Fig 1): It has a round and a concave face head. It is used for hollowing the sheet.

Hatchet stake (Fig 2): The hatchet stake has a sharp, straight edge, bevelled along one side. It is very useful for making sharp bends, folding the edges of sheet metal, forming boxes and pans by hand.

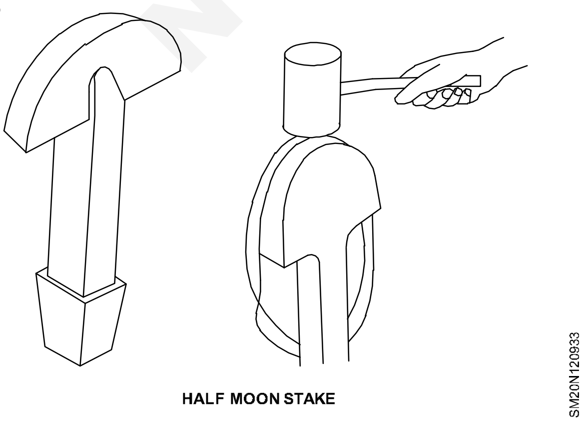
Fig 2



HATCHET STAKE

Half moon stake (Fig 3): This stake has a sharp head in the form of an arc of a circle, bevelled along one side. It is used for turning up flanges on metal discs.

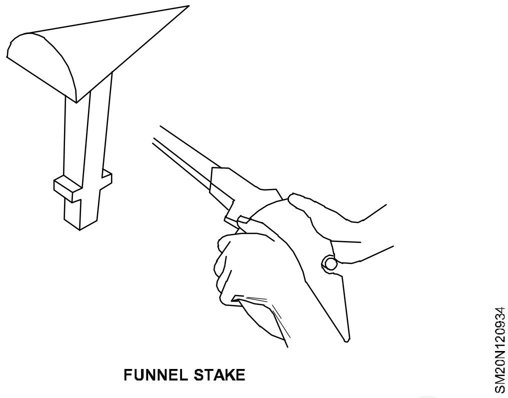
Fig 3



HALF MOON STAKE

Funnel stake (Fig 4): This stake is used when shaping and seaming funnels and tapered articles.

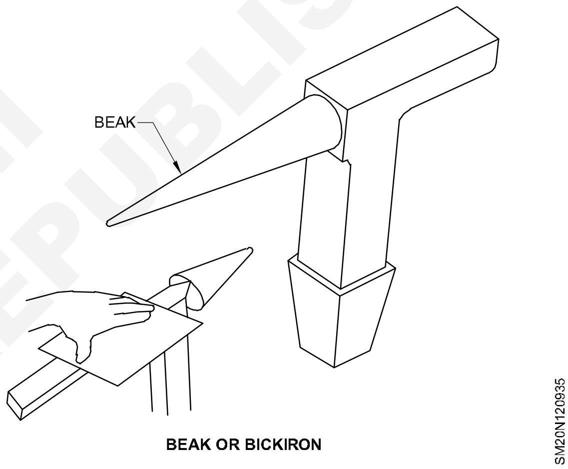
Fig 4



FUNNEL STAKE

Beak or Bick Iron stake (Fig 5): This stake has two horns, one of which is tapered the other is a rectangular shaped anvil. The thick tapered horn or beak is used when making spouts and sharp tapered articles. The anvil may be used for squaring corners, seaming and light riveting.

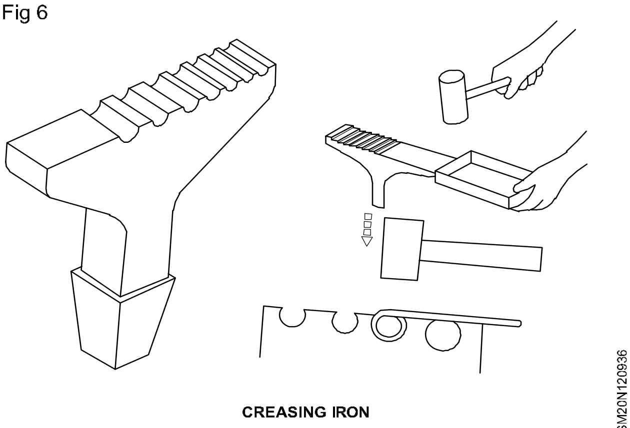
Fig 5



BEAK OR BICKIRON

Creasing Iron (Fig 6): This stake has two rectangular shaped horns, one of which is plain. The other horn contains a series of grooving slots of various sizes. The grooves are used when 'Sinking' a bead on a straight edge of a flat sheet. This is also used when making small diameter tubes with thin gauge metal.

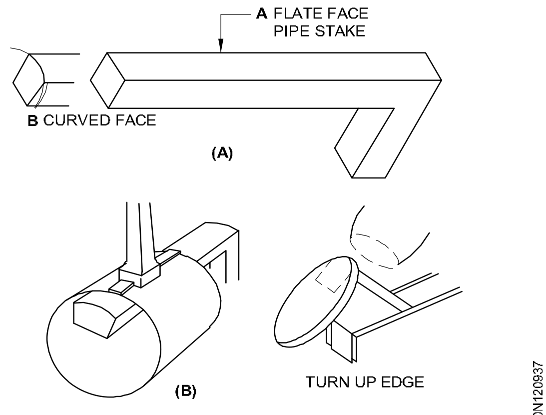
Fig 6



CREASING IRON

Pipe stake or Square edge stake (Fig 7): This stake has the horn and the shank. The horn is available in two types.one is with flat face as shown in (Fig 7A). Other one is with curved face as shown in (Fig 7B) Flat face horn stake is used to fold the edges, and to turn up straight edges. The curved face horn stake is used to turn circular disc or curved edges and to make knocked up joints.

Fig 7



SEAM SETTING

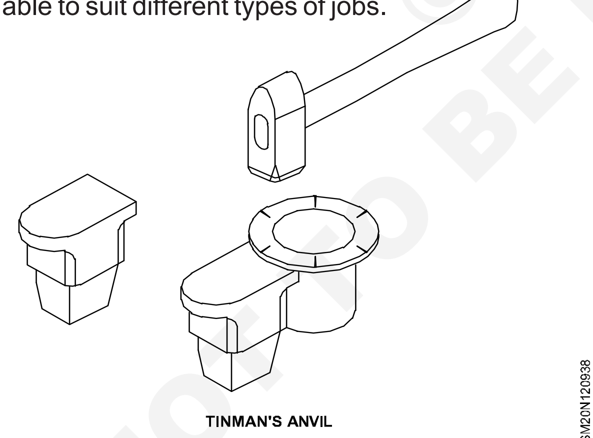
Tinman's Anvil (Fig 8): It is used for planishing all types of flat shaped works. It is highly polished on its working surface.

inman's Horse (Fig 9): This stake has two arms at its both ends, one of which is usually cranked downwards for clearance purpose. There is a square hole for the reception of a wide variety of heads. (Fig 10)

The surface of the stake is important for the workmanship of the finished article. Therefore, care must be taken to avoid any damage to the surface of the stake when centre punching or cutting with a cold chisel.

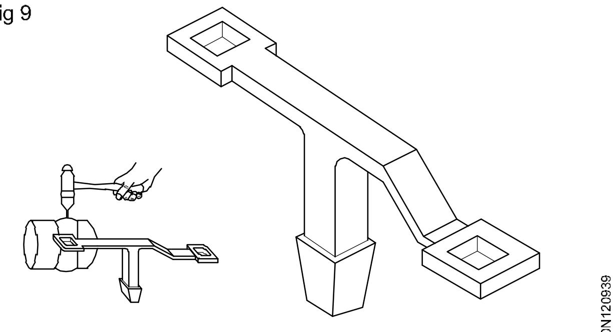
Apart from these stakes, special types of stakes are also available to suit different types of jobs.

Fig 8



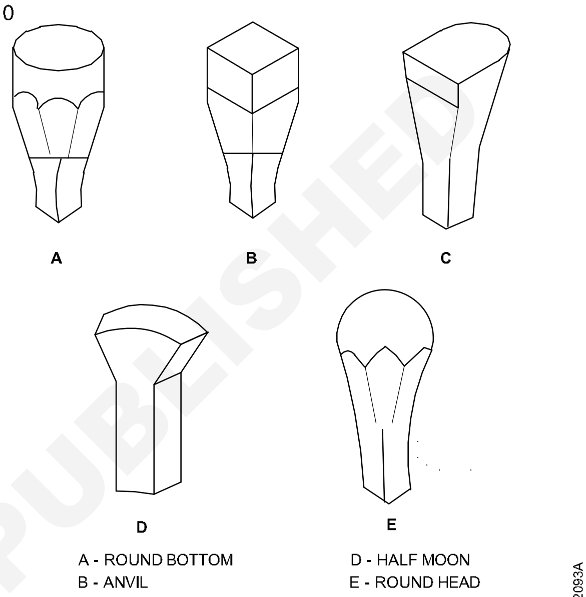
TINMAN'S ANVIL

Fig 9



TINMAN'S HORSE

Fig 10



HEADS

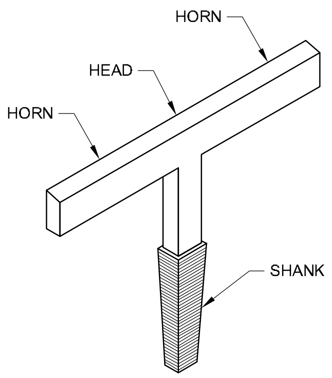
Hatchet stake

Objectives: At the end of this lesson you shall be able to
- **state what is a stake**
- **state the features of a hatchet stake**
- **state the method of folding using a hatchet stake.**

The parts of a stake are the shank, the head and the horn. The shanks are generally square tapered to fit into a tapered bench socket or bench plate. (Fig 1)

Hatchet stake(Fig 2)**:** It has a sharp, straight edge bevelled along one side. Angle of bevelled edge is normally 50 to 60°. It is used for making sharp bends, bending edges and forming rectangular articles.

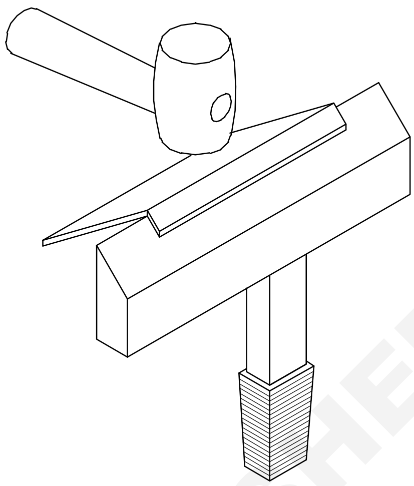
Fig 1



HATCHET STAKE

Hatchet stake is usually mounted in a tapered bench socket. Sometimes it can also be clamped in a bench vice. The sheet metal workpiece is held on a hatchet stake in the required position and folded to the required angle by striking with a mallet. (Fig 2)

Fig 2



Copper Smith Stake

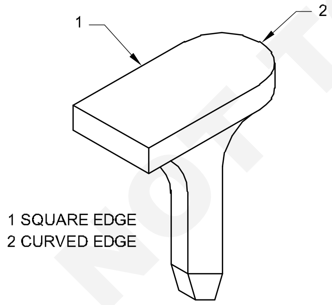
Objectives: At the end of this lesson you shall be able to
- **identify a copper smith stake**
- **state the constructional features of a copper smith stake**
- **state the uses of a copper smith stake**
- **state safety, care and maintenance while using a copper smith stake.**

It is not economical to have too many stakes for simple operations in a sheet metal shop.

Hence, an economical way of tooling is adopted and designed by combining two edges of different cross

sections on a common head as in Fig 1. This stake is called a copper smith stake or tinman's anvil. It is a very useful stake used in sheet metal work, due to its constructional features.

Fig 1



.These stakes are made of medium carbon steel and case hardened.

Safety Care and Maintenance:

1 Fix the stake firmly in the bench plate or stake holder to avoid slipping and causing accidents.

2 Do not use it for heavy work.

3 Do not spoil the surface of the stake by chiseling and punching.

4 Do not spoil the edges by cutting wire or nails on the edges of the stake.

5 Remove and keep it in its place after use.

Bottom round stake

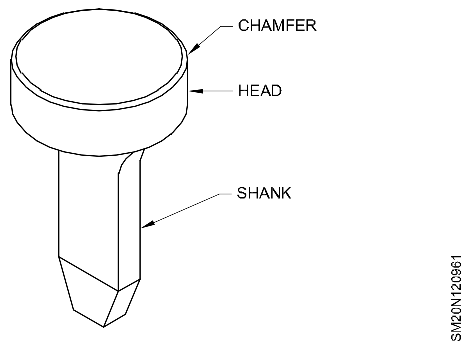
Objectives: At the end of this lesson you shall be able to
- **identify the Round Bottom Stake**

Bottom round stake: This is a very common stake used in a sheet metal shop. This stake is round in shape with a flat face, slightly chamfered to avoid the cracking or tearing of sheets while using it.

It is used for turning edge on circular discs, seaming and fixing bottom to cylindrical parts, making a paned down joint at the bottom of the cylindrical parts. The tail is designed to fit in the square slot made in the work bench or stake holder.

> **Do not cut wires or nails on the edge of the stake. This will spoil the edge and the same impression will be formed on the sheet or the part formed on it.**

Fig 1

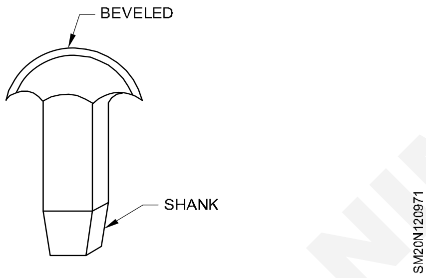


Half moon stake

Objectives: At the end of this lesson you shall be able to
- **state constructional features of a half moon stake**
- **state safety, care and maintenance while using a half moon stake**

This is one of the most commonly used stake in Sheet Metal Work. The shape of the head is in the form of half moon. So it is called as half moon stake.(Fig 1)

Fig 1



It has a sharp edge bevelled to an angle of 45^0.

These stakes are generally made from medium carbon steel and case hardened.

These stakes are used for turning, making sharp edges and flanges on circular articles, finishing the hemmed and wired edges on circular articles. (Fig 2 & 3)

Safety, Care and Maintenance

Do not use it for very heavy work.

Do not spoil the edges of the stake by cutting wires and nails on it. (Fig 4)

Always fasten the stake firmly on to the bench plate or bench vice, while using it.

Fig 2

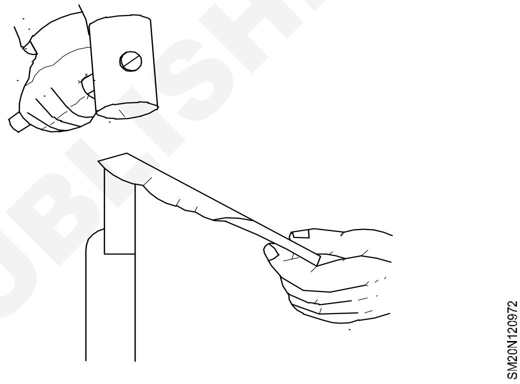


Fig 3

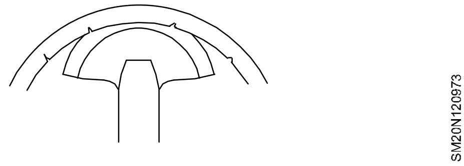
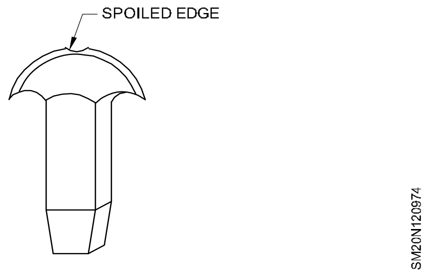


Fig 4



Stake Holders

Objectives: At the end of this lesson you shall be able to
- **identify different types of stake holders**
- **state the constructional features of stake holders**
- **state the uses of stake holders**
- **state safety, care and maintenance when using stake holders.**

There are three types of stake holders

1 Bench plate

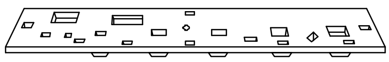
2 Revolving bench plate

3 Universal stake holder

Bench plate: Stakes are held in position while using them by means of a plate which is fastened to the work bench with bolts and nuts. These plates are called bench plates or stake holders.

These bench plates are made of cast iron and are rectangular in shape as in Fig 1. The tapered holes are conveniently arranged so that the shanks of the stakes may be fixed and used in any convenient position. The smaller holes are used to support the bench shears.

Fig 1



BENCH PLATE

SM20N120981

Revolving bench plate: Revolving bench plate consists of a revolving plate with tapered holes to support the shanks of the stakes while using them.

This revolving bench plate can be held in any convenient position by clamping it on to the work bench, with the clamping provision provided on it as in Fig 2.

Universal stake holder: Universal stake holder can be clamped to any desired position on the work bench. So it is preferred by most of the mechanics.

This stake holder is designed with a set of stakes which can be easily fixed on to the stake holder and hence it is termed as universal stake holder set as shown in Fig 3. One stake may be replaced by another very quickly by simply turning the swivel handle and replacing the stake.

When placing an order to purchase this type of stake holder set, we should specify clearly the type of stakes to be supplied along with the stake holder.

Safety, care and maintenance:

– Fix the stake holder firmly on to the work bench.

– Do not use it for very heavy work.

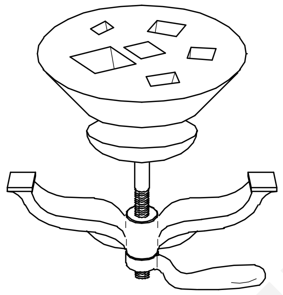
– Do not overtighten the locking arrangements which may spoil the threads on the device.

– Do not place the unnecessary accessories on the work table. Place only the required ones.

– Avoid chiseling or punching on this stake holder.

– Remove and keep it in its place after use.

Fig 2



REVOLVING BENCH PLATE

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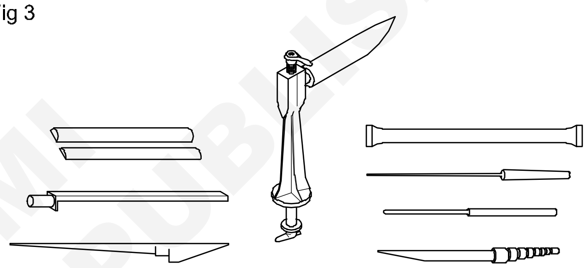
Fig 3



UNIVERSAL STAKE HOLDER

SM20N120983

Hollow mandrel

Objectives: At the end of this lesson you shall be able to
- **identify a hollow mandrel stake**
- **state the constructional features of the hollow mandrel stake**
- **state the safety, care and maintenance, when using the hollow mandrel**
- **state the uses of the hollow mandrel stake.**

Introduction

A Sheet metal worker often requires a proper supporting tool to perform different operations like folding, bending, forming, riveting, seaming and finishing while making sheet metal articles.

Hence many supporting tools are designed and used in sheet metal shops. These supporting tools are called stakes. One such supporting tool is a hollow mandrel stake.(Fig 1)

Hollow Mandrel Stake: This is the most commonly used stake in all sheet metal shops. It is a single horizontal metal piece in which one surface is flat and the other surface is round. It has a slot which permits it to slide on a bolt, so that it can be fastened to the bench to any required length.

These stakes are made from medium carbon steel and case hardened.

The rounded section is used for forming, seaming and finishing cylindrical shaped articles.

The flat shaped surface is used for flattening the sheets, double seaming, corners for pans, boxes etc.

This stake may be directly fixed on to the bench or to a universal stake holder.

Safety care and maintenance:

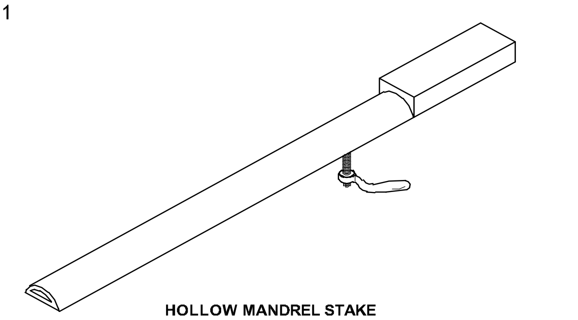
Do not over tight the locking bolts as the bolt will get bent or the threads will get spoiled.

Do not use it for heavy work as the stake may bend, or slip and fall causing an accident.

Keep the face of the stake free from scratches and dents as the same deformation will occur on the parts formed on it.

Remove and keep it in its place as it may occupy unnecessary place when not in use and restrict free movements.

Fig 1

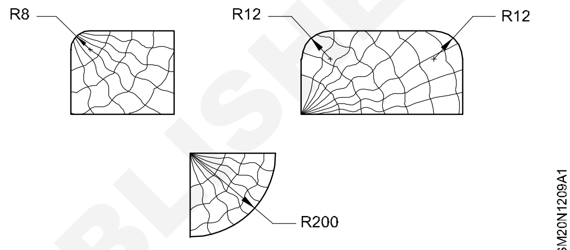


Wooden formers

Objectives: At the end of this lesson you shall be able to
- **State what is a wooden former**
- **State the uses of a wooden former.**

In sheet metal working, sheets are required to be formed in various radii and shapes to suit that paricular job. Sometimes suitable supports or stakes are not available in the shop. Hence hard wood are made to the required radius or shapes. These so formed hard wooden pieces are used as supports to re-produce the same radius or shapes on the sheet metal. These are called wooden formers. Different shapes of wooden formers are shown in Fig 1.

Fig 1



Folding the sheet metal, using hard wooden piece and c clamps

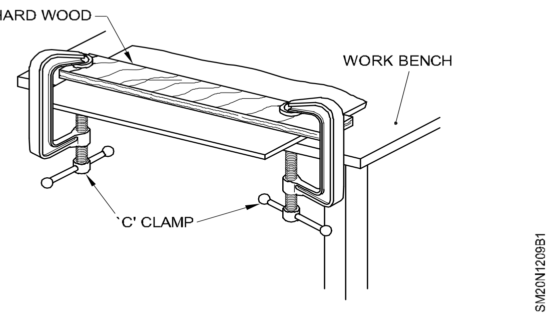
Objectives: At the end of this lesson you shall be able to
- **state the use of a hard wooden piece and C clamps for folding the sheet metal.**

In this process of folding, a hard wooden piece is used as a supporting tool. It is generally rectangular in shape.

Property of the hard wood is to resist deformation to prevent it from damage, after the hammer blows.

In this method of folding, (Fig 1) the sheet metal workpiece is clamped with the hard wooden piece with the help of two C clamps. Part of the sheet metal to be folded, is projected outside the edge of the workbench. The projected portion of the sheet metal workpiece is folded by striking with a wooden mallet.

Fig 1



Jigs & Fixtures

Objectives: At the end of this lesson you shall be able to
- **state the advantages of jigs and fixtures.**

Introduction: Mass production aims at high productivity to reduce unit cost and at interchangeability to facilitate easy assembly. This necessitates the manufacture of jigs and fixtures which increase the rate of production.

Jig is a work holding device used to hold the job in proper location as well as to guide the cutting tool. Jigs are rarely clamped on the machine and mostly used for drilling holes.

Fixture is a work holding device which holds the job in proper location, but the tool is not guided as in a jig. Fixtures are often clamped to the machine table.

Fixtures are used in machinery assembly and inspection.

Advantages of Jigs and Fixtures

1 **Productivity**

Jigs and fixtures eliminate marking, positioning and frequent checking. This minimise the operation time and increases the productivity.

2 **Interchangeability**

Jigs and fixtures facilitate uniform quality in manufacture. Any of the parts will fit properly in assembly, and all similar components are interchangeable.

3 **Skill reduction**

Jigs and fixtures simplify locating and clamping of workpieces. Even unskilled worker can operate using jigs and fixtures.

4 **Cost reduction**

Higher production, scrap reduction, easy assembly and savings in labour cost result in cost reduction for workpieces produced with jigs and fixtures.

Soldering iron (soldering bit)

Objectives: At the end of this lesson you shall be able to
- **state the purpose of soldering iron**
- **describe constructional features of soldering iron**
- **state different types of copper bits and their uses.**

Soldering iron: The soldering iron is used to melt the solder and heat metal that are joined together.

Soldering irons are normally made of copper or copper alloys. So they are also called as copper bits.

Copper is the preferred material for soldering bit because

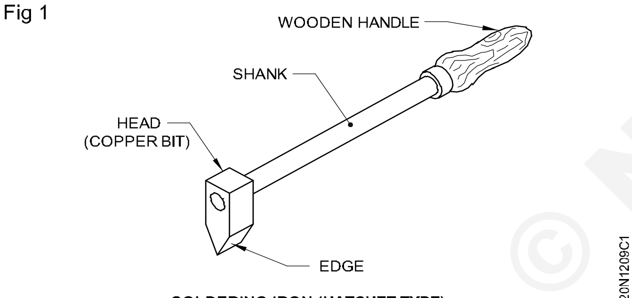
– it is a very good conductor of heat

– it has affinity for tin lead alloy

– it is easy to maintain in serviceable condition

– it can be easily forged to the required shape.

Fig 1



SOLDERING IRON (HATCHET TYPE)

A soldering iron has the following parts. (Fig 1)

– Head (copper bit)

– Shank

– Wooden handle

– Edge

SOLDERING COPPER BIT

Types of soldering copper bits: There are 7 types of soldering copper bits in general use,

They are

– The pointed soldering copper bit.

– The electric soldering copper bit.

– The gas heated soldering copper bit.

– Straight soldering copper bit.

– Hatchet soldering copper bit.

– Adjustable copper bit.

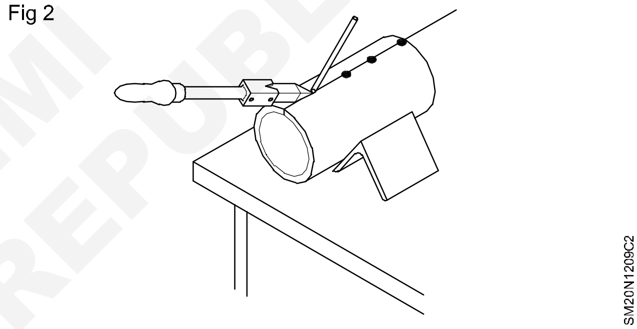
– Handy soldering copper bit.

The bits of soldering irons are made in various shapes and sizes to suit the particular job. They should be large enough to carry adequate heat to avoid too frequent reheating and not too heavy to be awkward to manipulate.

Soldering bits are specified by the weight of the copper head. For general soldering process, the shape of the head is a square pyramid but for repetition, or awkward placed joints, other shapes are designated.

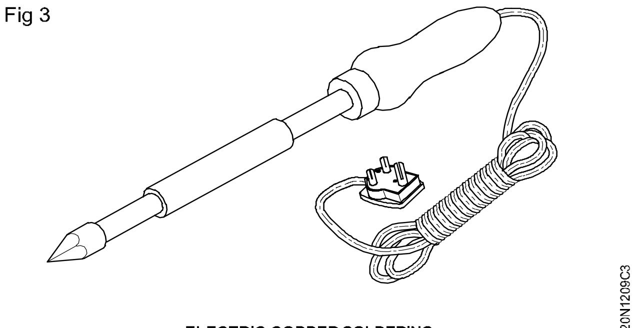
Point soldering copper bit: This is also called a square pointed soldering iron. The edge is shaped to an angle on four sides to form a pyramid. This is used for tacking and soldering. (Fig 2)

Fig 2



Electric soldering copper bit: The bit of the electric soldering iron is heated by an element. This type is preferred, if current is available because it maintains uniform heat. Electric soldering irons are available for different voltages and are usually supplied with a number of interchangeable tips. They can be made quite small and are generally used on electrical or radio assembly work. (Fig 3)

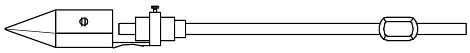
Fig 3



ELECTRIC COPPER SOLDERING

Gas heated soldering copper bit: A gas heated soldering copper bit is heated by a gas flame which impinges on the back of the head. High pressure gas is used and the bits is large enough to have a good heat storage capacity. Liquified petroleum gas (LPG) flame is used extensively for this purpose. Soldering kit normally includes many sizes and shapes of bits which can be used to make most kinds of soldering connections. (Fig 4)

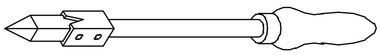
Fig 4



GAS HEATED SOLDERING COPPER BIT

Straight soldering copper bit: This type of soldering iron is suitable for soldering the inside bottom of a round job. (Fig 5)

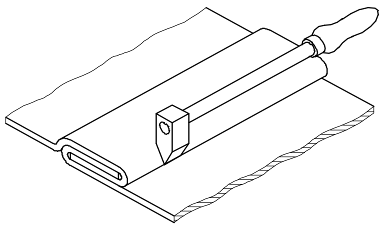
Fig 5



STRAIGHT SOLDERING COPPER WITH HANDLE

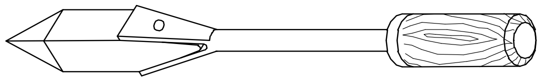
Hatchet soldering copper bit: This type of soldering iron is very much suitable for soldering on flat position lap or grooved joint outside round or square bottom. (Fig 6)

Fig 6



Adjustable soldering copper bit: This type of soldering iron is used for soldering where straight or hatchet bit cannot be used for soldering. Adjustable soldering bit can be adjusted in any position for soldering. (Fig 7)

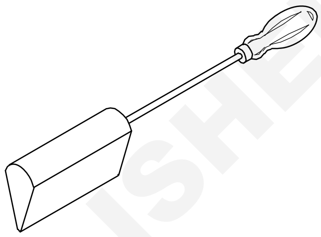
Fig 7



ADJUSTABLE SOLDERING BIT

Handy soldering copper bit: It is like a hatchet type but bigger in size than the hatchet. It is used for soldering heavy gauge of metal. It should not be used for soldering on light gauges of metal because additional heat will cause the metal to buckle. (Fig 8)

Fig 8



HANDY SOLDERING COPPER BIT

Sheet metal seams

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

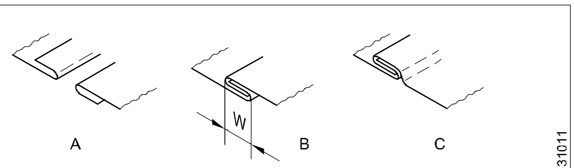
Introduction

In Sheet metal construction, mechanical seams are employed when joining light and medium gauge metal sheets. While fabricating sheet metal articles, the sheet metal worker should be able to select the type of seam that is best suited for the specific job.

Types of seams

1 **Grooved seam :** Grooved seam is most commonly used for joining sheet metal. This seam consists of two folded edges called locks as shown in Fig 1. The edges are hooked together and locked with a hand groover or a grooving machine.

Fig 1



STEPS IN FORMING A GROOVED SEAM.

2 **Pittsburgh seam:** This seam is also called hammer lock or hobolock. This seam is used as a longitudinal corner seam for various types of pipes such as duct work. The single lock is placed in a pocket lock and then the flange is hammered over, step by step as shown in Fig 2.

The advantage of the Pittsburgh seam is that the single lock can be turned on a curve and the pocket lock can be formed on a flat sheet and rolled to fit the curve as shown in Fig 3. If roll forming machine is not available in shop, Pittsburgh seam is formed on the brake.

3 **Double seam**

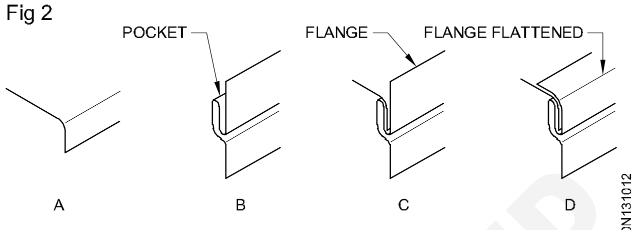
There are two types of double seams. One type is used for making irregular fittings such as square elbows, boxes, offsets, etc. This seam is used on corners and can also be used as a longitudinal seam on small square and rectangular ducts. A double edge is formed and placed over the single edge and the seam is completed step by step as shown in Fig 4.

The other type is used to fasten bottoms to cylindrically shaped jobs such as pails, tanks etc.

The steps in making this type of double seam is shown in Fig 5, where A is turned on the machine. B is burred on the burring machine. The bottom is snapped on the body as in C and is peened down as in D. Finally the seam is completed by using a mallet as in E. This seam is called Bottom double seam or Knocked up seam.

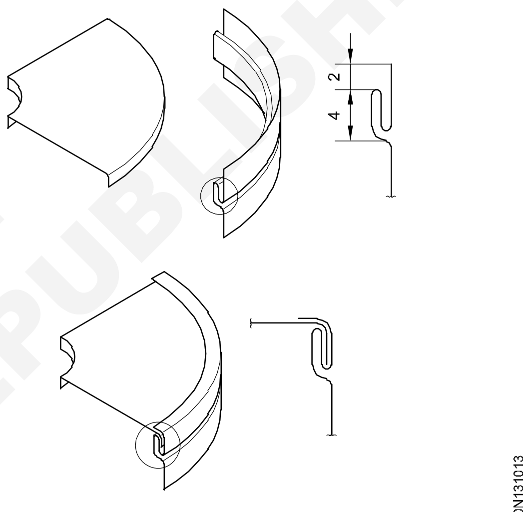
If the seam is not turned up, as in D, the seam is called paned down seam.

Fig 2



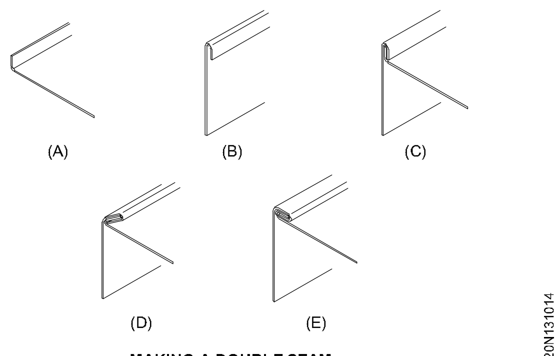
STEPS IN FORMING THE PITTSBURGH SEAM.

Fig 3



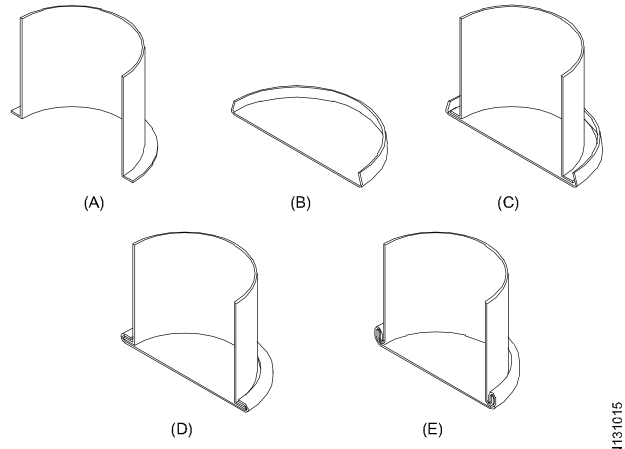
PITTSBURGH SEAMS CAN BE FORMED ON CURVES.

Fig 4



MAKING A DOUBLE SEAM.

Fig 5

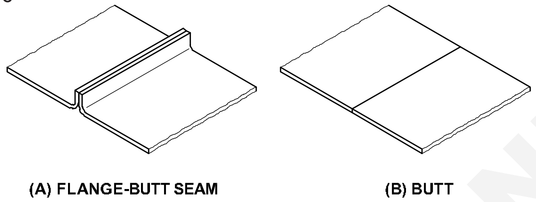


STEPS IN MAKING A BOTTOM DOUBLE SEAM.

4 Butt seam

This seam has two pieces butt together and soldered as shown in Fig 6. Figure shows two types of butt seams. One is flanged butt seam and the other one is butt seam.

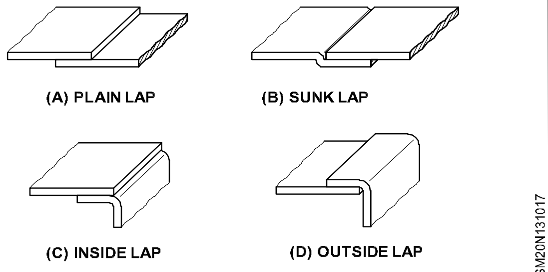
Fig 6



5 Lap seam

The lap seam is made by lapping the edge of one piece over the other piece and soldered as shown in Fig 7. Figure shows plain lap, sunk lap, inside lap and outside lap seams.

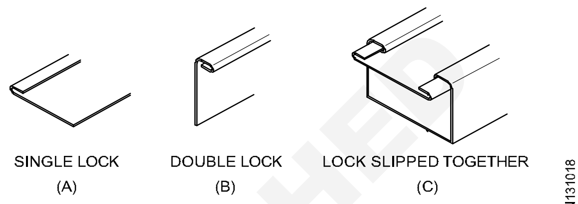
Fig 7



6 Slip joint seam

This seam is used for a longitudinal corner seam as shown in Fig 8.

Fig 8

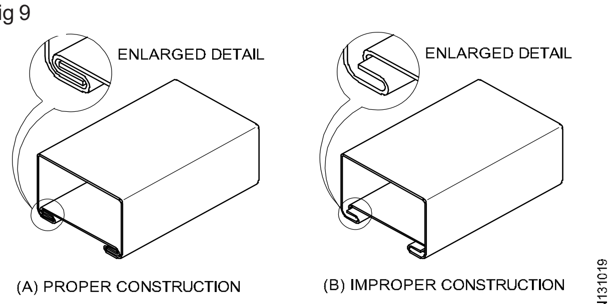


SLIP JOINT SEAM.

The assembly of the seam consists of a single lock A and a double lock B. The single lock is slipped into the double lock C to complete the seam.

For making pipes with a slip joint seam, proper care should be taken to see that the corners of the metal are squared and the edges are trimmed. The proper slip joint is shown as A and improper as B in Fig 9 If the edges are not trimmed, it will twist the pipe out of shape and may cause the edges of the pipe to be uneven.

Fig 9



PROPER AND IMPROPER JOINING OF SLIP JOINT SEAMS.

Locked grooved joint (Seam)

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

- **state the purpose of a joint**
- **state the use of the groover**
- **determine the allowance for the locked grooved joint**

Locked grooved joint: Many methods are employed to join and strengthen the pieces of a sheet metal. One of the common joint is called locked grooved joint.

This is usually done on straight lines. The workpieces to be joined are made in the form of a hook, inserted and locked using a groover.

When they are interlocked and tightened only then it is called a “grooved joint” (Fig 1).

When the grooved joint is clinched down, making one side plane using a groover is called a “Locked grooved joint”. (Fig 2)

Fig 1

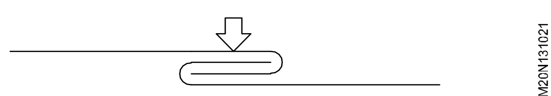
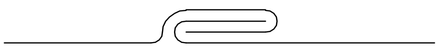


Fig 2



External and internal locked grooved joints: This joint is used to join the two ends of a sheet metal to form a circular shape in longitudinal direction. When the seam is formed outside as shown in Fig 3 then it is called 'external locked grooved joint'.

If the seam is formed using grooved mandrel then it is called 'Internal locked grooved joint' (Fig 3)

Fig 3

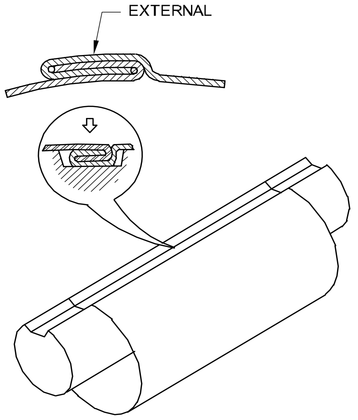
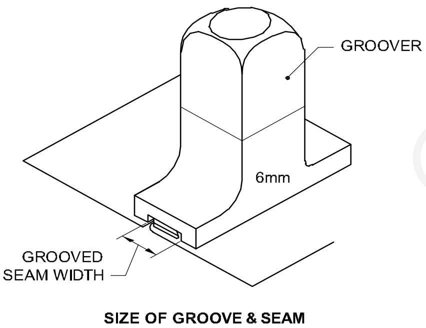


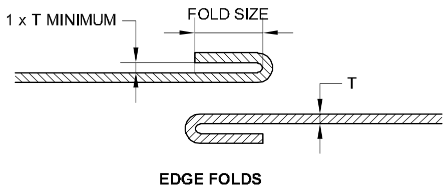
Fig 4



Hand Groover: The hand groover is made up of cast steel and is used to make external locked grooved joint.

A groove is made at the bottom of this tool to the required width and depth.

Fig 5



This has a handle in square or hexagonal shape like chisel to hold. This whole part is hardened and tempered. (Fig 4)

The hand groover is specified according to the size of the groove of the groover.

Locked grooved joint allowance: To arrive the size (width) of the fold to suit a particular groover, subtract the thickness by 3 times from the width of the groove. (Fig 5)

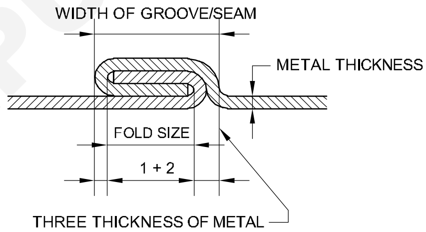
For example, the width of the groover is 6 mm and the sheet thickness is 0.5 mm,

Then the width of the fold

= 6 - (3 x 0.5)

= 4.5 mm (See Fig 6).

Fig 6



Pittsburg Lock

Objective:At the end of this lesson you shall be able to
- **define a pittsburg seam**
- **state the different types of pittsburg seams**
- **state the uses of pittsburg seams.**

Pittsburgh lock is used in Duct work and is formed using folding machine.

It consists of a single lock or flanged section and a pocket lock or pocket section. (Fig 1)

Single lock can be turned on the curve and pocket lock can be formed on a flat sheet and then rolled to fit the curve.

The allowance for the pocket is equal to twice the width of the pocket plus an allowance for knocking over.

Example: W + W + 6.35 mm

The width of the flanged edge is normally made slightly less than the depth of the pocket.

Usually, the allowance for the pocket is between 25 and 30 and for the flange is between 6 to 8.

Fig 1

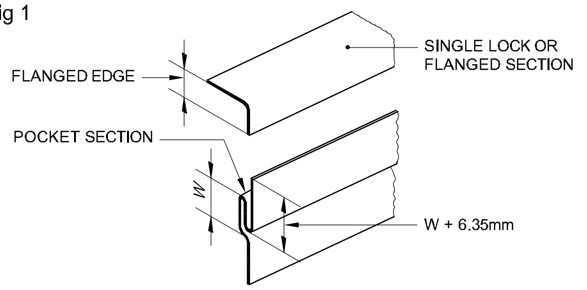
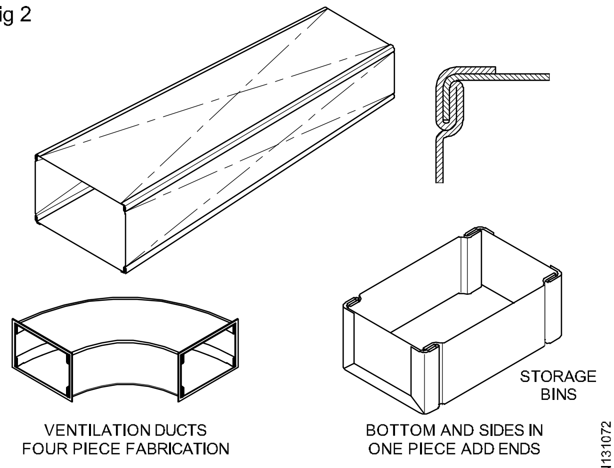


Fig 2 shows the applications of Pittsburgh lock seam.

Fig 2



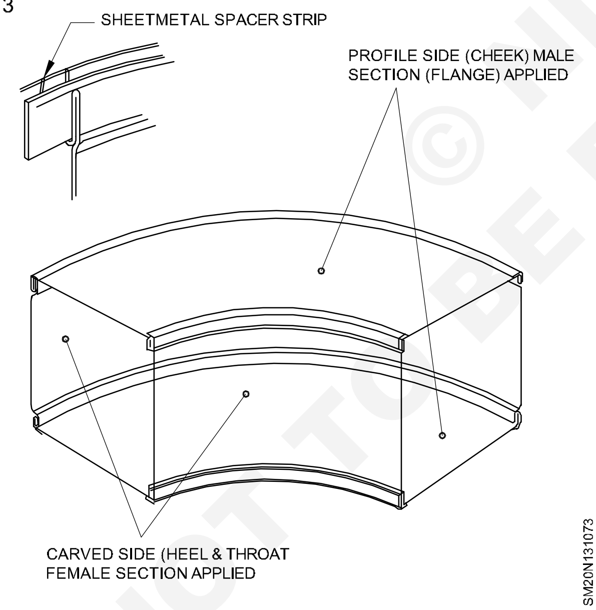
APPLICATIONS PITTSBURGH LOCK SEAM

Pittsburgh lock seam applied to curved work (Fig 3)

When curved ducts like elbows are to be made which incorporate the Pittsburgh lock, the female section of the seam is formed prior to curving.

To make correct lock shape, a sheet metal strip spacer is placed in between the first and second layers of the lock. The side is then curved to the shape in curving rolls. The spacing strip is removed before assembling the component.

Fig 3



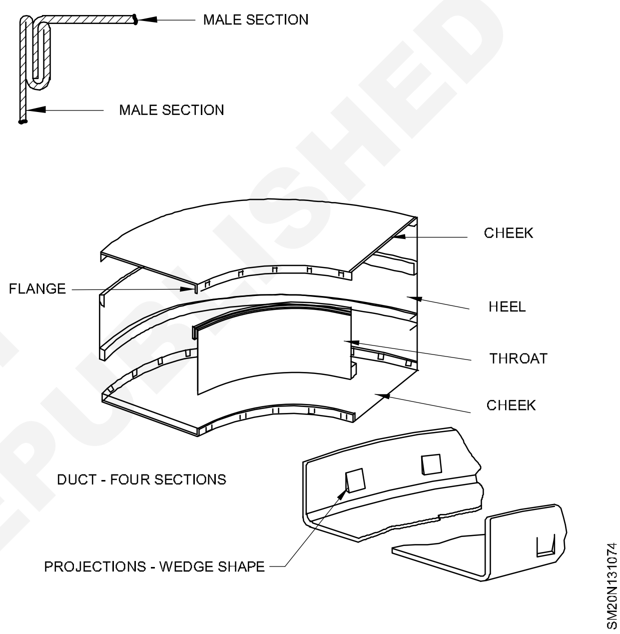
Snap Lock Seam: Snap Lock Seam is a role formed seam and is machine made similar to Pittsburgh lock seam.

The allowance for this joint depends on the machine setting and is usually 25 to 30 mm on the female lock section and 10 mm allowance for the male section.

The male section has small wedge shaped projections, punched at regular intervals on the flange as shown in Fig 4. When this flange is pressed into the female section, the projections lock under a fold edge. This joint is a longitudinal seam used in duct work. It is better than

Pittsburgh seam because it is neat in appearance and requires less time in fabrication.

Fig 4



Folding and joining allowances

Objectives: At the end of this lesson you shall be able to
- **state the necessity for providing allowances in sheet metal operations**
- **calculate the allowances for grooved joints**
- **calculate the allowances for dovetail joints**

When making self secured joints or seams, it is necessary to provide material for the preparation of the edges and seams, the extra material is called an allowance.

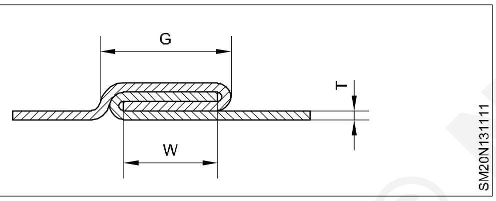
The allowance is necessary for maintaining the correct size of the finished product and for improving the strength at the joints of all edges.

Allowance is also necessary for avoiding cracking or warping, and for obtaining the required finish.

This allowance depends upon the width of the folded edge and the thickness of the metal.

You may neglect the thickness of the metal for thinner sheet of 0.4 mm or less.

Fig 1

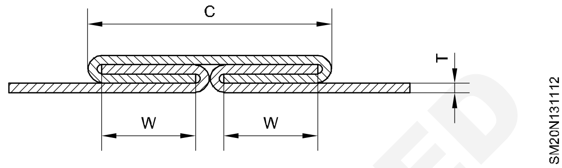


Allowance for Grooved Joints/Seams (Fig 1): If we fold over the edges to width W and form the joint, the final completed width of the joint G will be greater than W. It can be seen that the final width of the groove will have a minimum value of W + 3T, where T represents the metal thickness.

The allowance for a grooved seam is the width of the seam + three times the thickness of the sheet

Allowance for Double Grooved Seam/Joint: It will be seen from Fig 2 that the width of the capping strip is equivalent of two times the width of the folded edge plus four times the thickness of the metal size.

Fig 2



The complete allowance for the Double Grooved Seam/ Joint will be four times the width of the folded edge plus four times the thickness of the metal.

Allowance for paned down and knocked-up-joints

The size of paned down and knocked-up joints is determined by the width of the single folded edge.

'P' represents the size of the paned down joint (Fig 3) and 'K' represents the size of the knocked-up joint. (Fig 4)

Allowance for P = 2W + 2T

Allowance for K = 2W + 3T

Fig 3

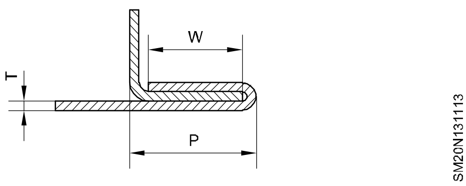
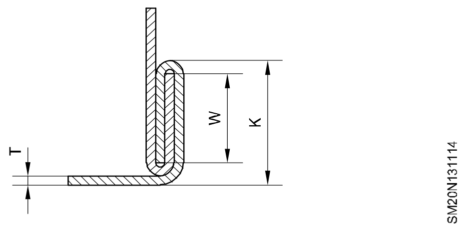


Fig 4



Edge stiffening by wiring

Objectives: At the end of this lesson you shall be able to
- **state what is edge stiffening**
- **state what is the purpose of edge stiffening**
- **state methods of edge stiffening by wiring.**

Edge stiffening: Edge stiffening is the process by which edges of the sheets are made stronger and rigid.

Edge stiffening is done by

1 wiring

2 hemming

3 flanging

4 curling

5 beading

6 gutting

7 ribbing

Purpose of edge stiffening:

1 To give extra strength and rigidity to edges, to prevent it from bending/buckling, damage during handling etc.

2 To avoid sharp edges for safe handling.

3 In addition, this adds to decorative appearance of the sheet metal articles.

Methods of edge stiffening by wiring

1 Solid wiring

2 False wiring.

In solid wiring, sheet metal edges are wrapped around the wire and wires are kept permanent in place. This is generally called simple "Wiring".

In false wiring, sheet metal edges are wrapped around the wire, after forming final shape, the wire is removed from the edge to retain it hollow.

If the edge of the sheet metal is straight, the edge formed is called "straight wired edge".

If the edge of the sheet metal is curved, the edge formed is called "Curved wired edge".

False wiring cannot be done on curved edges.

Wiring Allowance

Objectives: **At the end of this lesson you shall be able to**
- **state what is wiring allowance**
- **determine the wiring allowance.**

Wiring allowance is nothing but the amount of additional length provided on sheet metal to wrap around the wire to make a wired edge.

Wiring allowance is determined by the following formula.

Wiring allowance = 2.5 x d + t

where

d = dia of wire

t = thickness of sheet metal.

If wiring allowance provided is more, then the correct shape of the wire is not formed. If wiring allowance provided is less, then gap is found at the inner side of the edge and the wire can be seen.

Generally, the length of the wire provided is slightly more than the length of the edge. This is required to hold the wire at ends, while forming the edge of the sheet metal around the wire.

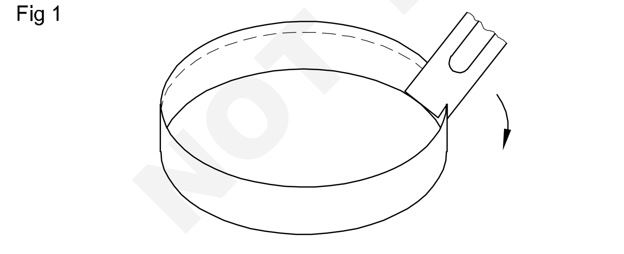
Surplus wire is cut after the wired edge is finished.

Making wired edge along a curved surface by hand process

Objectives: This shall help you to
- **mark the wiring allowance at the curved edge**
- **make a wired edge along a curved surface by hand process**

Mark the wiring allowance at the curved edge to be wired using a gauge with sheet metal as shown in Fig 1.

Fig 1



Flange the edge to be wired using a hatchet stake and a setting hammer, step by step upto 90^0. (Fig 2) Then upset the flange to its half the width and make curve on the flange for wiring. (Fig 3)

Fig 2

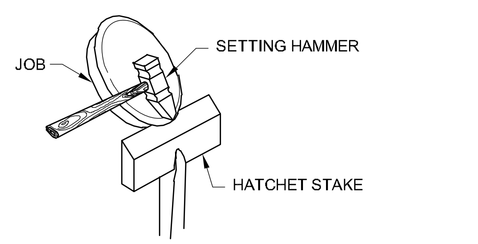
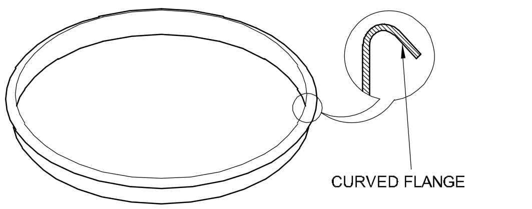


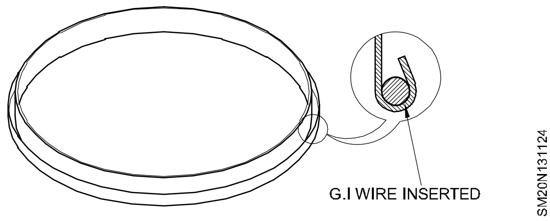
Fig 3



Make a round ring from the given G.I.wire to the required dia. (Fig 3)

The joint of the wire should be opposite to the locked grooved joint.

Fig 4



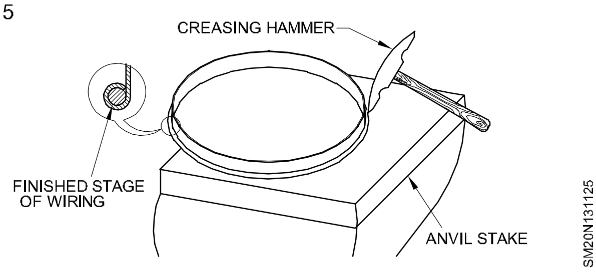
Place the G.I. Wire ring on the flange. (Fig 4)

Complete the wiring using a creasing hammer. (Fig 5)

Dress the wiring by using a half moon stake and a mallet.

Redress the trueness of the cylindrical shape by a round mandrel and a mallet.

Fig 5



False wiring

Objectives: At the end of this lesson you shall be able to
- **state what is false wiring**
- **state advantages of false wiring.**

False wiring is one of the methods of edge stiffening in which wired edge is formed and finally wire is removed from the edge, to make the edge hollow.

Advantages of false wiring: In addition to advantages by wiring, false wiring gives following advantages.

1 Cost of the article is reduced.
2 Weight of the article is also reduced.

In sheet metal articles like trunks, boxes etc., wiring is done only at the corners of the adjacent sides and the remaining portion of the wired edge is kept hollow.

This helps to maintain the sides in position.

Edge Stiffening

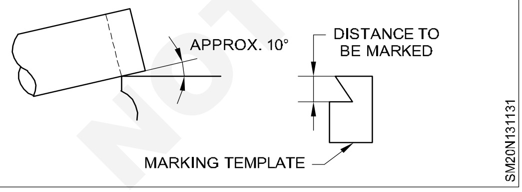
Objectives: This shall help you to
- **make a single hemming on a curved edge using anvil stake and setting hammer.**

Mark the hemming allowance on the formed body using a marking template.

Fix the anvil stake on to the vice or bench plate.

Hold the workpiece such that the marked line coincides with the edge of the stake approximately inclined an angle of 10^0 as shown in Fig 1.

Fig 1



Strike and rotate the workpiece gradually along the marked line to form a small flange using a setting hammer. (Fig 2)

Gradually increase the angle of inclination while forming the flange as shown in Fig 3.

Fig 2

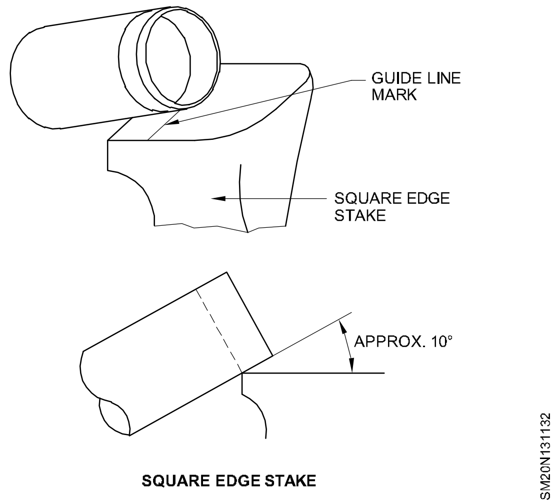
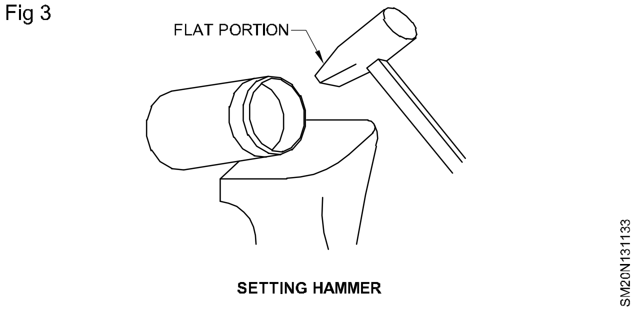


Fig 3

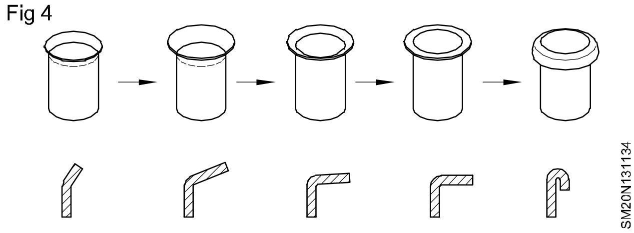


SETTING HAMMER

Finish the hemmed edge on a round mandrel stake by a mallet. (Fig 4)

Dress the disturbed body of the cylinder to a round shape using a round mandrel stake and a mallet.

Fig 4

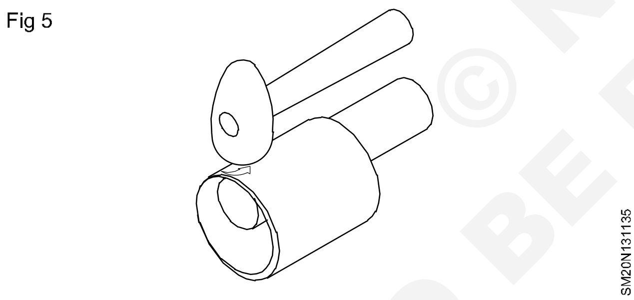


Check the cylindrical body for roundness and the marking allowance for flanging.

Fix the copper smith stake in the benchvice or bench plate firmly.

Mark the flanging allowance as guideline on the stake as in Fig 5.

Fig 5



Hold the cylinder such that the marked line on the cylinder for flanging, coincides with the straight edge of the stake. (Fig 6)

Position the cylinder as in figure 1 and strike the metal using the flat face of the finishing hammer.

Rotate the body of the cylinder by one hand.

Strike with finishing hammer to increase the angle of bending gradually as in (Fig 7) till the flange is bent to 90^0.

Fig 6

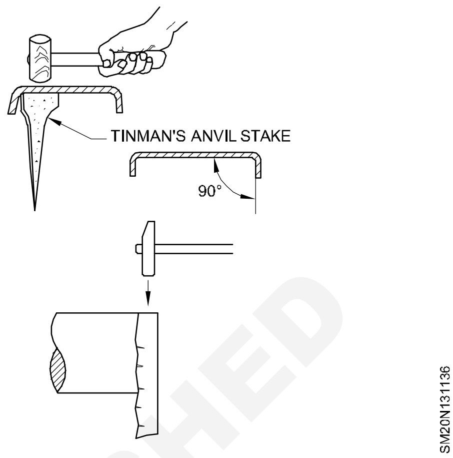
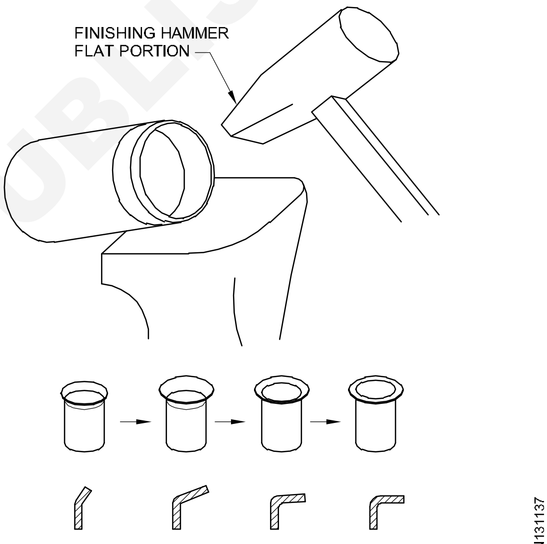


Fig 7



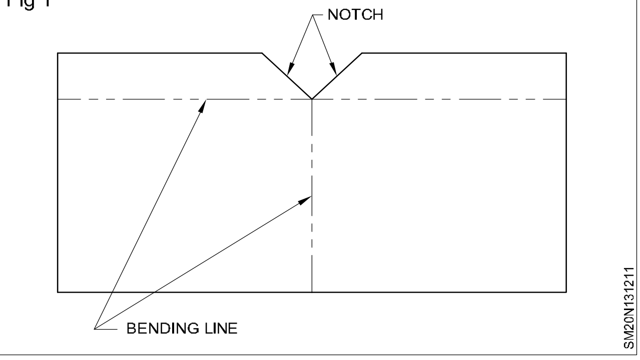
FLANGING

Notches in sheet metal

Objectives: At the end of this lesson you shall be able to
- **state the purpose of notches**
- **name the types of notches**
- **distinguish the features of different notch forms and state the uses of each.**

Notches: Notches are the spaces provided for joining the edges when sheet metals are cut from the layout. (Fig.1)

Fig 1

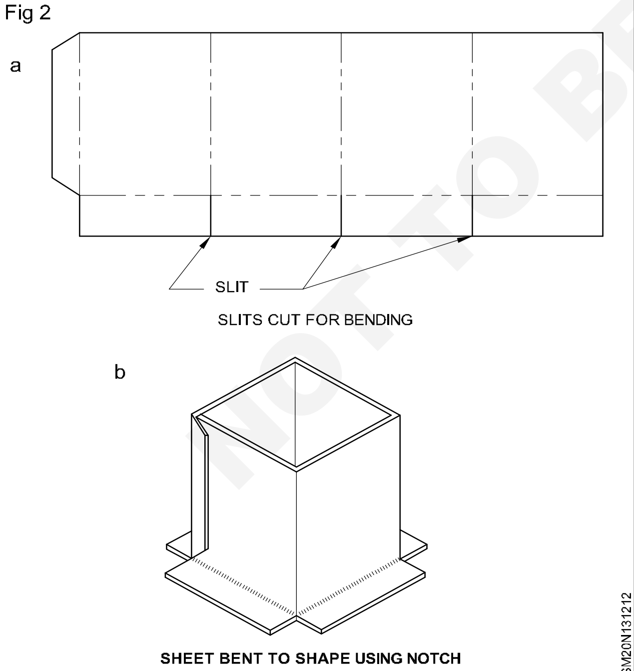


Purpose of notches

Notches help to :

– to prevent surplus material from overlapping and causing a bulge at the seam and edges
– to allow the work to be formed to the required size and shape
– to allow the work to assemble better.

Fig 2



Types of notches

Straight notch or slit: Straight cuts made from the edge of the sheet to a distance where it is to be bent is known as a straight notch. (Figs.2a and 2b)

Square notch: A square notch is used when forming a square or rectangular box. (Figs.3,4 and 5)

Fig 3

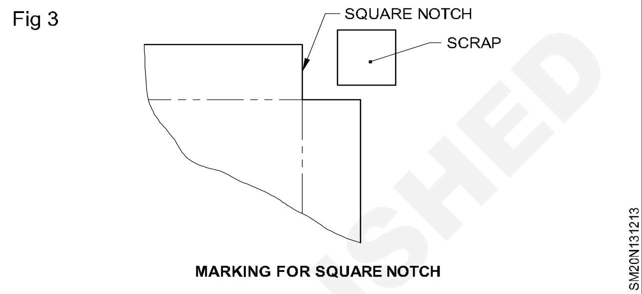


Fig 4

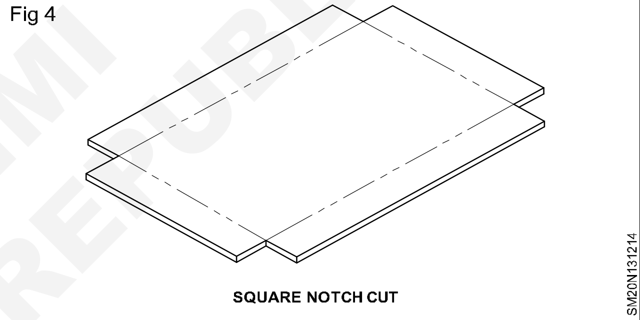
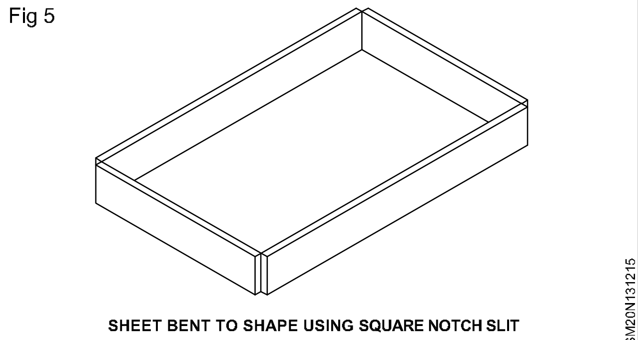


Fig 5



Slant notch: This notch is cut at an angle of 45^0 to the corner of the sheet. It is used when a single hem meets at right angles. (Figs.6 & 7)

Fig 6

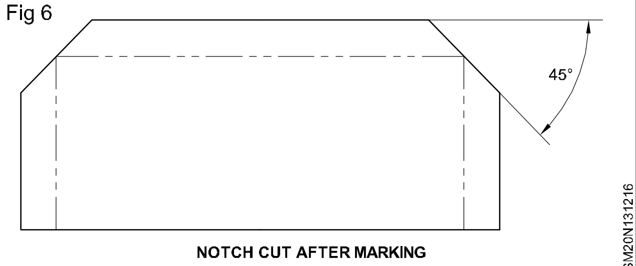
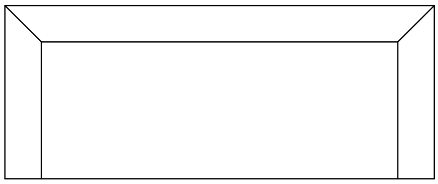


Fig 7

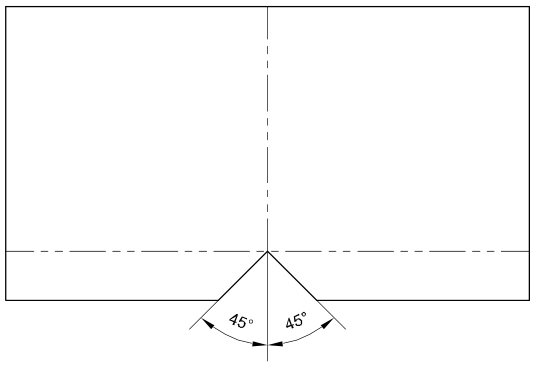


BENT TO SHAPE USING SLANT NOTCH

'V' Notch: In this notch, both the sides are cut at a 45° angle to the edge of the sheet.

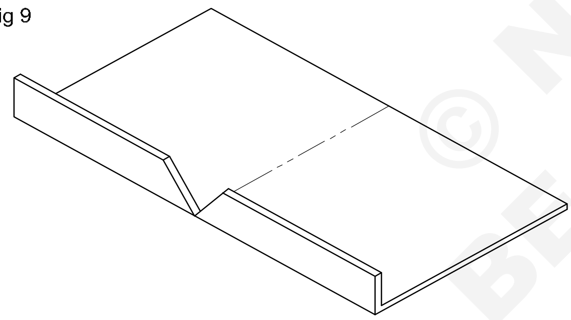
The sides of the notch meet at 90°. This notch is used when making a job with a 90° bend and an inside flange. (Figs.8, 9 and 10)

Fig 8



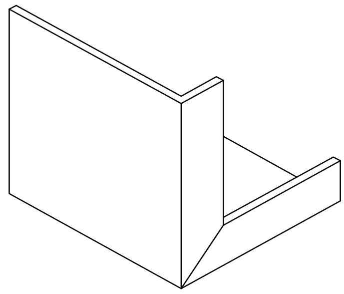
'V' NOTCH MARKED AND CUT

Fig 9



FIRST FOLDING 'V' NOTCH

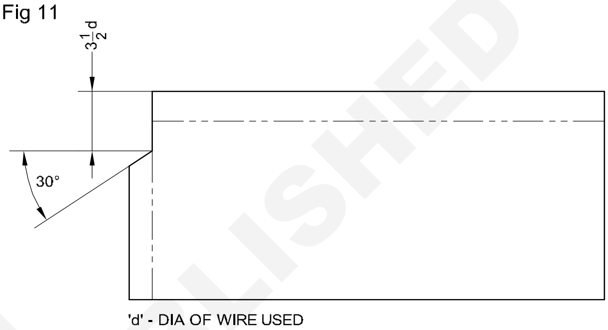
Fig 10



BENT TO SHAPE USING 'V' NOTCH

Wire notch: The angle of this notch is usually 30° and the distance from which the notch is started is 3½ times the diameter of the wire. (Fig.11)

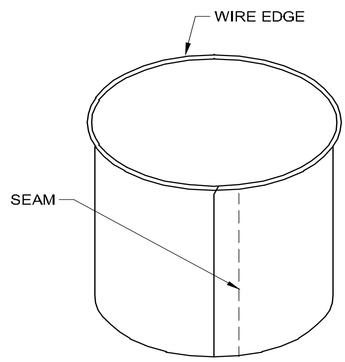
Fig 11



WIRE NOTCH MARKED CUT

Uses: The wire notch is used on a work which has wired edges. This notch is provided to prevent the wired edge from overlapping at the seam. (Fig.12)

Fig 12



AN EDGE WIRED USING WIRE NOTCHES

Development of surface

Objectives: At the end of this lesson you shall be able to
- **state what is a pattern, a layout and a stretch out**
- **state what are the allowances for edges and seaming considered in pattern development**
- **state what are the allowances for notching and clipping, considered in pattern development**
- **state different methods of pattern layout development.**

Pattern: The pattern is a piece of material, which is cut to the exact size and shape, to form the desired object.

It is nothing but, a flat outline of an object, to be formed to its final shape.

The pattern may be drawn on a paper first, then transferred to the sheet metal. This makes possible the corrections if any, saving valuable material. Paper patterns are not suitable for repeated use.

However, experienced skilled sheet metal worker do pattern layouts directly on the sheet metal.

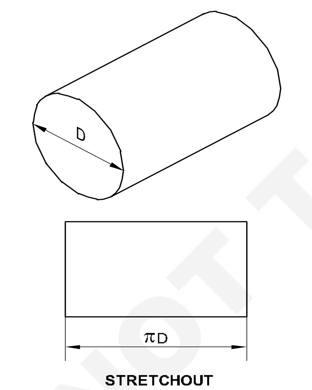
Layout: It is the method of developing the lines and curves which form the pattern.

Pattern layout is done by employing different geometrical constructions.

Different geometrical constructions are taught in the engineering drawing subject.

Stretchout: The term "stretchout" refers to the sizes of flat piece of metal before it is formed into shape. For example, the stretchout of a round pipe is the circumference of the pipe. (Fig 1)

Fig 1



Allowances for edges and seaming, considered in pattern layout development.

Allowances of edges: Different types of edges, are used to stiffen the edges of sheet metal articles and to eliminate sharp edges.

Edges are made either by bending or by wrapping the metal.

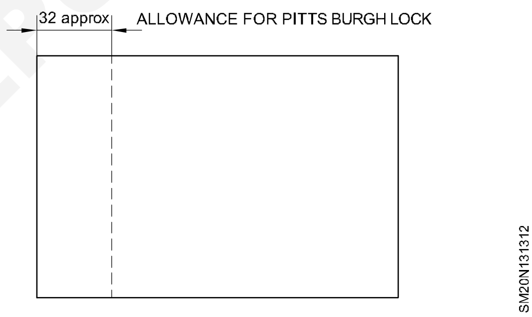
The amount of metal allowed for the edges is called allowance for edges.

The following table shows the allowance for different edge.

S.No.	Type of edge	Allowance generally kept
1	Single hem	6 mm above 22 gauge sheet 8 mm below 22 gauge sheet
2	Double hem	Twice the hem size - 1.6 mm
3	Wired edge gauge sheet	2.5 x dia of wire - above 24G 2.5 x dia of wire + thickness of metal - below 24 gauge sheet

Allowances for seaming: Sheet metal parts are joined by various types of seams. The amount of metal allowed for seaming is called "Allowances for seaming". The following table shows the allowance for different seams. (Fig 2)

Fig 2

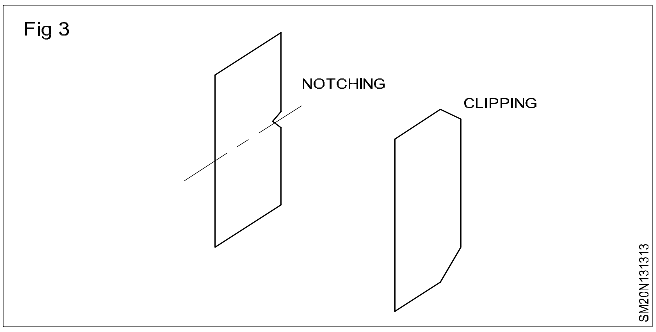


S.No.	Type of edge	Allowance generally kept
1	Grooved seam	3 x width of lock above 24 gauge sheet 3 x width of lock + 5 thickness of metal-below 24 gauge sheet

Allowances for Notching & Clipping: Notching and clipping are used to cut away that portions of the metal to prevent overlapping and bulging on seams and edges. (Fig 3) For detail information, please refer next lesson.

Four methods are commonly used for pattern development.

1 Parallel line development method
2 Radial line development method
3 Triangulation development method
4 Geometric construction method.



Developments

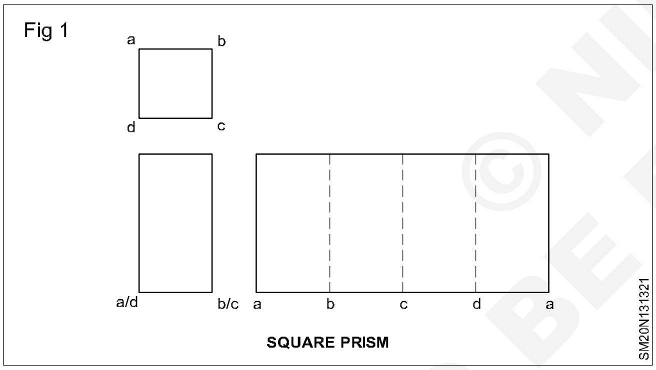
Objectives: At the end of this lesson you shall be able to
- **identify the projects that can be developed by parallel line method.**

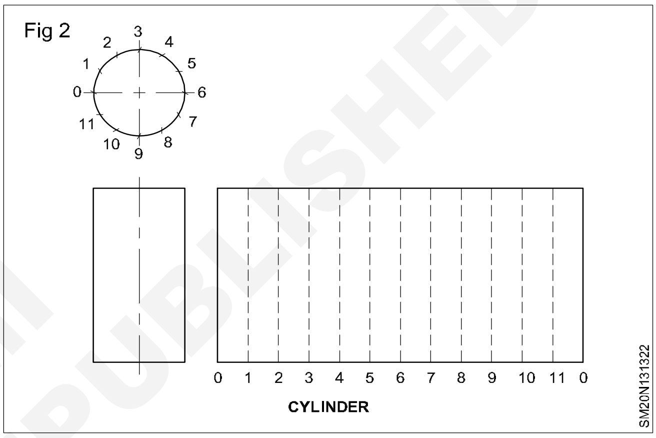
Parallel line method development: All articles or components which belong to the class of prisms, having a constant and uniform cross sections throughout their length may be developed by the parallel line method.

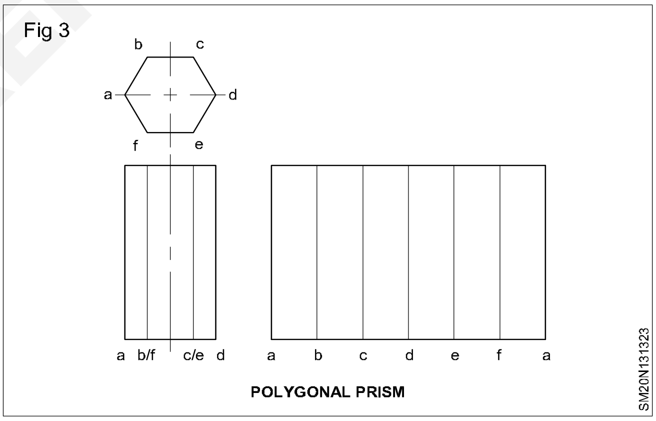
A few components or articles that can be developed by this method are

Prisms with square, rectangular and polygonal base, hollow cylinders, elbows, regular pipe 'T' joints etc.

A few are shown by sketches. (Fig 1, 2&3)







Templates

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

emplates: Templates are used in the sheet metal and plate fabrication industries. For example

1 To avoid repetitive measuring and marking the same dimension, and where many identical parts are required.

2 To avoid unnecessary wastage of material and from information given on drawing, it is almost impossible to anticipate exactly where to begin in order that the complete layout can be economically accommodated.

3 To act as a guide for cutting processes.

4 As a simple means of checking bend angles and contours.

Information given on templates:

Written on templates may be as follows:

1 Job or contract number

2 Size and thickness of plate

3 Quantity required

4 Bending or folding instructions

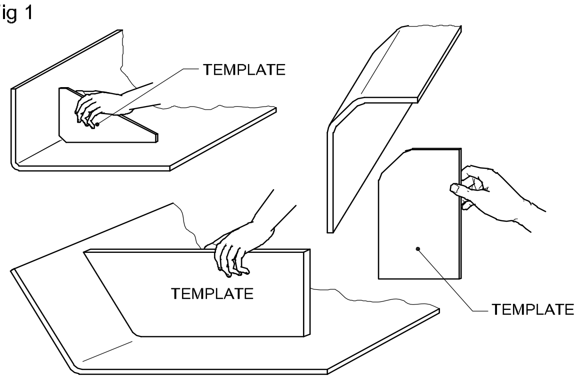
5 Drilling requirement

6 Cutting instructions

7 Assembly reference mark.

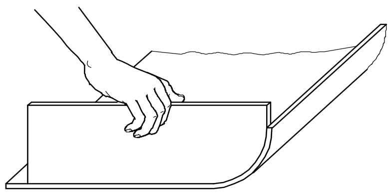
Templates as a means of checking is shown in Fig 4,5,6,7,8,9.

Fig 1



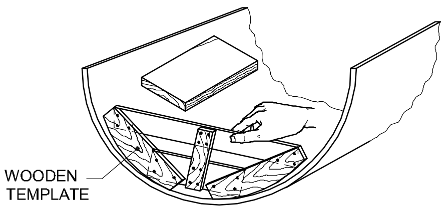
CHECKING ANGLES WITH A TEMPLATE

Fig 2



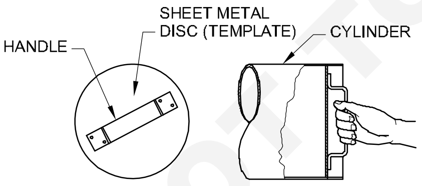
CHECKING THE CONTOUR OF A RADIUSED CORNER

Fig 3



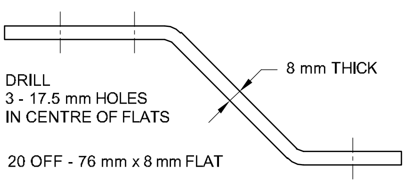
CHECKING THE CONTOUR OF A ROLLED PLATE

Fig 4



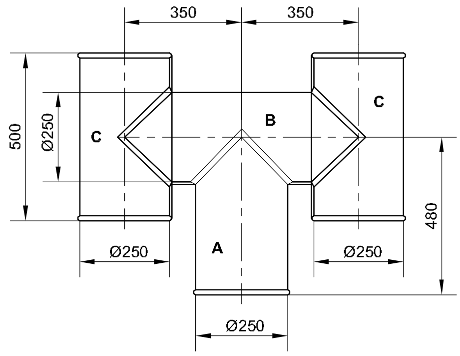
TEMPLATE USED FOR CHECKING CONTOUR OF CYLINDRICAL WORK SUCH AS DUCTWORK.

Fig 5



THE USE OF TEMPLATES AS A MEANS OF CHECKING

Fig 6



CHIMNEY SMOKE COWL

Templates for setting out sheet metal fabrications: For economy reasons, many patterns are made for marking out the sheet metal prior to cutting and forming operations. Fig 9,10,11 show a smoke cowl. Here a template is required to check and to mark out the contours of the intersection joint lines for the parts A,B & C whose developed sizes are marked out in the flat with the appripriate datum lines.

Fig 7

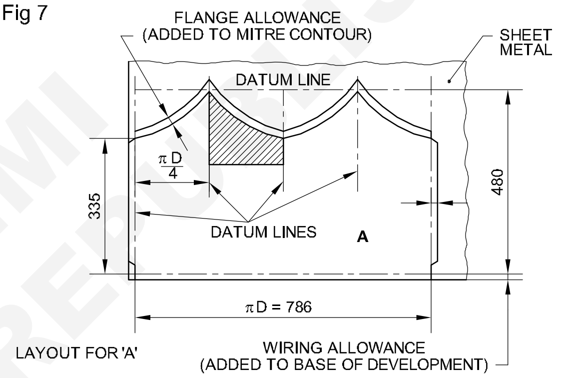
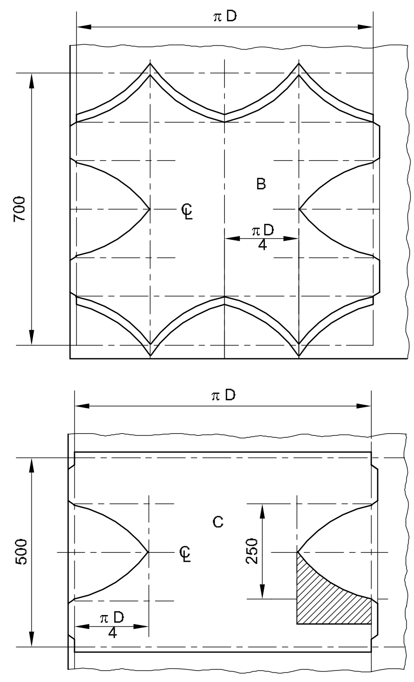


Fig 8

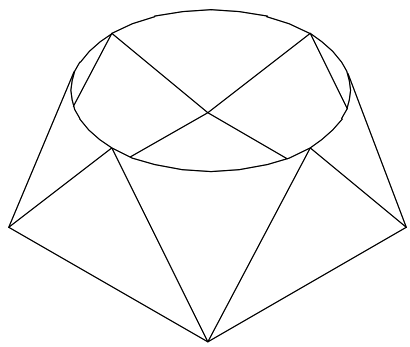


LAYOUT FOR B & C

AN EXAMPLE OF THE USE OF TEMPLATES

Fig 12 shows a square to round transformer is an isometric view of the sheet metal trans forming piece which is used to connect a circular duct to a square duct of equal area of cross section. In this example the dia of the round duct is 860 mm and length of one side of the square duct is 762 mm and the distance between the two ducts is 458 mm and sheet thickness is 1.2 mm.

Fig 9

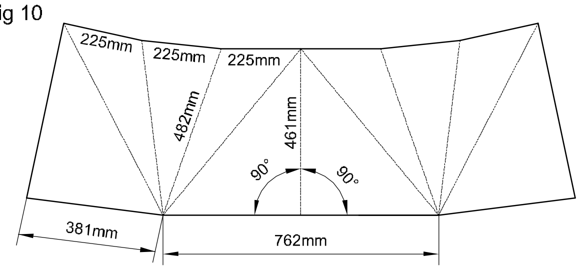


THE COMPLETE TRANSFORMER

SM20N131339

Fig 13 shows a scale development pattern on which are marked the full size dimensions. This type of drawings are supplied by the drawing office for marking out purposes. Allowances for the seams and the joints must be added to the layout.

Fig 10



PATTERN OR HALF-TEMPLATE WITHOUT JOINT ALLOWANCES

SQUARE TO ROUND TRANSFORMER

SM20N13133A

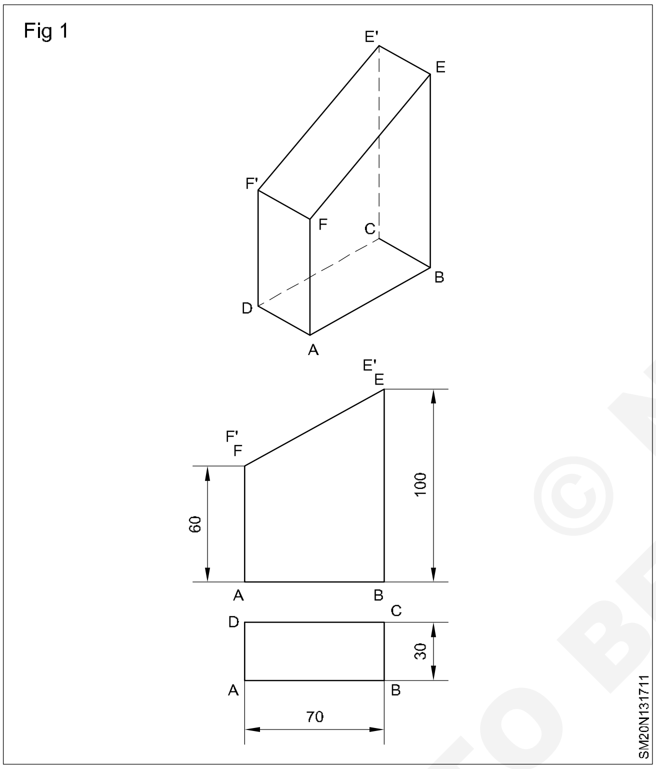
Parallel line development method

Objectives: At the end of this lesson you shall be able to
- **state what is parallel line development method**
- **layout patterns for simple objects by parallel line development method.**

Parallel line development method: Parallel line development method is used for pattern development of the objects whose sides run parallel to one another as in ducts, elbows and T joints.

In developing any pattern by parallel line development method, following procedure is followed (for illustration refer object shown in Fig 1).

Fig 1



1 Draw the elevation and plan of the object with dimensions (Fig 1)

2 Draw the stretchout of the pattern (Fig 2).

3 Locate measuring lines from elevation or plan on the pattern stretchout. While locating measuring lines, these lines should be in proper distance apart and in proper order. (Fig 3)

4 Transfer the lengths of the measuring lines from elevation to the same lines on the pattern. (Fig 3)

5 Connect the points located on the measuring lines. (Fig 3)

Fig 2

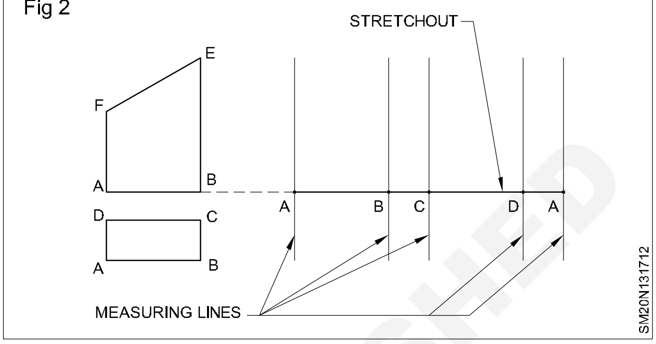
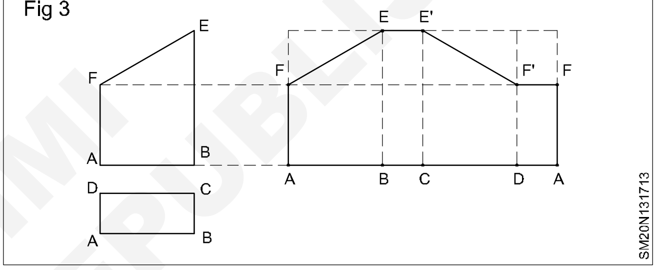
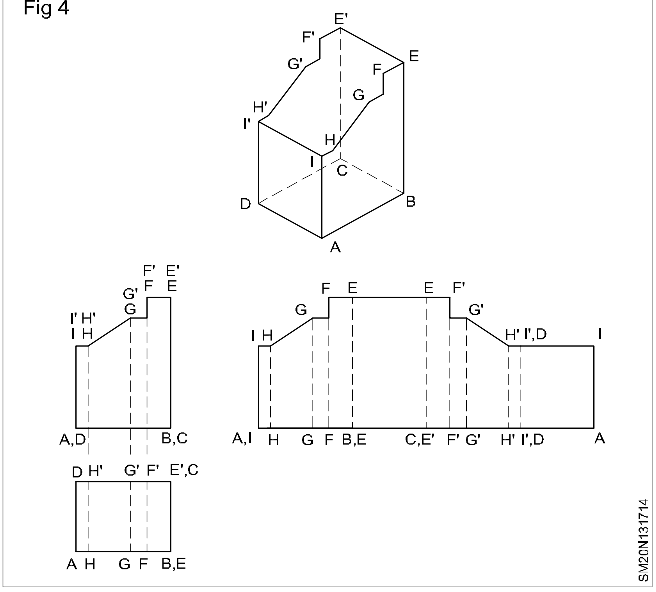


Fig 3



By this method, the pattern layout of the following object is shown for better understanding of parallel line development method. (Fig 4)

Fig 4



Radial line development

Objectives: At the end of this lesson you shall be able to
- **state what is a radial line development**
- **state the principle of the radial line development.**

The Radial line method is applied for developing the pattern of articles or components which are tapered to an apex.

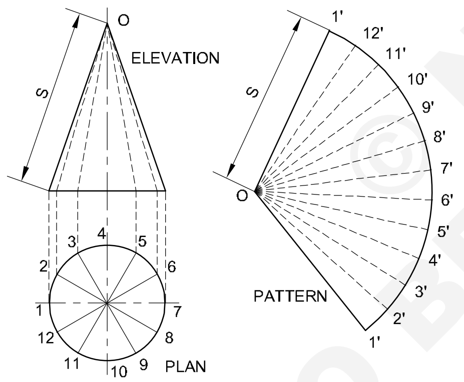
This method is also adopted for the development of the frustrum, which are tapered to an apex when the sides are produced.

Principle of the radial line development is based on the location of a series of lines which radiate down from the apex along the surface of the article/component to a base, or an assumed base, from which a curve is drawn whose perimeter is equal in length to the perimeter of the base.

Cones and pyramids or their frustrum are developed by the radial line method.

Fig 1,2,3&4 shows the development of a cone, the frustrum of a cone, the square based pyramid and the frustrum of a square based pyramid.

Fig 1



DEVELOPMENT OF A CONE

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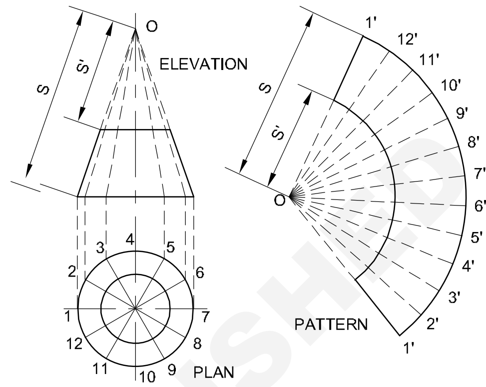
Fig 2



DEVELOPMENT OF FRUSTUM OF A CONE

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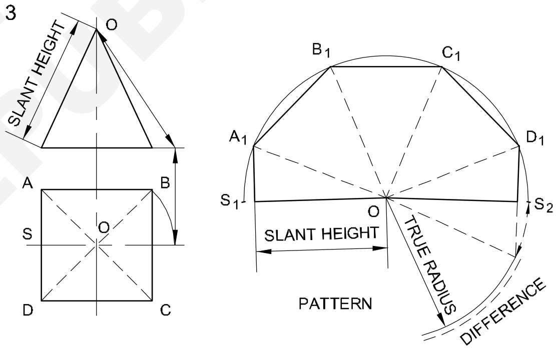
Fig 3



DEVELOPMENT OF SQUARE BASED PYRAMID

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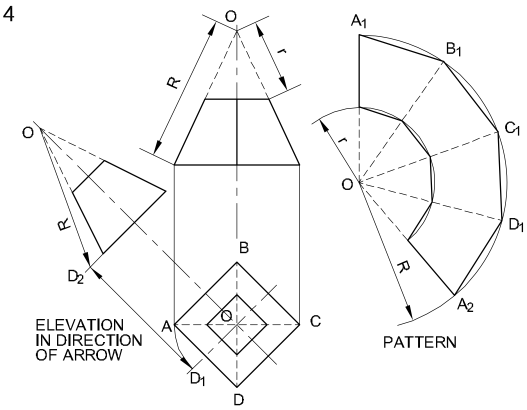
Fig 4



DEVELOPMENT OF FRUSTUM OF A SQUARE BASED PYRAMID

SM20N131814

Triangulation method of pattern development

Objectives: At the end of this lesson you shall be able to
- **state what is triangulation method**
- **state the application of triangulation method**
- **state what is true length**
- **explain the method of finding true length**
- **describe the procedure of pattern development of square to square tapered chute by triangulation method.**

riangulation method of pattern development: Triangulation is one of the important methods of pattern development.

Triangulation method is a method of dividing the surface of the object in triangles, finding the true size of each triangle seperately and placing them side by side in proper order to obtain the full pattern.

True length: To obtain the true size of each triangle, the true length of each side must be found and placed in its correct relation to the other sides.

Method of finding the true length of a line is very simple.

Place the plan length of a line at right angles to its vertical height. The diagonal represents its true length.

The principle of this rule will be seen by reference to (Fig 1) which shows, particularly, a ladder lean against a wall.

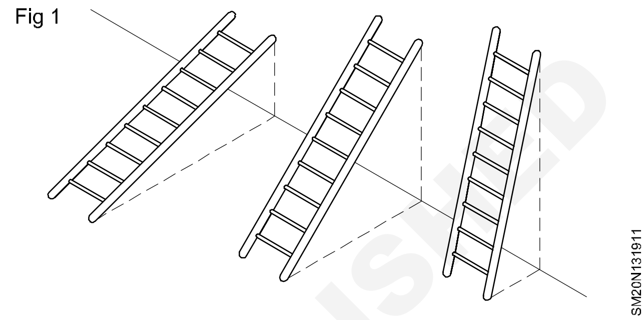
The plan length is the horizontal distance from the wall to the base of the ladder.

The vertical height is the height of the wall from the base to the top point of the ladder where it leans against it and the True length is the actual length of the ladder itself.

It is observed that when the position of the ladder is altered, the plan length and the vertical height vary accordingly.

In triangulation, two views i.e Top view and Elevation of an object are essential;

Fig 1

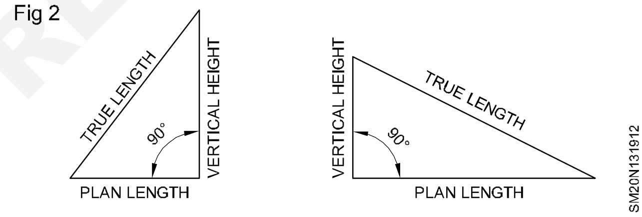


The vertical height of any line is found from the elevation. (Fig 1)

The plan length of any line is found from the plan.

If the length of any perpendicular line from the plan is placed at right angles to the vertical height of the same line from the elevation then the diagonal gives the true length (Fig 2).

Fig 2



Pattern development of square to square tapered chute by triangulation method

Square to Square Tapered chute

To develop the pattern layout for square to square tapered chute

- Draw the plan and elevation of the tapered chute and name them as in Fig 1.
- S's denotes the seam.
- The length of AB, BC, CD and DA of the big square and 12, 23, 34 and 41 of the small square will represent the true lengths of sides.
- Join the corners A1, B2, C3, D4 and SS' which will represent slant length.
- Join 1B, 2C, 3D, DS', S'A in dotted lines to represent diagonals. (Fig 2)

Fig 1

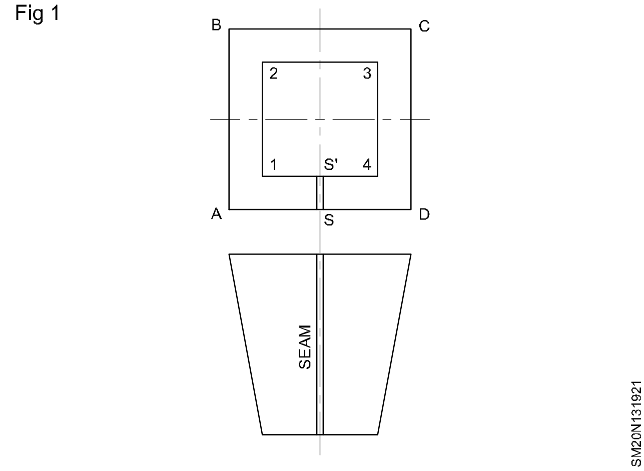
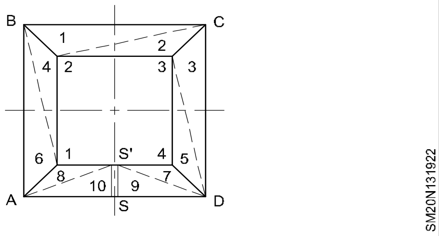
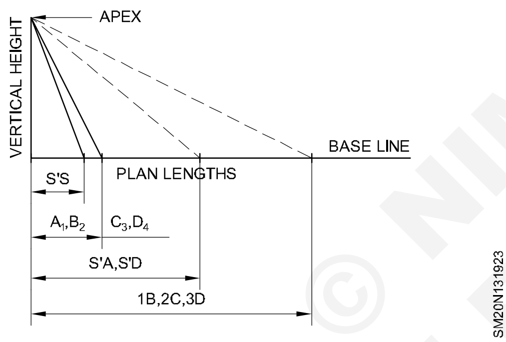


Fig 2



- Number the so formed triangles in the plan. (Fig 2)
- To find the true slant length and true diagonal length, draw a horizontal line and a vertical line equal to the height of the job. (Fig 3)
- Take length S'S from the plan and step off on the baseline and join it to the apex by a thin line. (Fig 3)
- Take length A1 from the plan and step of 6 on the base line and join it to the apex by a thin line. (Fig 3)
- Take length S'A from the plan and step off on the base line and join it to the apex by dotted line.
- Take length "1B" from the plan and step off on the baseline and join it to the apex by dotted line.

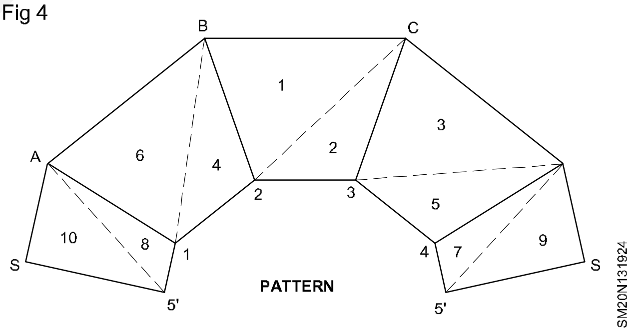
Fig 3



The dotted lines represent true diagonal lengths. The thin lines represent true slant lengths.

- For the first triangle in the pattern, take true length distance BC (in plan) and mark it in the pattern.
- With 'B' and 'C' as centres and slant length height B2 and C3 as radius swing arcs.
- With 'B' and 'C' as centres and diagonal length equal to 'C,2' as radius intersect the arcs diagonally and name the points 2&3. Join B2 and C3 by thin lines.
- Join C2 by dotted line. This completes triangles 1&2 of the plan in the pattern.
- With '2' as centre and radius equal to '2,1' C (side of the small square) swing an arc.
- With 'B' as centre and radius equal to the diagonal length '1,B' intersect the arc. Join the point and name the point as 1.
- With 1 as centre and radius equal to 'A,1' swing an arc.
- With 'B' as centre and radius equal to BA (side of the big square) intersect the arc. Join the point and name the point as 'A'. Join 'AB'.
- Join '1.B' by dotted line.
- This completes triangles 4 and 6 of the plan in the pattern.
- Similarly, complete triangles 3 and 5 on the other side of the pattern.
- With 'A' as centre and radius equal to AS' swing an arc.
- With '1' as centre and radius equal to 1S' (Side of the small square) intersect the arc and join the point and name the point as S'.
- With 'A' as centre and radius equal to AS (Side of the big square) intersect the arc and name the point 'S'. Join SS'.
- Join S'A by dotted line.
- This completes triangles 8 and 10 of the plan in the pattern.
- Similarly, complete the triangles 7 and 9 of the plan and complete the pattern development, as shown in Fig 4.

Fig 4

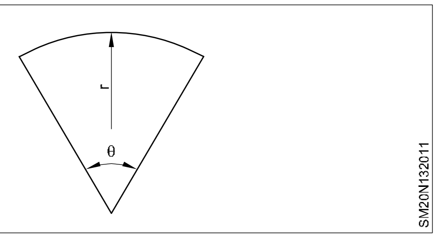


Geometrical construction method

Objectives: At the end of this lesson you shall be able to
- **state what is geometrical construction method.**

Components which cannot be developed either by parallel line method or radial line method or triangulation method can be easily developed by geometrical construction method. For example Taper tray.

Fig 1



In this method, slant lengths, arc lengths, segment of the circle are calculated to get the blank size of the articles.

Slant lengths are calculated by trigonometry.

Arc length is calculated by the formula

l = $2\pi r \times \theta^0/360$
l = length of the arc
r = radius
θ = included angle

Punches

Objectives: At the end of this lesson you shall be able to
- **state the types of punches used for making holes**
- **state the specification of punches**
- **state the material of punches**
- **state the application of different punches.**

Punch is a hand tool used for producing holes in thin section material. These punches are used in cold condition, so they are also called as "cold punches".

Punches are classified into two types.

a) Solid punch

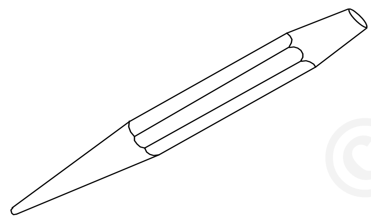
b) Hollow punch

Punches are made of a high carbon steel or a tool steel. They are hardened and tempered.

Punches are specified by their diameters.

Solid punch (Fig 1): These punches are solid in the cross section. Cutting edge is formed by the grinding face and diameter.

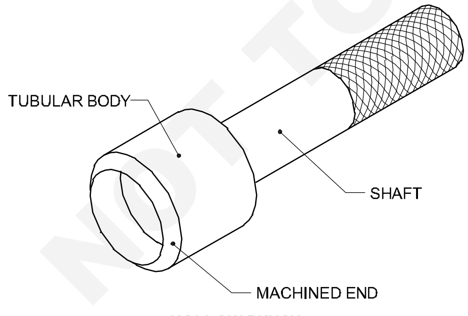
Fig 1



SOLID PUNCH

Hollow punches (Fig 2):These punches are hollow in cross section. Cutting edge is formed by grinding the end diameter at an angle.

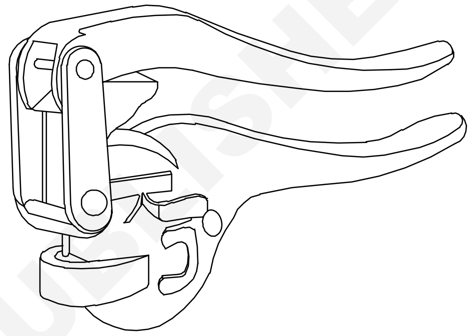
Fig 2



HOLLOW PUNCH

Hand lever punch (Fig 3): It is one of the solid punch, consists of punch and die. Punch is fixed on upper lever and die on lower lever. Sheet metal workpiece is placed between punch and die and hole is cut by pressing levers by hand.

Fig 3

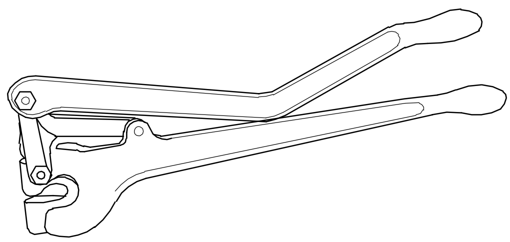


TINNER'S HAND PUNCH

There are two types of hand lever punches.

1 Tinner's hand punch (Fig 3)
2 Iron hand punch (Fig 4)

Fig 4



IRON HAND PUNCH

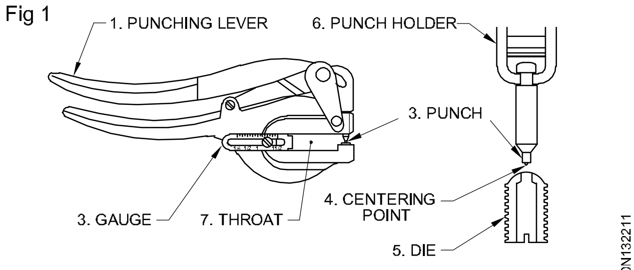
Tinner's hand punch is used for punching the holes upto 6 mm dia. Iron hand punch is heavy duty punch, which can punch holes upto 12 mm dia. in thin sheet.

The hand lever punch

At the end of this lesson you shall be able to
- **state what is a hand lever punch**
- **state the constructional features and principal parts.**

Hand lever punch (Fig 1)

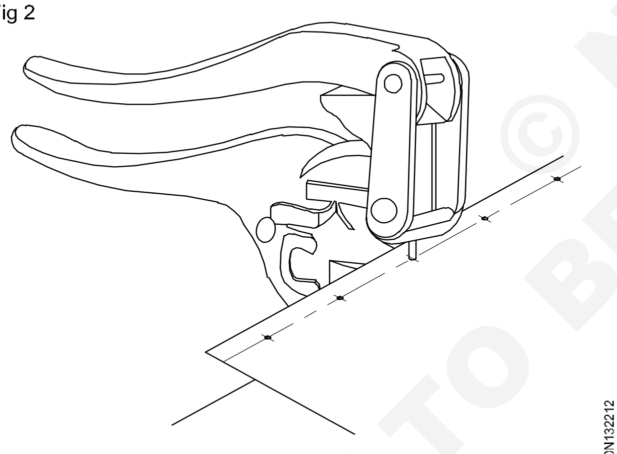
Fig 1



THE HAND LEVER PUNCH

It is used for punching small holes near the edges of thin sheets. (20 to 24 SWG) In this tool a die and a punch of the required hole size is fixed. Sheet is placed in between the punch and the die. The punch is forced by a lever by hand into the die to get the required sized hole. That is why it is called a hand lever punch. (Fig 2)

Fig 2



PUNCHING HOLES

PRINCIPLE PARTS

1 **Punching lever**

2 **The punch**

3 **The gauge:** It acts as a stopper and enables to punch

holes at equal distances. It can be adjusted to set the

distances from the edges of the sheet.

4 **Centering point:** It locates the centres of the holes.

The centering point is provided on the punch itself.

5 **Die:** It is threaded outside and a slot is provided at the bottom side to facilitate changing it, with the help of a screw driver.

6 **The punch holder:** It is provided with flanges which helps it to be fitted into the recess of the punch.

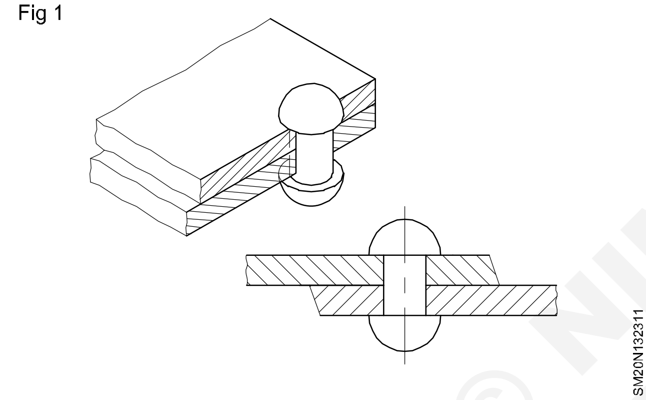
7 **Throat:** It governs the distance from the edge of the sheet to the hole to be punched.

Rivets - Types & Uses

Objectives: At the end of this lesson you shall be able to
- **state what is riveting**
- **state the uses of a rivet**
- **name the features of a rivet**
- **identify different types of rivets**
- **state the uses of the different types of rivets**
- **designate rivets**
- **name the materials from which rivets are made**

Riveting: Riveting is a method of making permanent joints. For riveting, the plates to be joined are drilled or punched. The head on the other end is formed after assembling the parts.(Fig 1)

Fig 1



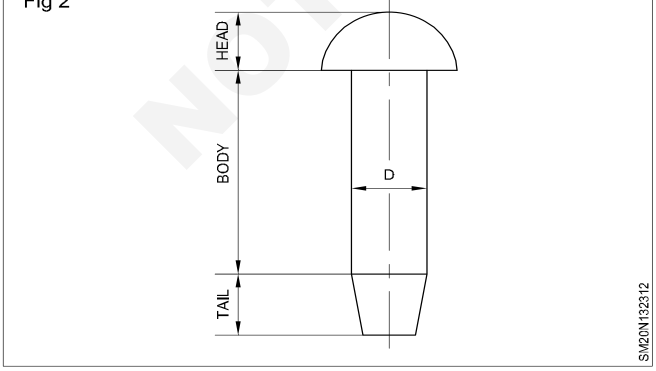
The rivets are then inserted and closed by force so that they completely fill the hole and form a rigid joint.

Uses: Rivets are fasteners used for joining metal sheets and plates in fabrication work such as bridges, ships, cranes, structural steel work, boilers, aircraft etc.

Parts: The following are the parts of a rivet. (Fig 2)

– Head
– Body
– Tail

Fig 2



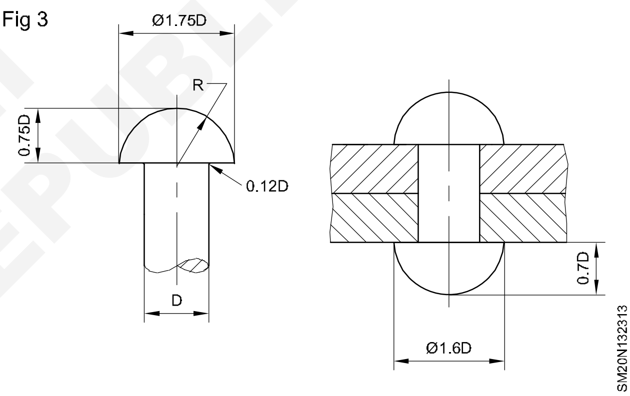
Materials: In riveting, the rivets are secured by deforming the shank to form the head. These are made of ductile materials.

Examples: Low carbon steel, brass, copper and aluminium.

Rivet head-shapes

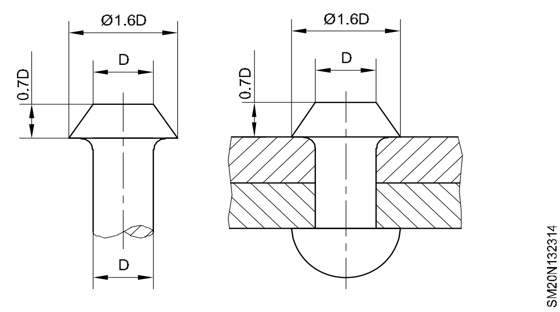
Snap-head: This rivet is most commonly used for structural works. The opposite end of the rivet is shaped similar to the head. (Fig 3)

Fig 3



Pan head: It is a very strong rivet. The opposite end is usually finished to the snap-head shape. Pan head rivets are used in heavy construction.(Fig 4)

Fig 4



Countersunk head: This rivet is mainly used in fabrication where projection of the rivet head has to be avoided. The opposite end is either finished to snap-head or countersunk head. Countersunk heads are available with different angles.

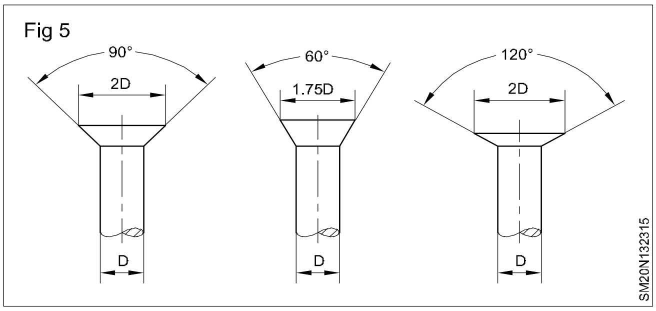


Fig 5

The standard countersunk head has 90^0. Rivets with 120^0 angle are used for joining thin plates. The method of joining thin sheets to thick plates is shown in the Figs 5 & 6.

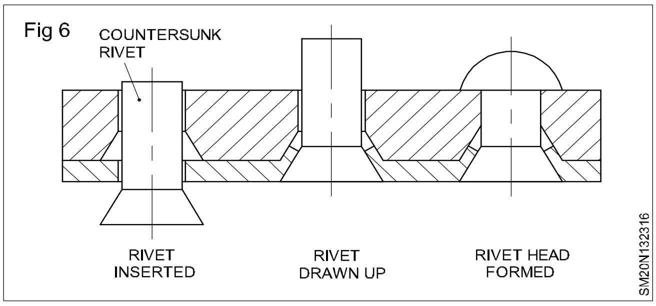


Fig 6

Mushroom head: These rivets are used to reduce the height of the rivet head above the metal surface.(Fig 7)

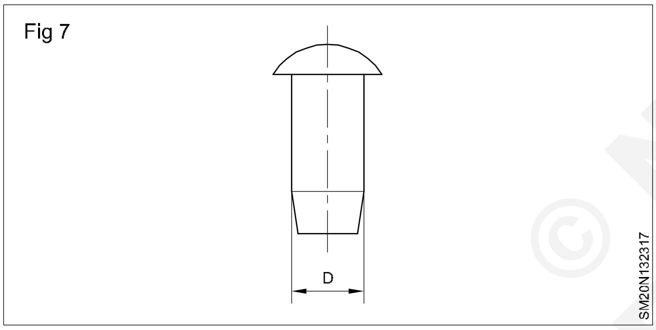


Fig 7

Flat head: Flat head rivets are most commonly used in sheet metal fabrication where the metal is very thin and a projecting head of the rivet is objectionable.

Flat head rivets are also available for heavy fabrication work.

Designation of steel rivets: A mild steel snap-head rivet of 16 mm diameter having a length of 70 mm shall be designated as snap head rivet 16 x 70 IS.(Fig 8)

A high tensile steel snap-head rivet of 16 mm diameter having a length of 70 mm shall be designated as snap head rivet 16 x 70 HT IS.

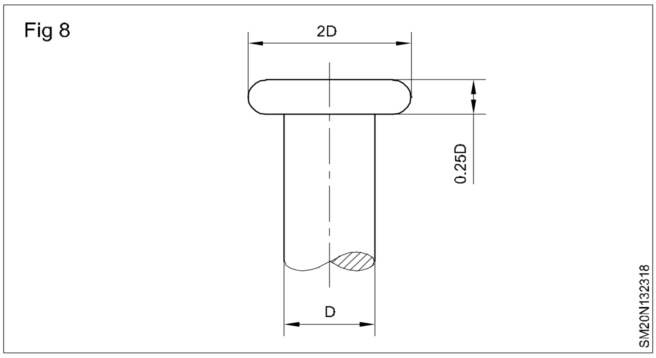


Fig 8

Other types of rivets are also designated in a similar manner. (Fig 9)

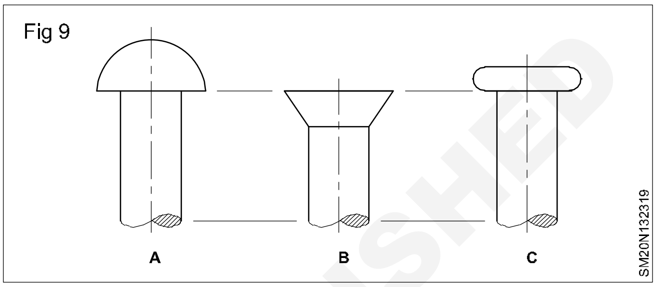


Fig 9

The length of rivets is indicated by the shank length.

Riveting (Hot and cold working): Riveted joints can be formed either hot or cold.

Smaller diameter rivets used in light fabrication are worked cold.

Larger diameter rivets are usually worked hot.

For hot working, the holes in which rivets are inserted are made larger for accommodating thermal expansion.

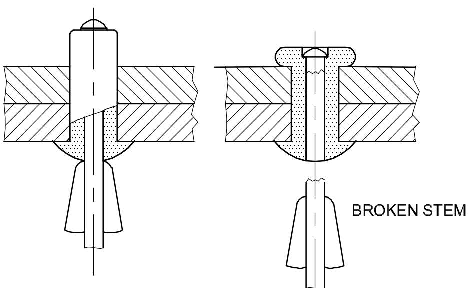
The clearance provided in the holes for cold working is less than that provided for hot working.

Special sheet metal rivets and their applications

Objectives: At the end of this lesson you shall be able to
- **state the types and uses of tubular rivets**
- **state the use of 'hank' rivet bushes**
- **state the use of speed nuts.**

Tubular rivet: The use of the tubular rivet removes much of the skill necessary, and there is no need for the support as with a solid rivet.(Fig 1)

Fig 1

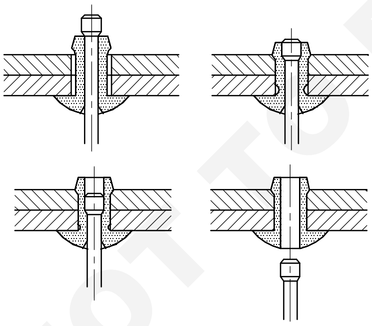


'POP' RIVET

SM20N132411

One type of tubular rivet is the 'pop rivet'. While it is held by its stem in the riveting 'gun', the rivet is pushed into the rivet hole and the gun causes the stem to be pulled back into the gun, while the gun nozzle remains pushed against the flanged head. The stem-head causes the rivet tube to be swaged out thus forming a new head on the far side of the joint, and consequently pulling the plates tightly together. Finally the pulling force on the stem is sufficient to fracture the stem below its head on the stem diameter. (Fig 2)

Fig 2

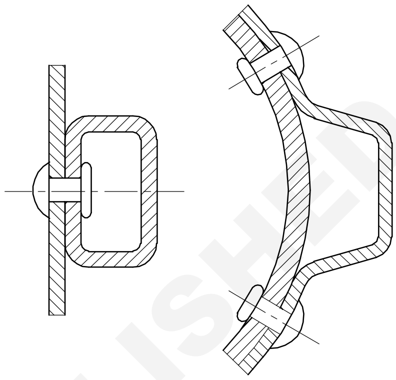


SM20N132412

Another type of tubular rivet has a stem-head which breaks off outside the rivet tube after the swaging stage, thus leaving the central hole clear. This is essential where drainage from cavities and hollow sections is necessary. (Fig 3)

'Hank' rivet bushes: These bushes are a means of providing a thin sheet metal with a deep tapped hole, and diameters and thread form, and they are used in conjunction with the standard set screws where access cannot be gained to fit the standard nuts.

Fig 3



APPLICATION OF TUBULAR RIVETS

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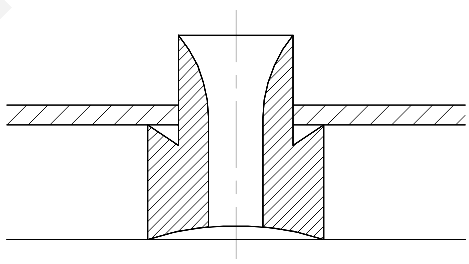
The following steps are required to fit hank bushes.(Fig 4)

Position the previously drilled hole in the panel.

Mark the centre punch hole position.

Fig 4



HANK BUSH

SM20N132414

Drill a hole of the required size. The hole should be the clearance size of the bush shank.

Remove the burrs: Fit the hank bush through the underside.

Support for riveting operation.

Using a ball pein hammer, spread the shank of the bush. Strike squarely to ensure the even spread of the shank . (Fig 5)

Change to the flat face of the hammer. Strike squarely, flatten the shank.(Fig 6)

Fig 5

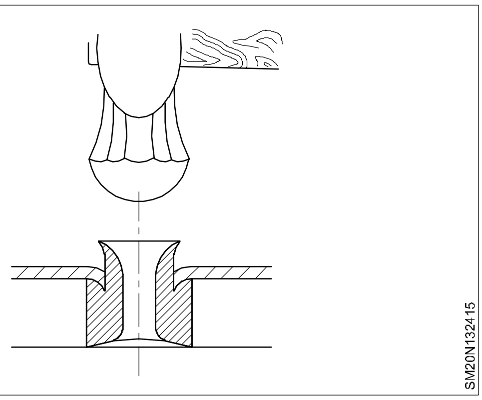
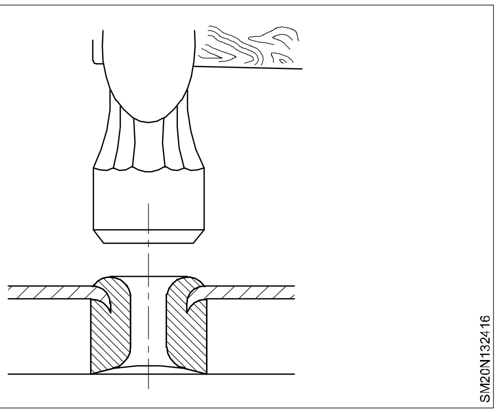


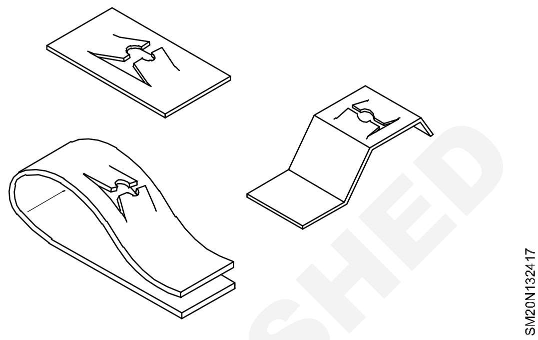
Fig 6



Speed nut: Speed nuts are available in a variety of forms and are made from different materials such as spring steel, stainless steel etc. The speed nut consists of a strip of metal stamped in such a manner that one or more thread-engaging portions are pressed upwards from the base to form part of a screw thread.(Fig 7)

Speed nuts are generally used in conjunction with coarse thread or self-tapping screws. As the screw is tightened, the pressure exerted on the tongues gives a self-locking action.

Fig 7



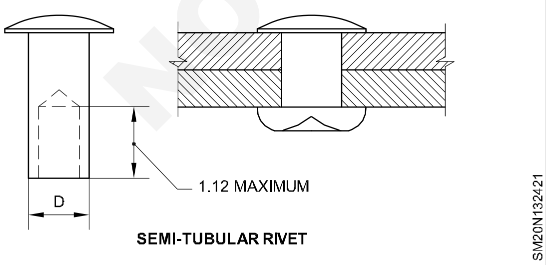
Tubular Bifurcated and metal Piercing Rivets

Objectives: At the end of this lesson you shall be able to
- **state different types of tubular and bifurcated rivets**
- **state the constructional features of them**
- **state the application of them.**

Tubular and bifurcated rivets: These rivets are used in low tension joints or for joining softer materials to sheet metals, as given hereunder.

Semi-Tubular rivets: This rivet has straight hole or tapered hole at the end of the shank. The depth of the hole must not exceed 1.12 time shank diameter as shown in Fig 1. The rivet shank should extend upto the full thickness of the joint, with the hollow portion set to give correct upsetting.

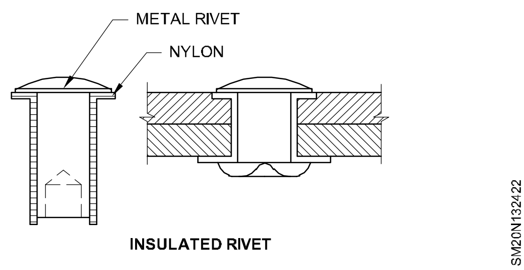
Fig 1



Insulated rivets: This rivet is semi-tubular and under the rivet head, it is covered with thick nylon as shown in Fig 2.

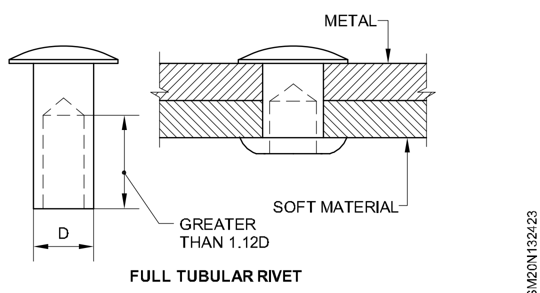
The main application of these rivets are in electrical assemblies, where the rivet needs to be insulated from the workpiece, and also for air tight or water tight joints.

Fig 2



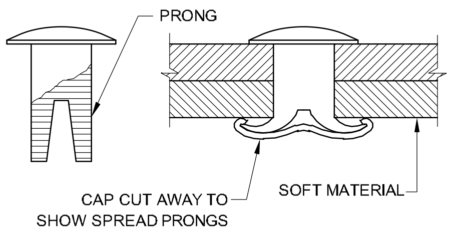
Full Tubular rivets: This rivet has a hole greater than 1.12D and is designed for use, where the rivets is desired to punch the rivet through soft materials as shown in Fig 3.

Fig 3



Bifurcated or Split rivet: The bifurcated or split rivet is machined to produce two prongs at the shank end to pierce soft materials as shown in Fig 4.

Fig 4



BIFURCATED OR SPLIT RIVET

Metal piercing rivets (Fig 5)**:** These rivets pierce their own holes into the sheet metal joints.

These are similar to solid rivets and have good tension and shear characteristics. These are economical as they produce their own holes and are used in mass production applications.

Semi-tubular metal piercing rivets: These rivets are designed to use as punches to penetrate fully or partially on both pieces of the metal.

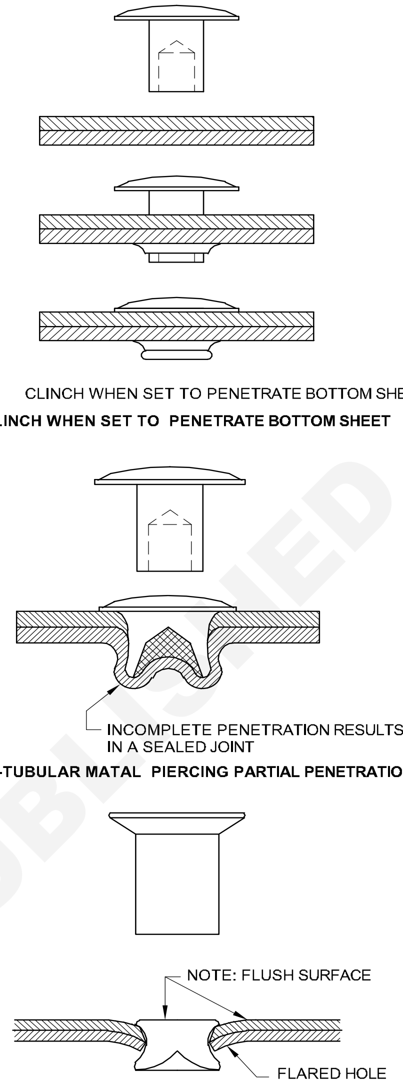
If the rivet fully penetrates the metal, it then completes the joint as shown in Fig . When the rivet partially penetrates the metal, the tail of the rivet forms a sealed joint.

Total sheet metal base thickness upto 2.5 mm can be used for semi-tubular metal piercing rivets.

Metal-piercing solid rivets: In this countersunk solid rivets can be driven into the sheet steel upto 3.2 mm total thickness with out the need of a hole. Penetration by the rivet, counter sinking and clinching the rivet against an upsetting tool, are completed in a single stroke. The counter sunk head produces a flashed hole which improves joint shear strength.

Expansion of the rivet end on the other side of the workpiece,prevents pull out.

Fig 5



CLINCH WHEN SET TO PENETRATE BOTTOM SHEET

SEMI-TUBULAR MATAL PIERCING PARTIAL PENETRATION

METAL PIERCING RIVETS

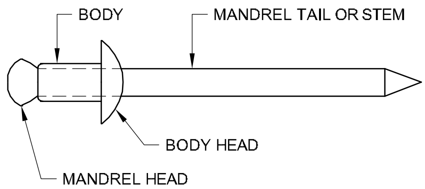
Blind rivet or Pop Rivet

Objectives: At the end of this lesson you shall be able to
- **state the types of blind rivets, their parts and application**
- **state the blind riveting equipment**
- **state the steps in riveting the blind rivets.**

Blind rivets are designed to allow them to be installed in joints which are accessible from one side only. However, for many reasons including simplicity and good appearance, they are used for joints from both sides are accessible. Prepared holes are required for blind riveting.

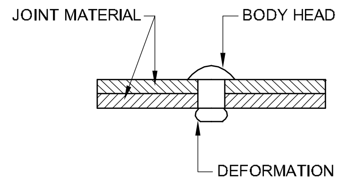
The parts of the rivet is shown in the Fig 1. The mandrel portion is used for assembly purposes only and after use, it is either totally or partially discorded. (Fig 2)

Fig 1



BLIND RIVET

Fig 2



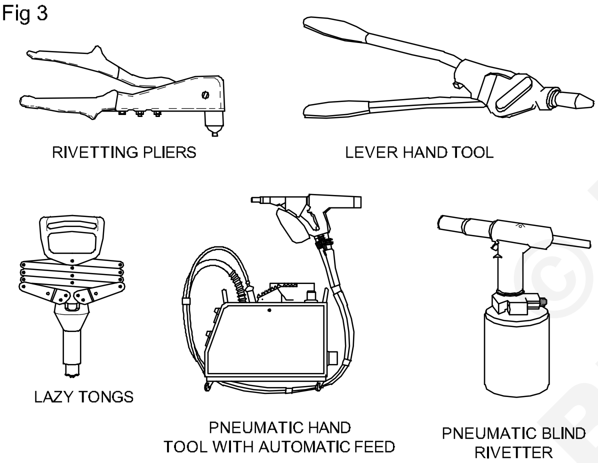
BLIND RIVET SET IN PLACE

Blind riveting equipment: The equipment used for blind rivets are blind rivet pliers, lazy tongs, lever hand tools, pneumatic and hydraulic magazine feed and semi-automatic fasteners as shown in Fig 3.

Types of Blind or Pop rivets: In setting a blind rivet, the body of the rivet is inserted into a hole and the mandrel is pulled deforming the tail which pulls and fixes the joint together. Blind rivets are available in many types and systems. Some of these are given here-under.

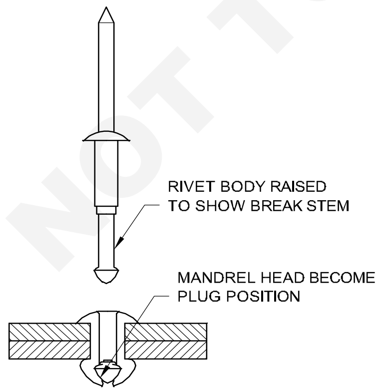
Plugged break stem: After the rivet tail has been deformed by the action of the mandrel, the mandrel stem breaks, leaving the head behind forming a plug as shown in Fig 4.

Fig 3



BLIND RIVETTING EQUIPMENT

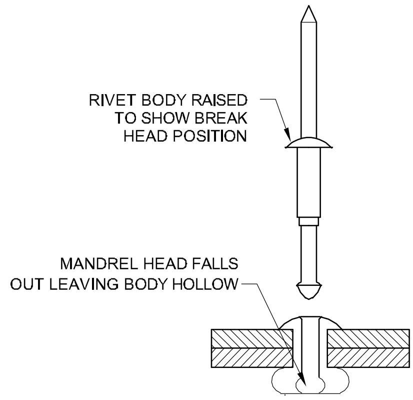
Fig 4



PLUGGED BREAK STEM

Open break stem: It is similar to the break stem, but the head breaks off and falls out after deforming the tail, leaving the hollow body open. (Fig 5)

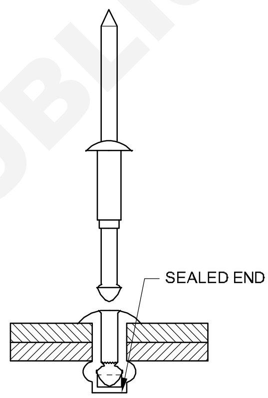
Fig 5



OPEN BREAK STEM

Sealed: The sealed type rivet is hollow cored with a closed blind end and is used where a water or pressure tight rivet is essential. (Fig 6)

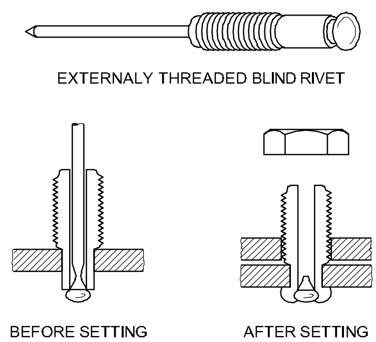
Fig 6



SEALED

Externally threaded blind rivets: This rivet is a conventional pull mandrel blind rivet. When the rivet is set, the head section protrudes providing a metric thread stud into which a nut can be fastened. (Fig 7)

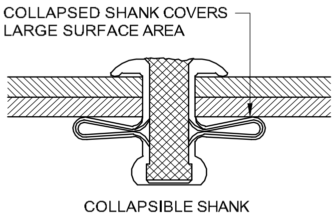
Fig 7



SETTING THE EXTERNALY THREADED BLIND RIVET

Collapsible shank: The tail or shank of this rivet is designed to deform into three segments. (as shown in Fig 8) It spreads the clamp up load over a wide area, making it suitable for assemblies having bigger size hole and also to prevent pull out in soft materials.

Fig 8

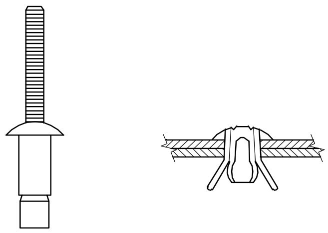


BLIND RIVET TYPES

SM20N132438

Flush break high strength: This blind rivet in 3 to 6 mm diameters has a mandrel with specially designed head that breaks off flush with the top of the rivet. (Fig 9)

Fig 9

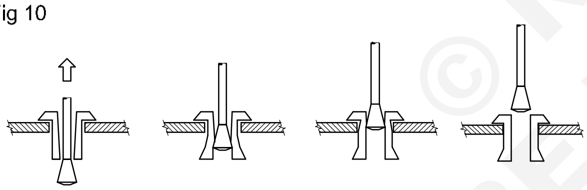


FLUSH BREAK HIGH STRENGTH

SM20N132439

Repetition blind riveting systems: Rivet is loaded onto a mandrel which is placed into a pneumatic setting tool with a rivet in the ready position. This rivet is inserted into a preformed hole, the tool trigger is actuated, drawing the mandrel through the rivet, expanding the rivet tail. Sequence of rivet setting is shown in Fig 10.

Fig 10



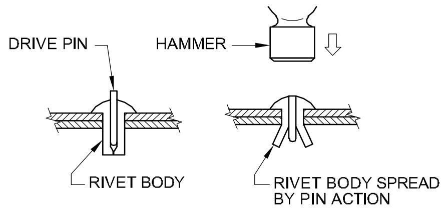
SEQUENCE OF RIVET SETTING REPETITION BLIND RIVETTING SYSTEMS

BLIND RIVET TYPES

SM20N13243A

Drive pin rivets: Drive pin rivets consist of a hollow body and a pin. In the manufactured condition itself, the pin projects from the rivet head. A hammer blow forces the rivet into the prepared hole, the pin expands the rivet and spreads pre-slotted shank prongs. (Fig 11)

Fig 11



DRIVE PIN RIVETS

SM20N13243B

Riveting blind rivet

Riveting steps

1 Select a rivet for the correct size of dia and length.

2 Drill a hole to the recommended diameter.

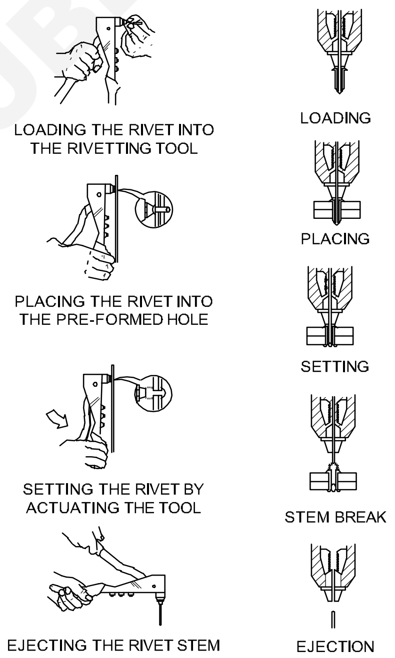
3 Open the riveting tool and insert the rivet stem into the tool nozzle.

4 Place the rivet body into the preformed hole.

5 Squeeze the rivet tool handles together to set the rivet, at the correct point of tension, the rivet stem will break.

6 When the rivet stem has broken, remove the tool from the job. Allow the tool to open fully to eject the spent rivet stem. (Fig 12)

Fig 12



SETTING A STANDARD BLIND RIVET

SM20N13243C

Lazy tong

Objectives: At the end of this lesson you shall be able to
- **state what is a lazy tong**
- **state parts and mechanism of a lazy tong**
- **state the operating instructions.**

Lazy tong is a hand operated tool, used for setting 1/8", 5/32" and 3/16" diameter standard open type blind rivets. It is important to use the correct nosepiece for the diameter of the rivet to be placed, to ensure the best performance of the tool. The parts list is shown in the figure and all parts are fully interchangeable.

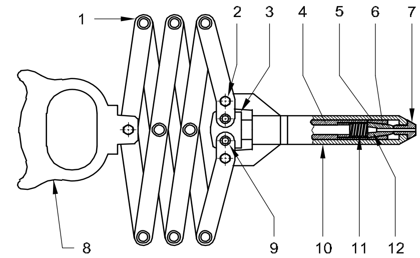
Description of mechanism: The mandrel gripping mechanism consists of a set of jaws (6) fitted into the jaw case (5) and screwed on to the power coupling assembly. The jaws are kept in the forward position by the jaw pusher (12) AND JAW PUSHER SPRING (11).

The lazy tong mechanism is connected to the power coupling in such a way that the operation of the handle (8) which draws the jaws, is gripping the rivet mandrel, thus setting the rivet.

Operating instructions: Check that the suitable nosepiece is fitted to the tool and firmly screwed into the threads.

\When the mandrel breaks, the rivet is set.

Fig 1



PARTS LIST OF LAZY TONG

NO.	DESCRIPTION	QTY.
1	LINKAGES	1 SET
2	LOCK NUT	2
3	YOKE	1
4	POWER COUPLING	1
5	JAW CASE	1
6	JAWS	1 SET
7	NOSE PIECE	1
8	HANDLE	1
9	FULCRUM PINS	2
10	BODY	1
11	JAW PUSHER SPRING	1
12	JAW PUSHER	1

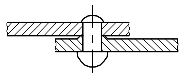
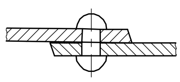
SM20N132441

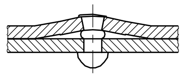
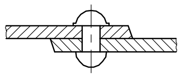
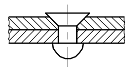
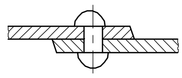
Defect in rivetted joints

Objectives: At the end of this lesson you shall be able to
- **relate riveting defects with their causes.**

While making riveted points certain precautions are to be exercised to avoid defects in the joints.

Few common causes and defects and resistant effects in riveting are given below: (Fig 1)

Causes of riveting defects	Resultant effect
Holes wrongly aligned	 RIVET DEFORMED AND DOES NOT COMPLETELY FILL THE HOLE.
Rivet too short	 PLATE SURFACES DAMMAGED. COUNTERSINKING NOT COMPLETELY FILLED.
Hole too large	 RIVET TENDS TO BEND AND DEFORM. HEAD WEAK AND POORLY SHAPED.
Burrs in drilling	 PLATES OR SHEETS NOT CLOSED TOGETHER UNEQUAL HEADS.
Burrs between plates	 GAP BETWEEN PLATES WEAK JOINT.

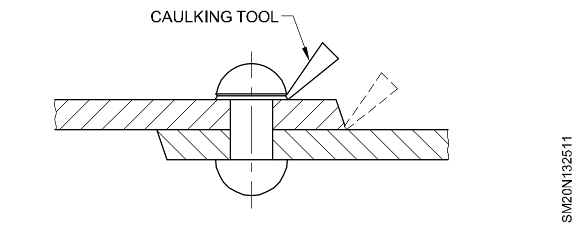
Rivet not set correctly	 RIVET SHANK SWELLS BETWEEN THE PLATES WEAK JOINTS.
Rivet length too long	 FLASH FORMED AROUND HEAD.  COUNTERSINKING OVERFILL
Head formed out of centre	 SHEET DAMAGED BY RIVETTING TOOL.

Caulking and fullering

Objectives: At the end of this lesson you shall be able to
- **state the purpose of caulking and fullering**
- **distinguish between caulking and fullering processes.**

Caulking: Caulking is an operation of closing down the edges of the plates and heads of the rivets to form a metal-to-metal joint.(Fig 1)

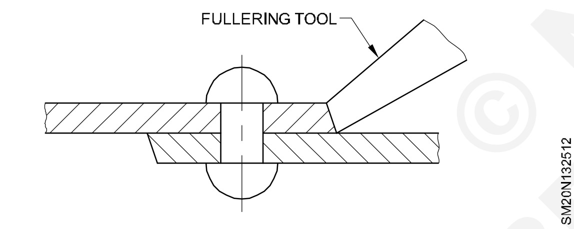
Fig 1



The edge of the rivet head is tightly pressed and expanded on the plate by a caulking tool which looks like a fattened cold chisel.

Fullering: Fullering is an operation of pressing the whole surface of the edge of the plate. It is done by a fullering tool.(Fig 2)

Fig 2



When the caulking tool is about as thick as the plate, it is called a fullering tool.

The whole surface of the edge of the first plate is tightly pressed on the second plate.

A better fluid-tight joint is achieved by fullering.

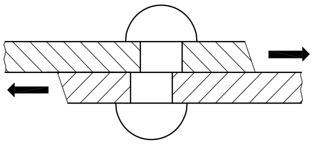
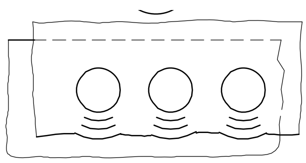
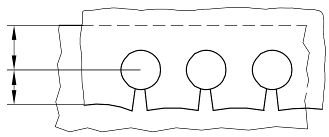
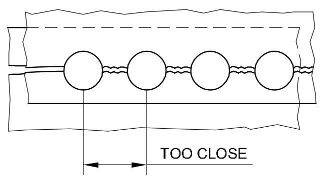
Caulking is done on the edges of the plates as well as on the edges of the rivet heads. But fullering is done on the edges of the plate only. To facilitate caulking and fullering on the plates, the edges of the plates are bevelled about 80^0 to 85^0.

The strength of riveted joints: A riveted joint is only as strong as its weakest part and it must be borne in mind that it may fail in one of the following four ways.

- Shearing of the rivet
- Crushing of the metal
- Splitting of the metal
- Rupture or tearing of the plate

These four undesirable effects are illustrated in the table below: (Fig 3)

TABLE

Riveted joints	Effect	Causes	Prevention
	Shearing of the rivet	Diameter of the rivet too small compared with the thickness of the plate. The diameter of the rivet must be greater than the thickness of the plate in which it is to be riveted. Strength of rivet material is less when compared to the material of the plates.	Select the correct diameter rivet to suit thickness of the plate. Select a suitable material rivet.
	Crussing of the rivet	Diameter of the rivet too large compared with the thickness of the plate. The rivets when driven tend to bulge and cursh the metal in front of them.	Select the correct diameter rivet for the thickness of the metal plate.
	Splitting of the metal	Rivet holes punched or drilled too near the edge of the plate Metal is likely to fail by splitting in front of the rivets.	Drill or punch the rivet at the correct distance from the edge and use the correct lap allowance for the diameter of the rivet.
	Tearing of the plate	Plates weakened by rivet holes being too close together. Plates tend to rupture along the centre line of the rivets.	Punch or drill rivet holes at the correct spacing or or pitch. In addition remove all burrs from the holes before final assembly.

Standard size of rivets

Objectives: At the end of this lesson you shall be able to
- **determine the hole sizes for different diameters of rivets**
- **choose the rivet diameters according to the thickness of the plates/sheets**
- **calculate the length and rivet interference for different diameter rivets and plate sizes.**

The size of the hole drilled for inserting the rivets.

The diameter of the rivet in proportion to the thickness of the plates/sheets to be joined.

The length of the rivet according to the type of the rivet and the thickness of the plates/sheets.

The size of the rivet and hole: The size of the hole to be drilled is according to the diameter of the rivet used.

A formula generally used for determining the diameter a solid rivet is

D.Min = T

to D.Max = 2T

The actual value used will depend upon the actual joint features and service conditions.

The size of the hole has to be slightly larger than the nominal diameter of the rivet. (Table 1)

For hot working, rivets will have holes with more clearance than for cold working.

TABLE 1
Hole diameter for rivets

Rivet nominal dia	2	3	4	5	6	8	10	12	15	15-40
Hole dia	2.2	3.2	4.2	5.3	6.3	8.5	11	18	16.5	Holes larger than the nominal dia by 1.5 to 2.0 mm

Length of rivets: The length of a rivet is the shank length. This will vary according to the thickness of the plates to be riveted and the type of the rivet head.(Fig 1 & 2)

A formula generally used in the shop floor is length of snap-head rivets.

L = T + 1.5D

Length of countersunk head rivets L = T + 0.6 D

L = shank length

T = total thickness of the number of plates used

D = rivet diameter

D_1 = hole diameter

Fig 1

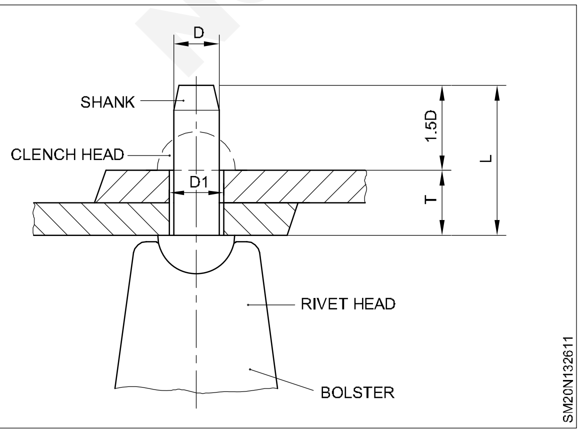
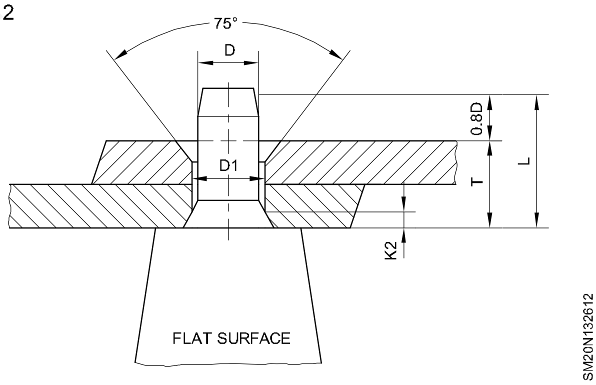


Fig 2



Rivet interference: The length required to form the head in riveting is called rivet interference.

When forming a round head (Fig 3) the interference x is given as

x = d x (1.3, - 1.6)

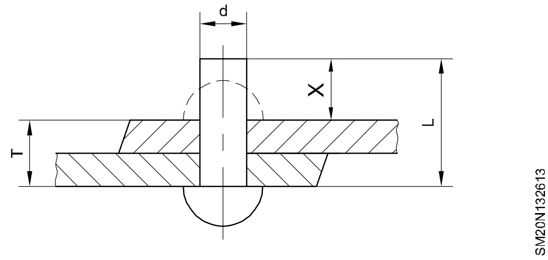
where x = rivet interference (mm)

d = rivet diameter (mm)

Therefore, the length of the rivet (L mm) to form a round head when the total thickness of the piled plates is T mm will be, as given below.

L = T + d (1.3 ~ 1.6)

Fig 3

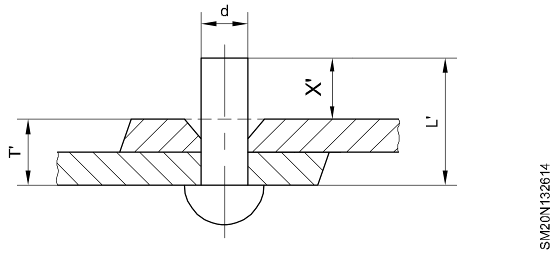


When forming a flat head (Fig 4) the length of the rivet (L'mm) will be as given below.

L' = T + d (0.8 ~ 1.2)

When he appropriate values of the rivet diameter and the length for the plate thickness are found out, choose the rivets with the standard size close to the calculated values.

Fig 4



Riveted Joints & spacing of rivets in joints

Objectives: At the end of this lesson you shall be able to
- **state the different types of riveted joints**
- **state the features of different types of riveted joints**
- **distinguish between chain riveting and zigzag riveting.**
- **determine the distance between the rivet and the edge of the joint**
- **state the effect on the joints when the rivets are too close or too far from the edge**
- **determine the pitch of rivets in joints**
- **state the effect of too close and too far a pitch of rivets in joints.**

In construction and fabrication work different types of riveted joints are made.

The commonly used joints are:

– single riveted lap joint

– double riveted lap joint

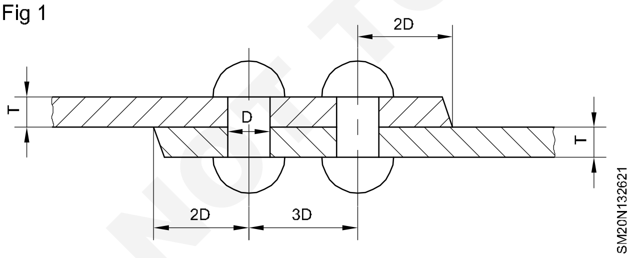
– single strap butt joint

– double strap butt joint

The spacing of the rivet holes depends upon the job. Given below is a general approach in determining this.

Distance from the edge to the centre of the rivet.(Fig 1)

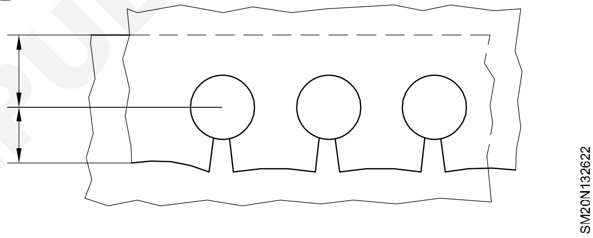
Fig 1



The space or distance from the edge of the metal to the centre of any rivet should be atleast twice the diameter of the rivet.

The purpose of this is to prevent the splitting of the edges. The maximum distance from the edge should not be more than ten times the thickness of the plate.(Fig 2)

Fig 2



Too much distance from the edge will lead to GAPING. (Fig 3)

Pitch of rivet: The minimum distance between rivets should be three times the diameter of the rivet. (3D) (Fig 4)

Fig 3

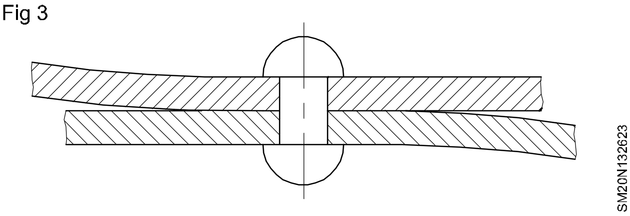
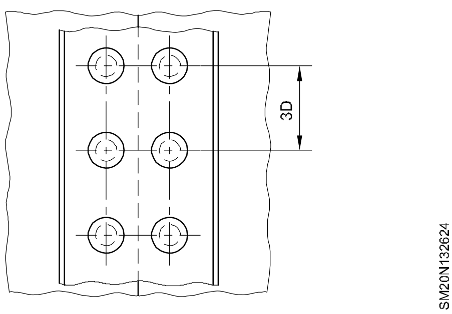
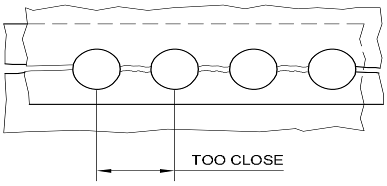


Fig 4



The distance will help to drive the rivets without interference.(Fig 5)

Fig 5

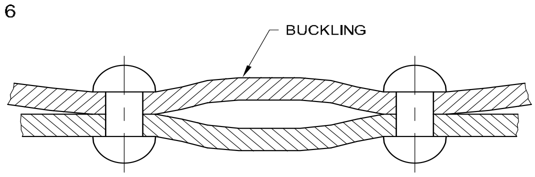


Too closely spaced rivets will tear the metal along the centre line of the rivets.

The maximum distance between the rivets should exceed twenty four times the thickness of the metal.(Fig 6)

Too far a pitch will allow the sheet/plate to buckle between the rivets.

Fig 6



Riveted Joints

Objectives: At the end of this lesson you shall be able to
- **state the different types of riveted joints**
- **state the features of different types of riveted joints**
- **distinguish between chain riveting and zigzag riveting.**

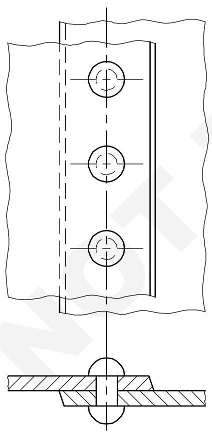
In construction and fabrication work different types of riveted joints are made.

The commonly used joints are:

- single riveted lap joint
- double riveted lap joint
- single strap butt joint
- double strap butt joint

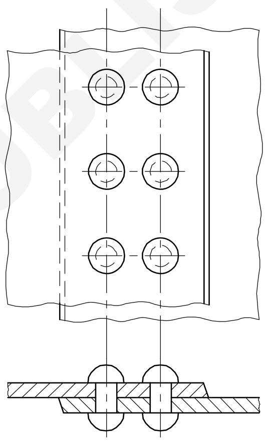
Single riveted lap joint: This is the simplest and most commonly used type of joint. This joint is useful for joining both thick and thin plates. In this, the plates to be joined are overlapped at the ends and single row of rivets is placed in the middle of the lap.(Fig 1)

Fig 1



Double riveted lap joint: This type of joint will have two rows of rivets. The overlap is large enough to accommodate two rows of rivets.(Fig 2)

Fig 2



Double riveted (Zigzag) lap joint: This provides a stronger joint than a single lap joint. The rivets are placed either in a square formation or in a triangular formation. The square formation of rivet placement is called CHAIN riveting. The triangular formation of rivet placement is called zigzag riveting.(Fig 3)

Pitch allowance: Three or four times the diameter of rivet + Sheet thickness 1 time.

The shank length is given by

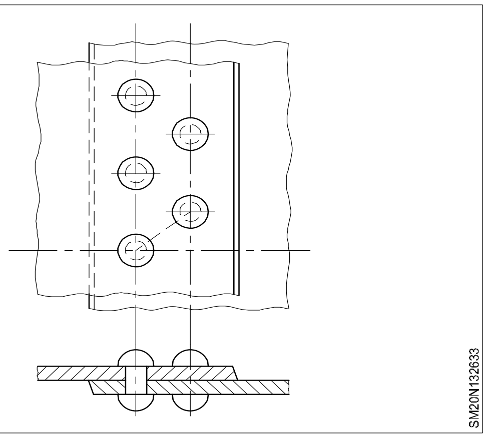
Length :- L = T + D where T is the Sheet thickness and D is the diameter of the rivet.

Normally Tinman's rivets are designated by numbers.

Thickness of sheet 14, 16, 18, 20, 22, 25

Dia of rivet 22, 24, 26, 27, 28, 30

Fig 3



Sketch

Draw a straight line of 1.25" and add sheet thickness, for total distance find out centre, and draw a semi circle with spring divider, Draw a perpendicular line projecting the line upto semi circle the distance is taken as a dia of rivet.

Rivet hole size and clearance: A rivet hole should be formed a little bigger than the nominal diameter of the rivet. The hole diameter will be bigger than the rivet shank nominal diameter by 0.2 to 0.3 mm for cold riveting and by 0.5 to 1.5 mm for high temperature (Red) for hot riveting process.

Working condition
Cold Riveting
Hot Riveting Process

Rivet Nominal
2 3 4 5 -6
8 10 12 15 15 to 40

diameter (MM)

Tolerance (DÂ)
0.2± ±0.2 ±0.5–0.2±0.5–0.2
0.2± ±0.2

0.2± ±0.2

Bigger than nominal diameter

by 1.5 to 2.0 mm plates.

Hole diameter
2.2 3.2 4.2
8.5 11 13 16.5

5.3 6.3

Annealing of rivet: Riveting is usually performed in the normal temperature when the rivet diameter is less than 6 mm. To prevent the breakage and failure of rivets and to facilitates the operation, rivets are used in the normal temperature. Rivets are annealed in the temperature of 650° to 700^{0}C and allow them to cool slowly. Generally M.S.Rivets are heated in furnaces uniformly. Aluminium rivets are used without annealing. High strength aluminium Alloyed Rivets in the Duralumin group are heated to 480^0-500^{0}C and , coded in water. Generally Electric furnaces are used for heating the rivets.

The ISI table giving the dimensions of the Turners rivets is given below.

Method of riveting: Riveting may be done by hand or by machine. While riveting by hand it can be done with a ball pane hammer and a rivet set.

Rivet set: The shallow, cup shape hole is used to draw the sheet and the rivet together. The output on the side allows the slug to drop out.

The cup strap is used for forming the rivet head. The rivet set selected should have a hole slightly larger than the diameter of the rivet.

Spacing of rivets: The space of distance from the edge of the metal to the centre of any rivet should be atleast twice the diameter of the rivet to avoid tearing.

The maximum distance should never exceed 24 times the thickness of the sheet. Otherwise buckling will take place.

Fastening of Sheet Metal (Various types of Fastning)

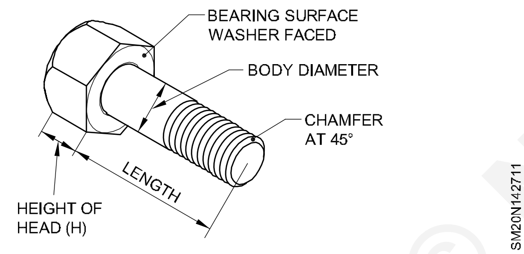
Objectives: At the end of this lesson you shall be able to
- **state the types of bolt and nuts**
- **state the types of washers**
- **state the types of joints.**

In joing number of parts together and dismandling without damaging any parts, devices called Bolts, nuts, screws etc are made use of. These are called "Screwed fasteners". Bolt is a metallic cylindricl rod having a specific shape on one end called "Head" and the other end called shank with screw threads cut on it. All the fasteners are generally made of steel of good tensile strengh.

Bolts and nuts

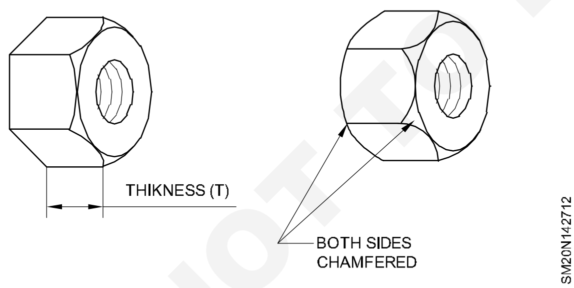
Bolt is a metallic piece of definite shape with threaded (screwed) hold on the centre of the face. It is used on the end of the bolt/screw to hold the parts in position. (Fig 1)

Fig 1



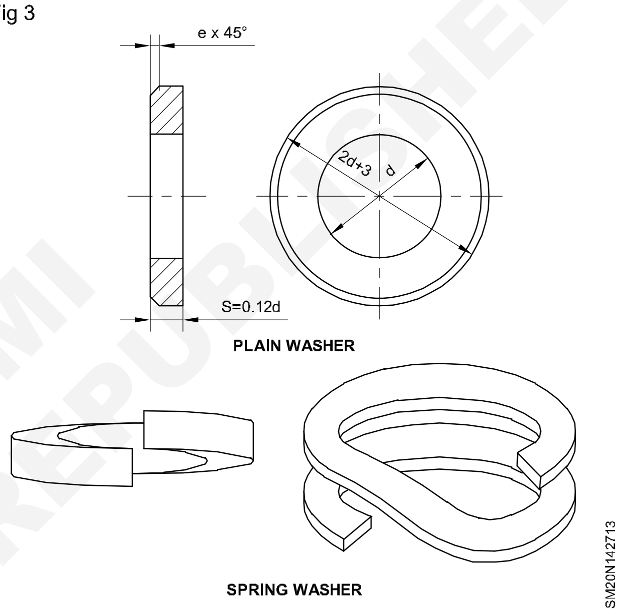
Nuts are known by their shape or their cross-section. The most commonly used forms are hexagonal and square. Nut are specified by the shape of the nut and the nominal dia of bolt/screw on which they are used. (Fig 2)

Fig 2



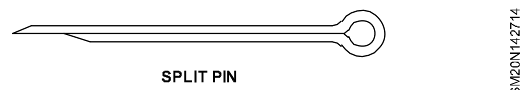
Washer: It is a cylindrical thin disc with a hole in the centre. Washer helps to provide smooth bearing surface between the nut and the part on which it is used. There by it prevents the nut corners from cutting into the metal. (Fig 3)

Fig 3



Split Pin: It is made of semi circular steel wires (IS:549) bent through the split pin holes in the bolt/screw ends and the ends are opened back wards. They are available in 16 sizes, 0.6 mm to 20 mm depending upon the bolt dia 2.5 to 170 mm dia. (Fig 4)

Fig 4

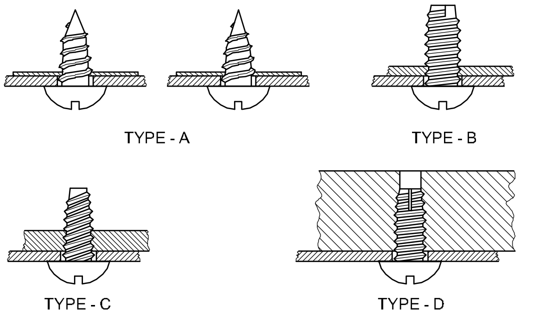


Types of screws applied in sheet metal work

Objectives: At the end of this lesson you shall be able to
- **state the type of self tapping screws**
- **state the application of each self tapping screws**
- **state the use of electric screw driver**
- **state the feature of lag screw and its application.**

Self tapping screws: Sheet metal screws are designed especially for sheet metal work. They are also called self-tapping screws because they tap their own mating threads as they are driven into the material. (Fig 1) Note that the screws are threaded to the full length of the screw. This causes the two pieces of the metal to be fastened tightly together under the head of the screw. Most types of sheet metal screws are available with slotted, philips and hex type head.

Fig 1



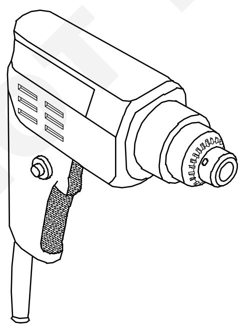
SELF TAPPING SHEET METAL SCREWS

Sheet metal screws are classified by the type of point and threading. The most common type is shown in Fig 1. "A" type has a sharp (or gimlet) point and coarse threads for ease in assembling. This type is used for fastening thin section. Type "B" is a modified form of type A screw and is now recommended in place of type A. Type B has a blunt point and threading similar to type A and is used for joining thicker sections. Type C has finer threads than type A and B and is used on heavier sheet and where greater strength is required. Type D has blunt point and fine threads. It is used mainly for joining heavy metals, metals of different thickness and to fasten sheet metal to structural members or casting. This type is used where great strength is required. Types A and C are thread forming screws. That is as they are driven, the pressure forms the mating threads in the metal.

In drilling holes for sheet metal screws, it is important to use the proper size bit, especially for type D. The drill bit size to be used is usually indicated on the box containing the screws. If the hole is too large, the screw will not hold, if the hole is too small the screw will either not start or will be difficult to turn and may break off in the hole.

Sheet metal screws may be driven with hand screw drivers or with electric drills with special screw driver bits. Also, there are electric screw drivers which are similar to electric drills except that they are equipped with special chuck assemblies to receive, insert bits for slotted and philips type screw heads and sockets for hex heads. (Fig 2)

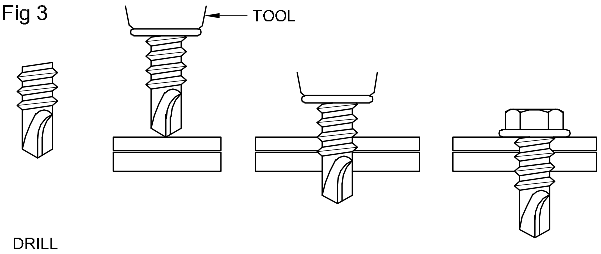
Fig 2



PORTABLE ELECTRIC DRILL

Self drilling screws: Self drilling screws are a further refinement of the self-tapping screws previously described. The tip of the screw is like a drill bit. This eliminates the need for pre-drilling or punching starter holes. Also, because the threads automatically tap the mating part, the self drilling screw drills and taps threads in one operation as shown in Fig 3.

Fig 3

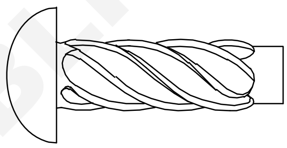


SELF DRILLING AND TAPPING SCREWS

The sizes and threading of self drilling screws are the same as those for self tapping screws.

Drive screws: The type U drive screw shown in Fig 4 is considered to be a sheet metal screw although it is used much like a nail. Its main use is to fasten sheet metal of heavy structural steel. A hole of the same size as the tip of the screw is drilled through both pieces and drive screw is driven in with a hammer. The raised threads then form mating threads like the self tapping and self drilling screws

Fig 4



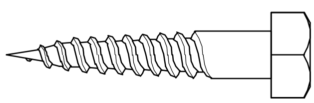
SHEET METAL DRIVE SCREW

Installation fasteners: The sheet metal worker will be often required to install the objects he has fabricated in the shop. Many times, this will involve fastening the sheet metal to other materials such as concrete, masonory, wood, plaster or dry wall. There are many purposes. The following examples are the more commonly used types in the sheet metal trade.

Nails: Many types of nails such as copper, zinc and tin coated are used in sheet metal work. Copper nails are used whenever copper sheets is fastened to wood. Tinned nails are used extensively in all kinds of tin roofing. Galvanised nails are used in all applications of galvanised sheet metal. Nails are designated by the symbol "d". This is the English symbol for penny. Thus 10 d means ten penny. The smaller the number the smaller the nail. The largest size generally used are 16 penny nails.

Lag screws: Lag screws shown in Fig 5 are large wood screws with a square or hex head instead of a slotted head. This is so that they can be turned with a wrench instead of a screw driver. Lag screws can be purchased either black or galvanised and are designated by diameter and length, thus a 1/4 x 4 lag screw is 1/4 inch in diameter and 4 inches long. Lag screws are available in upto 6 inches. They are used to fasten to wood. .

Fig 5



LAG SCREW

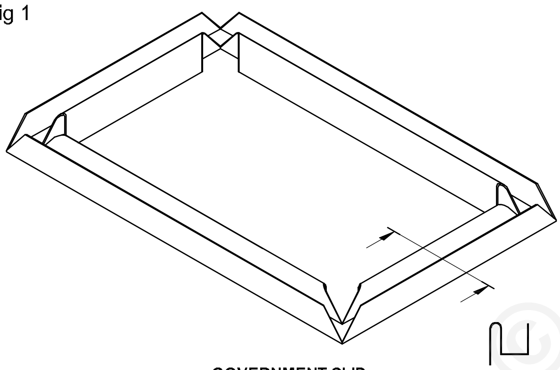
Clips

Objectives: At the end of this lesson you shall be able to
- **state what is a clip**
- **state the types of clips**
- **state the forms of clips and their application.**

Standard methods have been developed for connecting the joints of the sheet metal duct and the pipe. Normally the clips are used. The sheet metal worker should know thoroughly the uses of the allowances and the forming of all the clips.

Government clip (Fig 1): The Government clip is sometimes called the “Cup or Pocket clip”. Its principal use is in joining the sections of large, rectangular duct. Most shops have a lock forming machine that automatically forms the clips. The allowance on the duct for the clip is 1 inch as shown in Fig 2.

Fig 1



GOVERNMENT CLIP

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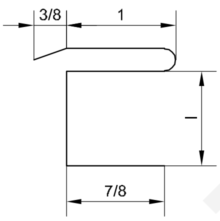
Fig 2



ALLOWANCE FOR GOVERNMENT CLIP

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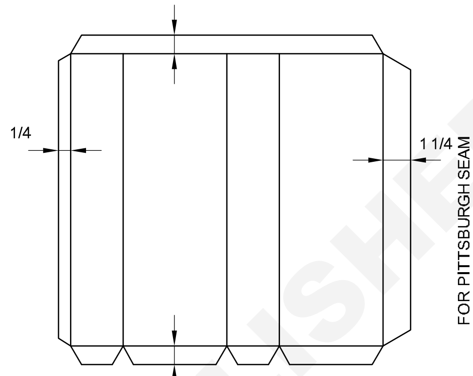
This allowance is not bent but is left straight for the clip to fit on. After the clip is set on the duct, it is fastened with a clip punch or by riveting. (Figs 3 & 4)

Nailing clips (Fig 5): Nailing clips are used to hold a sheet nailed down to a wood surface, while hiding the nails from sight. And also some are designed to hold the sheets down but to allow for the expansion and contraction of the metal. Nailing clip used on lock seam roofing is shown. This clip is usually about 1 inch wide. It hooks over the edge of the lock seam and is nailed into the wooden surface.

Fig 3



FLANGE AND ALLOWANCE FOR GOVERNMENT CLIP

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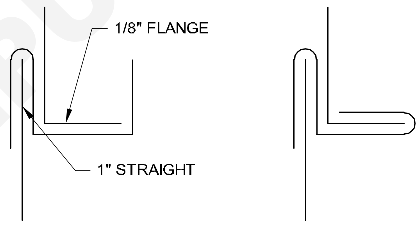
Fig 4



SECTIONAL VIEW OF GOVERNMENT CLIP

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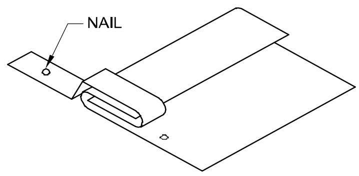
Fig 5



NAILING CLIP

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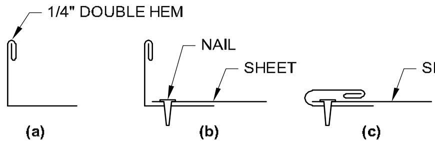
Another type of nailing clip is shown in Fig 6. This clip is often called a blind seam. This clip is usually used, when the sheet can be nailed down but the nail should be invisible.

Fig 6



NAILING CLIP USED ON BLIND SEAM

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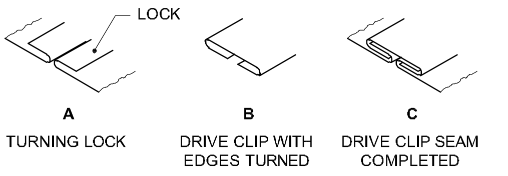
Drive clip (Fig 7): This clip is generally used for connecting cross seams on ducts.

The seam is made by turning edges as shown in Fig 7 on the two pieces to be joined. The common width of a drive clip is 1/2". Often the clip will have to be driven on with a hammer, which is the reason for its name.

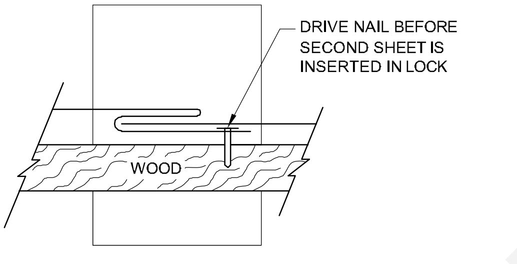
"S" Clip (Fig 8): The S clip is an S shaped piece of metal that forms two pocket locks for the joining metal to slip in as shown in Fig 8.

Fig 7



STEPS IN ASSEMBLING A DRIVE CLIP SEAM

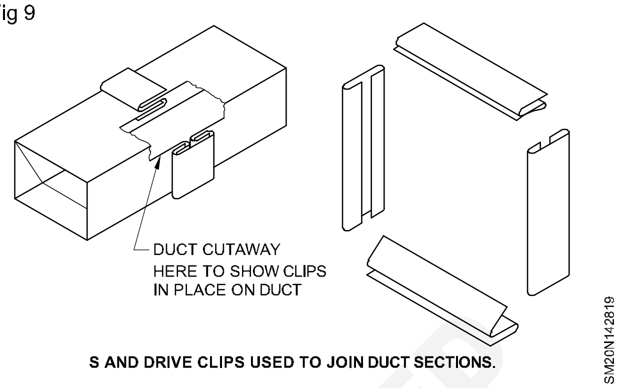
Fig 8



With the drive clip, the most common application of the 'S' clip is in joining the sections of the duct.

'S' and drive clips are used to join the sections of the duct. (Fig 9)

Fig 9



S AND DRIVE CLIPS USED TO JOIN DUCT SECTIONS.

Solders

Objectives: At the end of this lesson you shall be able to
- **define a solder**
- **state the types of solders**
- **state the constituents of soft and hard solders.**

Solder is a bonding filler metal used in soldering process.

Pure metals or alloys are used as solders. Solders are applied in the form of wires, sticks ingots, rods, threads, tapes, formed sections, powder, pastes etc.

TYPES OF SOLDERS

There are two types of solders.

– Soft solder

– Hard solder

Soft solders: Soft solders are alloys of tin and lead in varying proportions. They are called soft solders because of their comparatively low melting point. One distinguishes between soft solder whose melting points are 450^{0}C and hard solders whose melting points lie above 450^{0}C. These are alloys of the materials tin, lead, antimony, copper, cadmium and zinc and are used for soldering heavy (thick) and light metals. Table shows different compositions of solder and their application.

In the composition of soft solder, tin is always stated first.

WARNING

For cooking utensils, do not use solder containing lead. This could cause poisoning. Use pure tin only.

Hard solders: These are alloys of copper, tin, silver, zinc, cadmium and phosphorus and are used for soldering heavy metals.

Sl.No.	Types of solder	Tin	Lead	Application
1	Common solder	50	50	General sheet metal applications
2	Fine solder	60	40	Because of quick setting properties and higher strength, they are used for copper water tanks, heaters and general electrical work.
3	Fine solder	70	30	
4	Coarse solder	40	60	Used on galvanised iron sheets
5	Extra fine solder	66	34	Soldering brass, copper and jewellery
6	Eutectic alloy	63	37	Similar to fine solder

Soldering Flux

Objectives: At the end of this lesson you shall be able to
- **state the functions of soldering fluxes**
- **state the criteria for the selection of fluxes**
- **distinguish between corrosive and non-corrosive fluxes**
- **state different types of fluxes and their applications.**

All metal rust to some extent, when exposed to the atmosphere because of oxidation. The layer of the rust must be removed before soldering. For this, a chemical compound applied to the joint is called flux.

Function of the fluxes:

1 Fluxes remove oxides from the soldering surface. It prevents corrosion.

2 It forms a liquid cover over the workpiece and prevents further oxidation.

3 It helps molten solder to flow easily in the required place by lowering the surface tension of the molten solder.

Selection of flux: The following criterias are important for selecting a flux.

- Working temperature of the solder
- Soldering process
- Material to be joined

Different types of fluxes: Flux can be classified as (1) Inorganic or Corrosive (Active) & (2) Organic or non-corrosive (Passive).

Inorganic fluxes are acidic and chemically active and remove oxides by chemically dissolving them. They are applied by brush directly on to the surface to be soldered and should be washed immediately after the soldering operation is completed.

Organic fluxes are chemically inactive. These fluxes coat the surface of the metals to be joined and exclude the air from the surface, to avoid further oxidation. They are applied only to the metal surfaces which have been previously cleaned, by mechanical abrasion. They are in the form of lump, powder, paste or liquid.

DIFFERENT TYPES OF FLUXES

(A) Inorganic fluxes

1 Hydrochloric acid: Concentrated hydrochloric acid is a liquid which fumes when it comes into contact with air. After mixing with water 2 or 3 times the quantity of the acid, it is used as dilute hydrochloric acid. Hydrochloric acid combines with zinc forming zinc chloride and acts as a flux. So it cannot be used as a flux for sheet metals other than zinc iron or galvanised sheets. This is also known as muriatic acid.

2 Zinc chloride: Zinc chloride is produced by adding small pieces of clean zinc to hydrochloric acid. It gives off hydrogen gas and heat after a vigorous bubbling action, thus producing zinc chloride. The zinc chloride is prepared in heat resisting glass beakers in small quantities. (Fig 1)

Zinc chlorides are known as killed spirits. It is mainly used for soldering copper, brass and tin sheets.

3 Ammonium chloride or Sal-Ammoniac: It is a solid white crystalline substance used when soldering copper, brass, iron and steel. It is used in the form of powder or mixed with water. It is also used as a cleaning agent in dipping solution.

4 Phosphoric acid: It is mainly used a flux for stainless steel. It is extremely reactive. It is stored in plastic containers because it attacks glass.

(B) Organic fluxes

1 Resin: It is an amber coloured substance extracted from pine tree sap. It is available in paste or powder form.

Resin is used for soldering copper, brass, bronze, tin plate, cadmium, nickel, silver and some alloys of these metals. This is used extensively for electrical soldering work.

2 Tallow: It is a form of animal fat. It is used when soldering lead, brass and pewter.

The following Table shows the nature and type of flux used in soldering.

Metal to be soldered	Inorganic flux	Organic flux	Remarks
Aluminium Aluminium-bronze			Commercially prepared flux and solder required
Brass	Killed spirits Sal-ammoniac	Resin Tallow	Commercial flux available
Cadmium	Killed spirits	Resin	Commercial flux available
Copper	Killed spirits Sal-ammoniac	Resin	Commercial flux available
Gold		Resin	
Lead	Killed spirits	Tallow Resin	
Monel			Commercial flux required
Nickel	Killed spirits	Resin	Commercial flux available
Silver		Resin	
Stainless steel	Phosphoric acid		Commercial flux available
Steel	Killed spirits		
Tin	Killed spirits		Commercial flux available
Tin-bronze	Killed spirits	Resin	
Tin-lead			
Tin-zinc	Killed spirits	Resin	
Zinc	Muriatic acid		

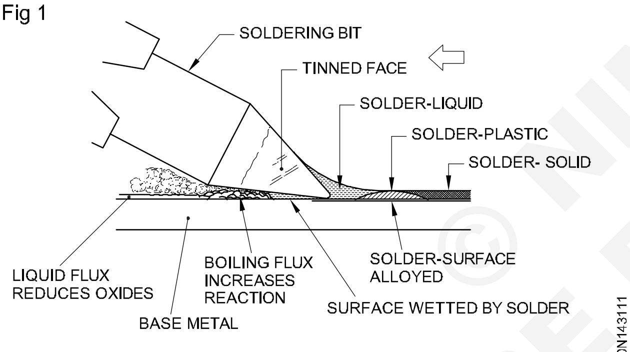
Soft soldering

Objectives: At the end of this lesson you shall be able to
- **explain soft soldering process**
- **state the melting characteristics of soft solders**
- **state the essential features of the soldering technique**
- **state the characteristics of the soldered seams to be observed while inspection.**

Soft soldering involves the process.

- preparing the workpiece.
- select the correct soft solder.
- preparing the soldering iron.
- select and apply suitable flux.
- heat the soldering iron bit and the workpiece to the correct temperature.
- manipulating the soldering iron on the workpiece skillfully as shown in Fig 1.
- complete the job to a satisfactory standard.

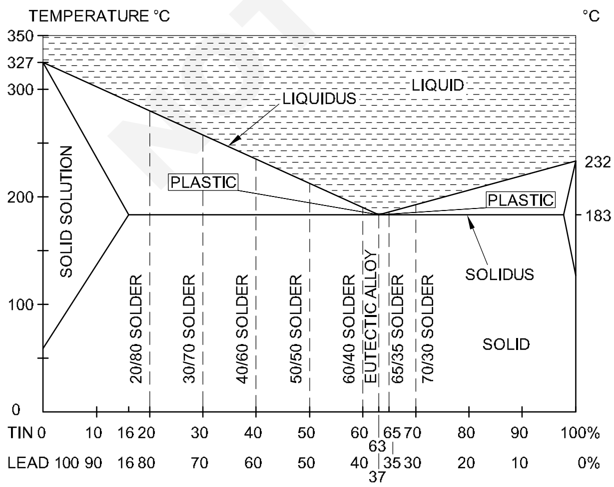
Fig 1



THE SOFT SOLDERING PROCESS

Melting characteristics of soft solders: The eutectic alloy of tin lead solder is a mixture of 63% tin and 37% lead. 63/37 solder melts at 183^{0}C and is the lowest melting point of all combinations in the alloy series as shown in Fig 2.

Fig 2



MELTING CHARACTERISTICS OF TIN-LEAD SOLDER

Soldering Techniques: The following features are essential to do soldering.

- Correct joint design
- Preparation of the joint
- Selection of the solder
- Selection and preparation of the soldering iron.
- Copper bit heating
- Soldering bit manipulation
- Cleaning after soldering
- Inspection of the seam.

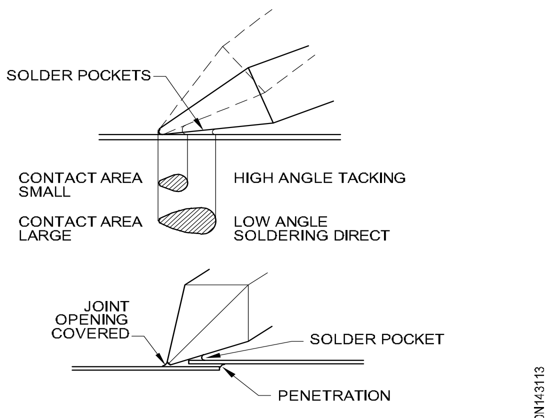
Attitude of the bit: The soldering iron bit should be placed in a position that enables sufficient heat and solder to flow into the joint.

The angle between a working face of the bit and the joint surface should be filled with a pocket of solder.(Fig 3)

Any variation of this angle will control the amount of heat and solder which is transferred onto the lapped surfaces.

Contact between the molten solder and the joint opening is essential for the penetration of the solder into the joint as shown in figure.

Fig 3



ATTITUDE OF BIT

Soldering

Objectives: At the end of this lesson you shall be able to
- **define 'soldering'**
- **state the different types of soldering processes**
- **state the different types of solder and their applications**
- **state the different types of soldering bits and their uses.**

Soldering method: There are different methods of joining metallic sheets. Soldering is one of them.

Soldering is the process by which metallic materials are joined with the help of another liquified metal (solder). The melting point of the solder is lower than that of the materials being joined.

The solder wets the base material without melting it.

Soldering should not be done on joints subjected to heat and vibrations and where more strength is required.

Soldering can be classed as soft soldering and hard soldering.

The process of joining metals using tin lead solders which melt below 420^0C is known as soft soldering.

The process of joining metals using hard solders consisting of copper, zinc, cadmium and silver which melt above 600^0C is known as hard soldering.

Brazing is a hard soldering process used to join copper, brass and most ferrous metals.

The bonding filler metal usually consists of copper and zinc alloys. Silver brazing or silver soldering is a process used to join steel, copper, bronze and brass and precious metals like gold and silver.

The bonding filler metal consists of silver, copper and zinc alloys.

Successful soldering

Objectives: At the end of this lesson you shall be able to
- **follow the hints for successful soldering.**

Hints for successful soldering

You should always wear safety glasses to avoid possible injury to the eyes.

Sheet metal must be cleaned with a file, wire brush, steel wool strip, or emery cloth.

Be sure that the pieces to be soldered fit closely together, for a strong joint.

Soldering flux must be applied by a swab or brush only to the surfaces on which molten solder is to be applied.

Hold the pieces to be soldered firmly to prevent their movement.

Hold the soldering iron in one hand, placing its widest tinned face flat against the surface to be soldered.

When soldering iron is held incorrectly, the point of the soldering iron touches only a portion of the area to be soldered, this is referred to as "skimming" the joint and results in a weak joint.

Apply the wire solder beneath the edge of the iron and nearest to the work. Move the soldering iron slowly along the work making sure that the solder melts, spreads and penetrates properly.

Solder as much surfaces as possible without re-heating the soldering iron or changing to another iron.

A temperature capable of merely melting the solder is not sufficient enough, heat must be transmitted by the soldering iron to the workpiece to quickly raise the temperature of the metals to the solder melting temperature.

It is this step in soldering that beginners often fail to understand and remember.

A soldering iron that is too small, often causes difficulty.

Do not breathe any smoke from the sal ammoniac block as it is a toxic gas and is dangerous.

Types of spelters and fluxes used in Brazing

Objectives: At the end of this lesson you shall be able to
- **state the types of spelter and flux used in brazing**
- **state the composition of spelter and its melting point.**

Brazing is essentially similar to soldering but it gives a much stronger joint than soldering. The principal differences is the use of a harder filler material, commercially known as spelter which fuses at some temperature above red heat, but below the melting temperature of the parts to be joined. Filler materials used in this process may be divided into two classes. Copper base alloys and silver base alloys. There are a number of different alloys in each class, but brass (Copper and Zinc) sometimes with upto 20% tin are mostly used mainly for brazing the ferrous metals. Silver alloys (Silver and Copper or Silver and Copper and Zinc) having a melting point range of 600 to 850^{0}C are suitable for brazing any metals capable of being brazed. They are giving a clean finish and a strong ductile joint. Spelters are commonly made according to the thickness of sheets.

After brazing, the joint must be hammered to check the leakages and to remove flux. Mostly and commonly used flux is "Borax" for ferrous and non-ferrous metals. It removes rust and prevents atmospheric effect, when brazing operation is going on.

COMPOSITION OF SPELTER AND MELTING POINTS

Sl. No.	Types of spelters	Common metals	Copper %	Zinc %	Silver %	Melting temperatures	Uses
1	Copper + Zinc Base spelter	Common	60	40	NIL	850^{0}C	Hard brazing on copper sheets and non-ferrous
2	-do-	Ferrous metals	80	20	NIL	600^{0}C	Brass sheet thick
3	-do-	brass	30	70	NIL	400^{0}C	Brass sheet thin
4	Silver solder	Gold	10	10	80%	350^{0}C	It is used for gold ornaments brazing

Portable hand forge with blower

Objectives: At the end of this lesson you shall be able to
- **state the purpsoe of hand forge**
- **describe the constructional feature of hand forge**
- **state the fuel used in hand forge.**

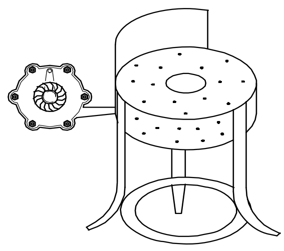
Hand forge: It is used for heating the soldering bit.

It is made of mild steel plates and angles. It is generally round in shape. the hand blower is attached to it for air supply.

A pefforated plate is fixed at the bottom to remove burnt residuals.

The fuel zone is built up with fire bricks and coated with the mixture of clay and sand, providing space at the centre for fuel. (Fig 1)

Fig 1



HAND FORGE

SM20N143121

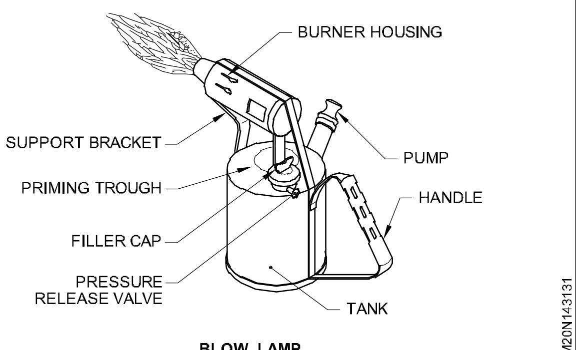
The fuel used for firing is mainly charcoal. The charcoal is prepared from hard wood.

Blow lamp

Objectives: At the end of this lesson you shall be able to
- **state the constructional feature of blow lamp**
- **identify the parts of blow lamp**
- **describe the operation of blow lamp.**

In blow lamp (Fig 1) the kerosene is pressurized to pass through pre-heated tubes, thus becoming vaporised. The kerosene vapour continues through a jet to mix with a air and when ignited directed through a nozzle, producing a forceful flame.

Fig 1



BLOW LAMP

The flame within the housing provides the heat to maintain vaporisation of the kerosene. The free flame at the nozzle outlet is used to heat the soldering bit.

Blow lamp is a portable heating appliance used as a direct source of heat for soldering irons or other parts to be soldered. Fig 1 shows parts of blow lamp.

It has an tank made of brass, filler cap is fitted at its top to fill kerosene. A pressure relief valve is connected to the mouth to switch ON/OFF and control the flame.

Priming trough is provided for filling methylated spirit for lighting the blow lamp. Set of nozzle is provided to direct the kerosene vapour to produce forceful flame. Burner housing is mounted on support brackets on which soldering iron is placed for heating as shown in figure.

Pump is provided to pressurise the kerosene in the tank.

Gas heated soldering copper bit : A gas heated soldering copper bit is heated by a gas flame which ignites on the back of the head. High pressure gas is used and the bit is large enough to have a good heat storage capacity. Liquified petroleum gas (L.P.G) flame is used extensively for this purpose. Soldering kit normally includes many sizes and shapes of bits which can be used to make most kinds of soldering connections. (Fig 4)

Fig 2

GAS HEATED SOLDERING COPPER BIT

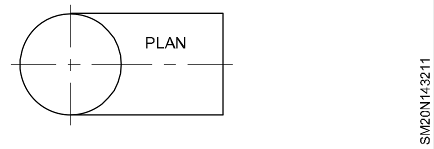
Development & laying out pattern of elbow pipe.

Objectives: At the end of this lesson you shall be able to
- **to develop and layout the pattern for 90º elbow joining two equal diameter pipe by parallel line method**
- **join two equal diameter pipes, obliquely cut, by soldered butt joint to make 90º elbow without mismatch and making it leak proof.**

Develop the pattern for a 90° elbow of equal diameter pipes by parallel line method:-

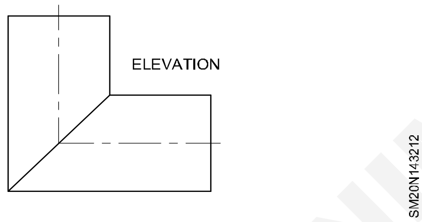
Draw plan as shown in Fig 1.

Fig 1



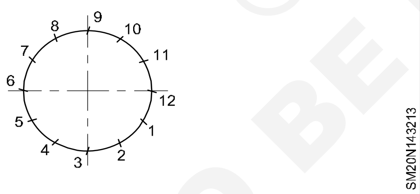
Below this, draw the front elevation as shown in Fig 2.

Fig 2



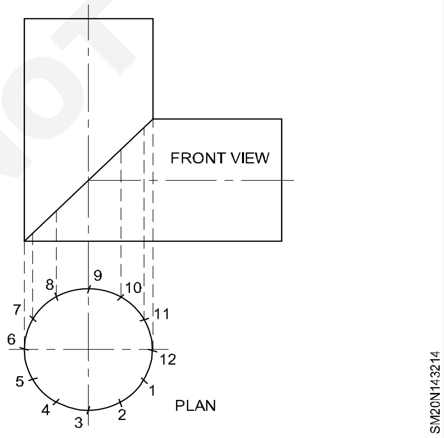
Divide the plan into twelve equal parts and number the points 0 to 12 as shown in Fig 3.

Fig 3



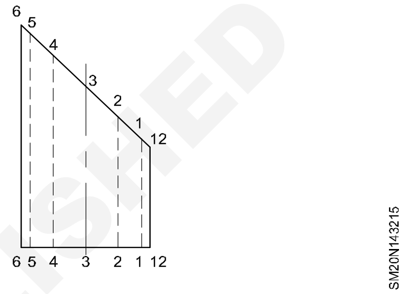
Draw the perpendicular line from these points towards the front view and number 1 to 12 as shown in Fig 4.

Fig 4



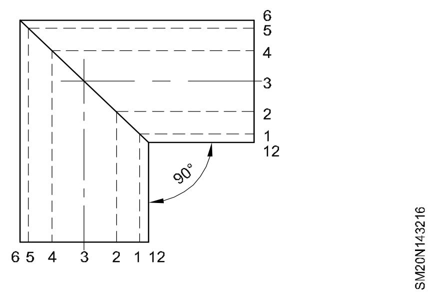
Now you find that the vertical lines are cutting at six different points top and bottom in the elevation line. Number them as shown in Fig 5.

Fig 5



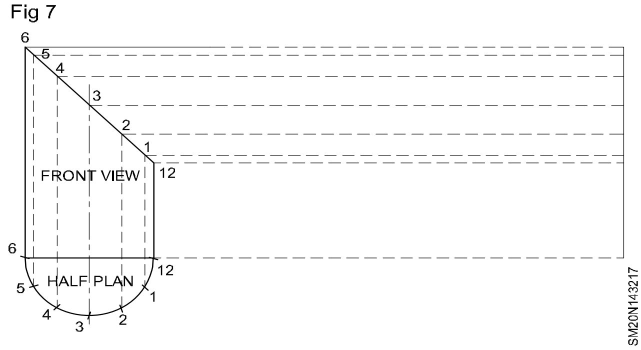
Draw horizontal parallel lines from each point and number them as shown in Fig 6.

Fig 6



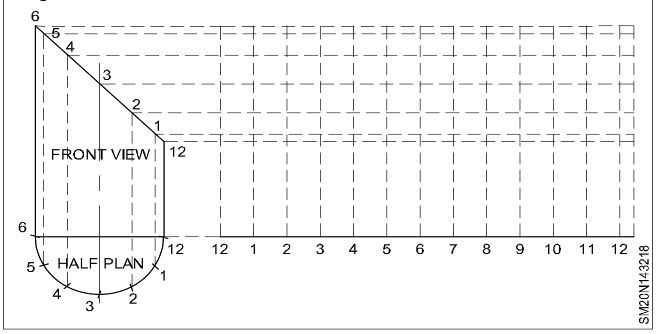
Extend the front elevation base line as shown in Fig 7.

Fig 7



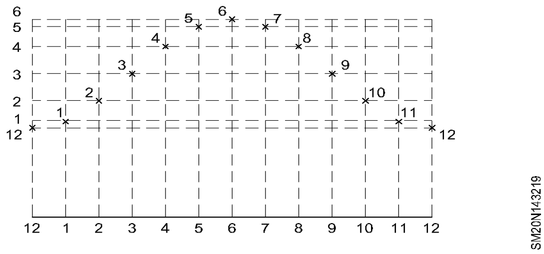
Take the distance equal to one division of plan and mark twelve times on base line by a compass and draw perpendicular lines from each point as shown in Fig 8.

Fig 8



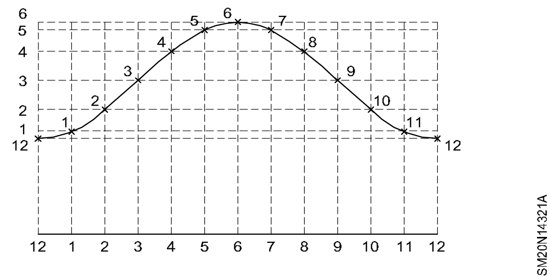
Now you find that each horizontal line and corresponding vertical line meet at a point. Number the points as 1 to 12 as shown in Fig 9.

Fig 9



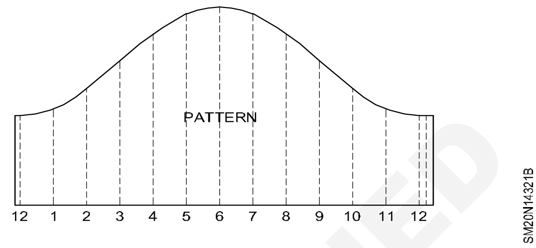
Join these points by free hand curve as shown in Fig 10.

Fig 10



Provide locked grooved joint allowance as shown in Fig 11.

Fig 11



Check the pattern before cutting it.

Cut the pattern using straight and bend snips.

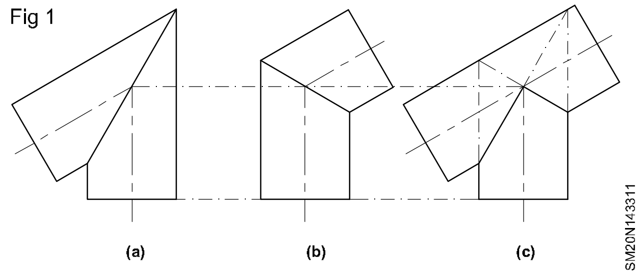
Place the pattern over another piece of metal, transfer the pattern on the other piece metal by marking and cut to get one more similar pattern.

T' pipe equal and unequal development pattern.

Objectives: At the end of this lesson you shall be able to
- **develop the pattern for equal and unequal dia 'T' joints by parallel line development method.**

A Tee joint may be taken as a combination of two elbows as shown in Fig 1 (a) is an acute elbow, and (b) is an obtuse elbow, in which the combined angles form 180 degrees. And the figure at (c) shows the two elbows combined, forming an oblique tee joint. The joint lines in tees between pipes of equal diameters are always represented by straight lines in the elevation.

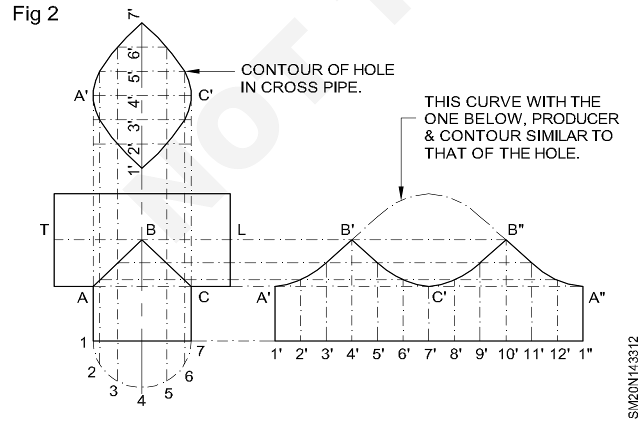
Fig 1



All joints of tees between pipes of unequal diameters present curved joint lines in the elevation.

The Right Angled Tee: To develop the pattern for the branch pipe which is forming a right angled tee joint as shown in Fig 2 is to draw the semi-circle at the end of the branch pipe, which represents half the circumference or girth of the pipe. Divide the semi-circle into six equal parts and name the points 1 to 7. From these points project lines perpendicularly upto the end of the pipe, and on the line ABC joint. Then, set off the base line in the pattern and mark off the parts 1'2'3'4'5'6'7'.....1", equal to the parts those around the semi-circle. From these marked points on the base line, each other. Now, from the points on the joint line ABC draw horizontal lines into the pattern to cut the perpendiculars from the baseline.

Fig 2



The curves drawn through these points in the pattern A'B'C'B"A" diagram should give the true form of the joint line.

The full outline of the pattern is now completed.

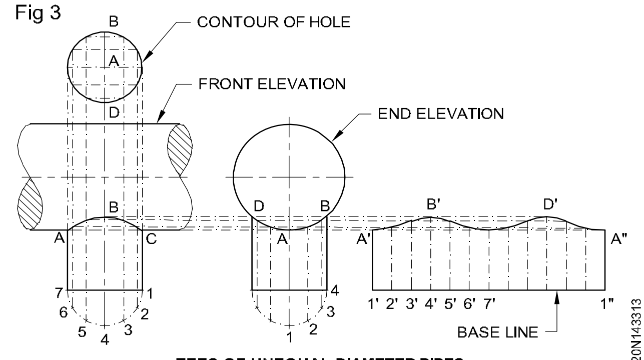
The shape of the hole in the cross pipe can be developed by projecting the points on the joint line ABC in the elevation. Extend the lines upwards at right angles to the centre line TL. On the middle line, mark off equal distances to those on the semi-circle as at 1',2',3',4',5',6' and 7'.

Through these points, draw lines at right angles to those drawn upwards and draw in the curves through the points of meeting as shown in the diagram.

Incidentally, if the curve B'C'B" in the pattern can be repeated on the opposite side of the line B'B", a contour similar to the hole will be obtained.

Right Angled Tee of unequal diameter pipes: The example shown in Fig 3 is of unequal diameter pipes of a right angled tee. To develop the pattern, describe semi-circles on the bases of the front elevation and the end elevations and divide each of them into six equal parts, and number them orderly as in the front elevation, from 1 to 7. It can be observed that the outside point numbered 1 in the front elevation will become the middle point in the end elevation.

Fig 3



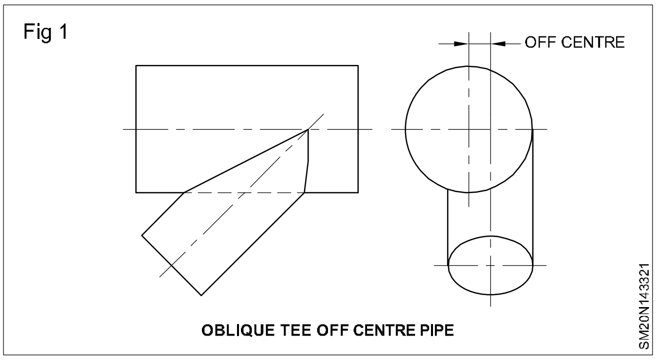
TEES OF UNEQUAL DIAMETER PIPES

Oblique Tee off centre pipe joint

Objectives: At the end of this lesson you shall be able to
- **develop and layout the pattern for an Oblique Tee off centre pipe joint.**

Introduction

The problem shown in Fig 1 is that of the branch tee or stump at an acute angle to the main pipe. The branch is on the centre with the main pipe instead of at the maximum off centre position as shown in Fig 1.



Although the patterns are different in shape, the method of development is the same for both the cases.

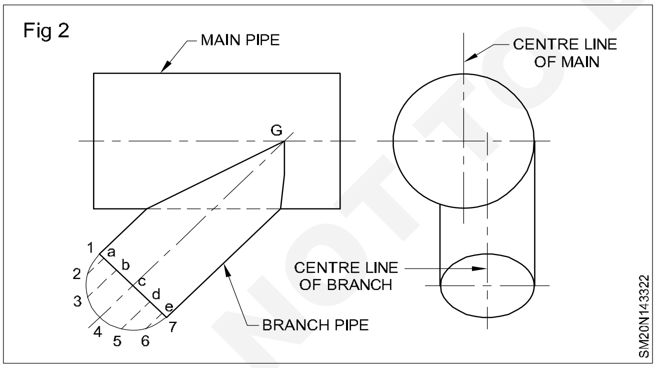
Pattern development: Draw the front elevation of the main pipe as required.

From any point 'G' on the centre line, draw the centre line for the branch pipe at the required angle and name it G.C. (Fig 2)

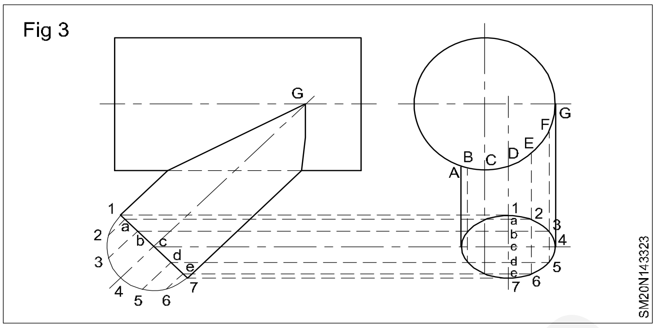
Complete the elevation of the branch pipe as required as in Fig 2.

Draw a semi-circle at the base of the branch pipe and divide it into 6 equal parts and name them 1 to 7 as in Fig 1.

Project these points to the baseline and name them as a,b,c,d as in Fig 2.



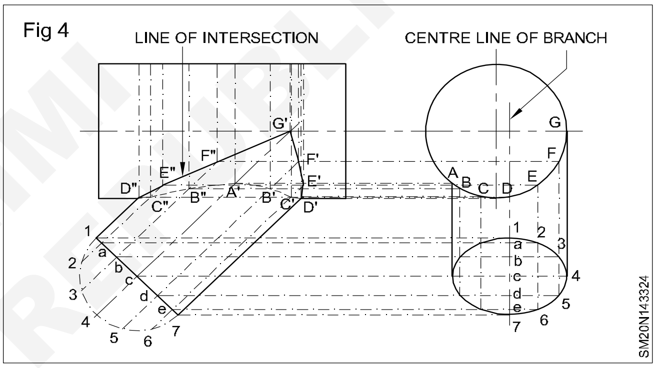
Draw the end view of the main pipe (Fig 2) and locate the centre line of the branch pipe to get the elliptical end of the branch pipe in the end view. Project horizontal lines from points 1 abcde 7, to cut the centre line of the branch pipe in the end view.



Take points a2,b3,c4,d5,e6 in the front elevation and mark off distances on either sides of the centre line 1,7 as in Fig 3.

Through these points complete the ellipse by a smooth curve. (Fig 4)

From these points draw vertical lines to cut the major circle and name them ABCDEFG.



From these points draw horizontal lines to the front elevation to meet another set of lines drawn from points abcde parallel to the centre axis of CG of the branch pipe.

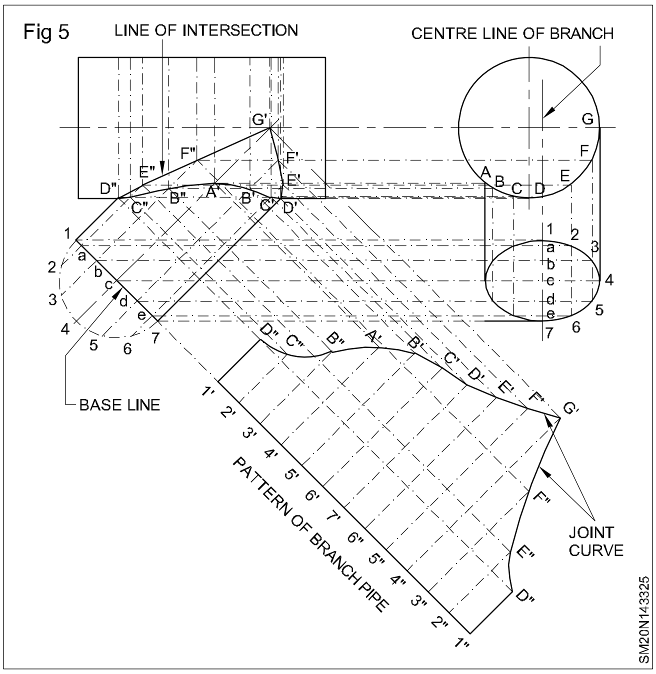
Name the points of intersection as A'B'C'D'E'F'G'F"E"D"C"N"A". (Same Fig 4)

To layout the pattern for branch pipe extend the base line of the branch and mark off 12 divisions and name them 1'2'3'4'5'6'7'6"5"4"3"2"1".

From these points draw lines at right angles to the base line.

From the points of intersection in the elevation, draw lines parallel to the base of the branch to meet the perpendicular lines.

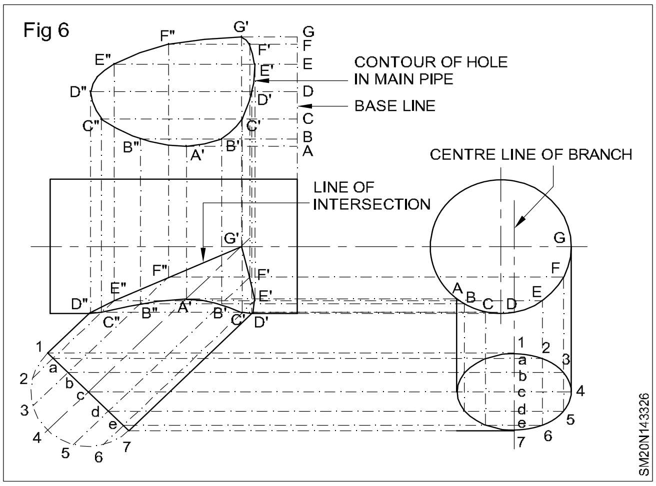
Fig 5



Join the points of intersection by a smooth curve as in Fig 5. This will be the pattern for the branch pipe.

To layout the pattern development for the major pipe with cutout, draw the base line at any convenient point as in Fig 6 to a convenient length.

Fig 6



Step off distances AB, BC, CD, DE, EF, FG on the base line. Draw horizontal lines from these points as in Fig 6.

From the elevation draw vertical lines from the points of intersections to meet the horizontal lines.

Join the intersecting points of vertical and horizontal lines by a smooth curve.

This will be the contour of the hole to be drawn.

Tubes and pipes

Objectives: At the end of this lesson you shall be able to
- **state the uses of tubes and pipes in sheetmetal work.**

INTRODUCTION

Metal tubes are used in different types of machines and installations. Tubes in hydraulic system rarely runs in a straight line. Tubes are curved, twisted for making structural frames and are bent by computerised numerical control (CNC) pipe bending machines.

Conduit pipes ranging from 16 mm to 65 mm diameter are used for electrical installations.

Pipes and tubes are made of metals and plastics and are used for transport, water, oil, gas and for domestic and industrial purposes. G.I.Pipe (galvanised iron) is commonly used for many purposes.

British standard pipe threads BSP, ISO, DIN. Standard threads are cut on pipes for joining purposes. Pipes are first cut to length with a hacksaw or pipe cutter and then a pipe reamer is used to remove the burr on the inside diameter of the pipe.

Generally the tube size is specified by the outer diameter, whereas the pipe size is specified by the internal diameter.

Pipe and Tubing: The sheet metal worker uses both black pipe and galvanized pipe as legs and stiffeners. In general the pipe work is done by plumber or pipe fitter.

Sheet metal worker may sometimes have to connect few small fittings to connect the equipment to the installed pipe.

Pipes can be obtained in various sizes. The pipes commonly used in the sheet metal trade are from 3/8 inch to 1 1/4 inch in diameter.

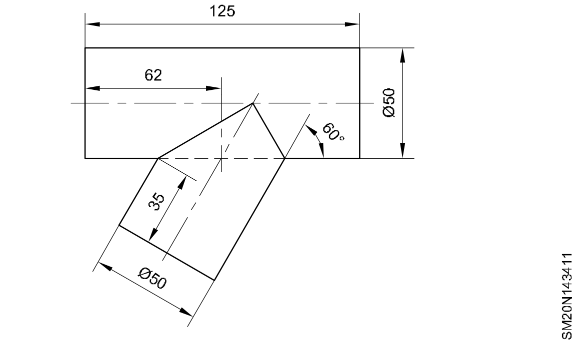
Split pipe: For a smooth, very stiff edge, the sheet metal worker uses split pipe. Split pipes are available in galvanized black and stainless steel pipes.

60° Tee pipe with equal diameter

Objectives: At the end of this lesson you shall be able to
- **define a mitre line**
- **develop and layout pattern for a 60° Tee pipe of equal diameter by parallel line method**
- **develop and layout patterns for pipe joints intersection at different positions.**

To develop and layout the pattern for a 60° Tee pipe of equal diameter is shown in Fig 1.

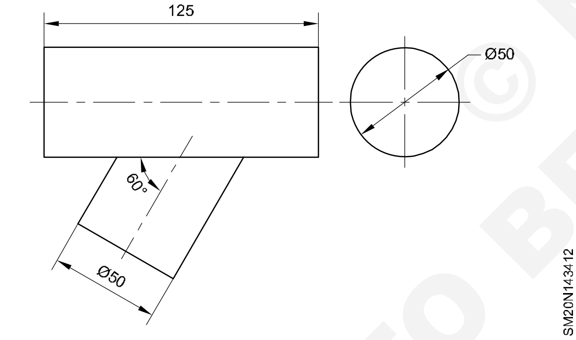
Fig 1



Draw the elevation in Fig 2.

Divide the diameter of the branch and main pipe into equal parts as in Fig 2.

Fig 2



Draw vertical lines and horizontal lines to intersect as shown in figure.

The line of intersections is called mitre line.

Joint the points as in Fig 3 to get the mitre line.

To layout the pattern for the main pipe produce the points XY as indicated by arrows.

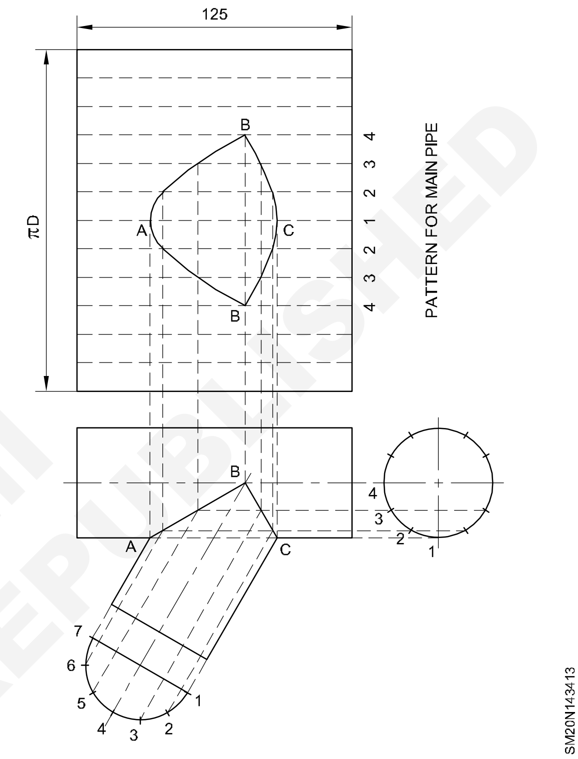
Step off twelve spaces and draw horizontal lines as shown in Fig 3.

Draw perpendiculars from the elevation from the points of intersection to meet the horizontal lines at points AB&C.

Join these points by a smooth curve. This will be the cutout for in the main pipe to accommodate the branch pipe.

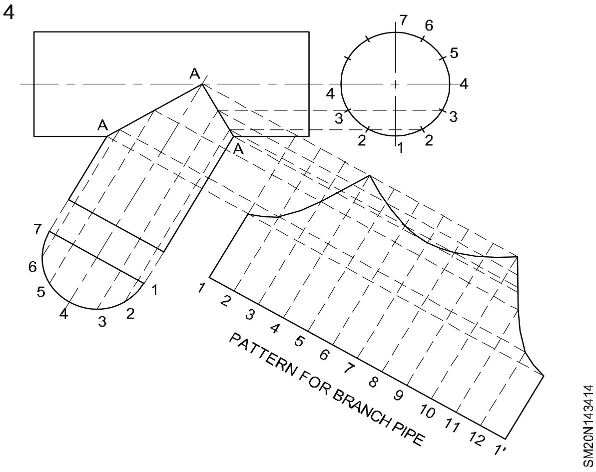
To layout the pattern for the branch pipe.

Fig 3



Produce the lines as in Fig 4.

Fig 4



Step off twelve divisions and erect perpendiculars at each division as shown in Fig 4.

Join the points of intersection by a smooth curve.

This will be the pattern for the branch pipe. (Fig 4)

Add allowances as required.

The right cylindrical `Y' piece

Objectives: At the end of this lesson you shall be able to
- **develop the pattern for right cylindrical 'Y' piece and an oblique connecting pipe by parallel line method.**

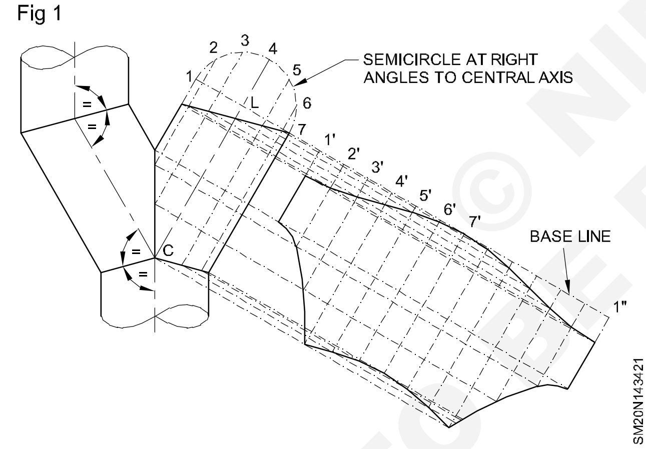
In the right cylindrical construction of the 'Y' pipe as shown in Fig 1, the joint lines bisect the angles of the central axis, as in the case of ordinary elbows.

This makes sure the cross sections being equal and circular. For developing the pattern, the main difference between this problem and the previous one lies in the method of spacing off the girth line. It can be observed that in the oblique cylindrical 'Y' piece the girth is obtained indirectly by the alternate method of spacing the distance round the curve. But in the example shown in Fig 1 the semi-circle from 1 to 7 represent the girth or circumference of the pipe and the spacing in the pattern is made direct on the base line.

For the remaining work the procedure is same as that of the previous exercise.

An Oblique connecting pipe: Fig 2 shows a connecting pipe between two circular holes in planes at 90 degrees to each other. The holes are so placed to make the connecting pipe lean at 45 degrees, by forming equal angles with the holes at each end.

Fig 1



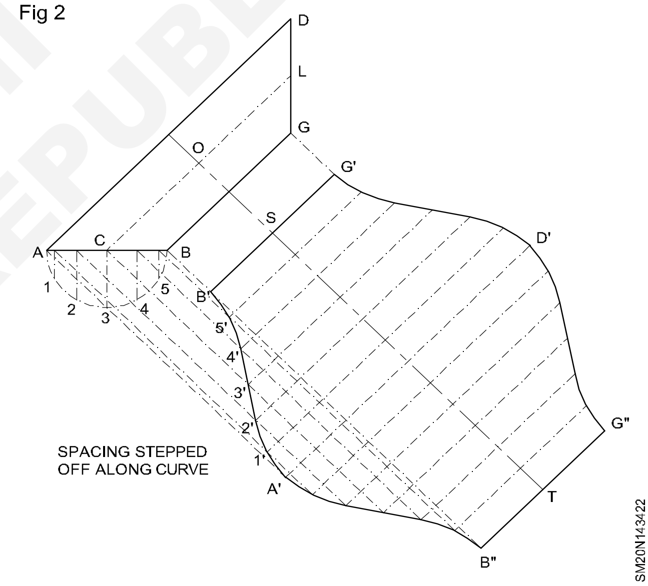
By these conditions, the connecting pipe is an oblique cylinder. To develop the pattern, project a centre line at right angles to the central axis CL through its centre point 0. Draw the semi-circle on the base line AB to show half the plan of the base end.

Divide the semi-circle into six equal parts as at A,1,2,3,4,5,B and from these points, project lines perpendicularly back to the base line. From the points obtained on the base line AB draw lines into the pattern at right angles to the central axis CL. From any point B' on the line projected from B mark off B',5',4',3',2',1',A'...B" equal to the corresponding spaces round the semi-circle.

The spacing should be stepped over from one line to the next until the outside point A' is reached and then repeated inwards to point B".

A line drawn through these points will provide the form of the base curve in the pattern. From these points on the base curve, draw parallel lines to the central axis CL or at right angles to the centre line ST of the pattern and on each mark off equal distance on the other side of the centre line ST. A line drawn through this new set of points will give the curve at the opposite end. The two end lines B'G' and B"G" complete the pattern.

Fig 2



Surface Preparation

Objectives: At the end of this lesson you shall be able to
- **state the need for surface preparation**
- **state the different methods of surface preparation**
- **state the different solvents used for degreasin**
- **state the pickling process of surface preparation**
- **state the process of blast cleaning for surface preparation.**

Surface carrying dirt, grease, corrosion or mill-scale are unsuitable for the direct application of anti-corrosion treatment.

The most important factor for any efficient anti-corrosion treatment is surface preparation.

The different methods used for surface preparation are:

- degreasing
- pickling
- blast cleaning
- flame descaling

Degreasing

In degreasing, the surface preparation for anti-corrosion treatment is done with a solvent such as:

- white spirit
- carbon tetrachloride
- trichlorethylene

The solvents used in dgreasing will create a health hazard. Safety precaution should be taken before using these solvents.

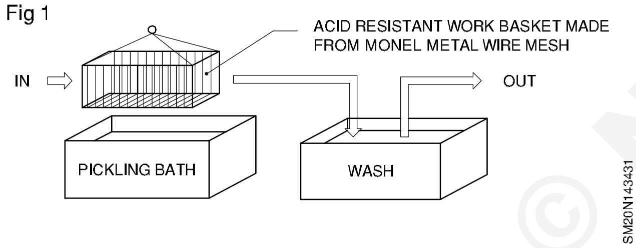
Pickling

Pickling is a chemical method of cleaning.

The surface of the metal is cleaned with dilute sulphuricid or mixed acids.

Fig 1 shows the arrangement of surface preparation by the pickling method.

Fig 1



Flame descaling (Fig 3)

The steel surface which is to be descaled, is heated with an oxy-feul gas torch with high-intensity flames. This rapid local thermal expansion of the loosely adhering scale against the relatively un-heated base mtal causes the scale to flake off.

Fig 2

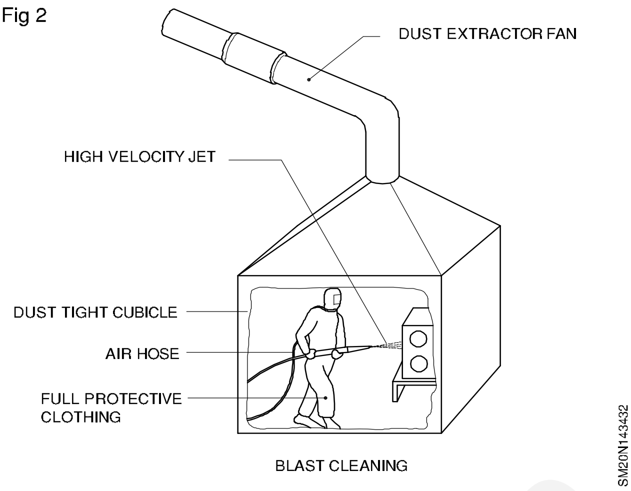
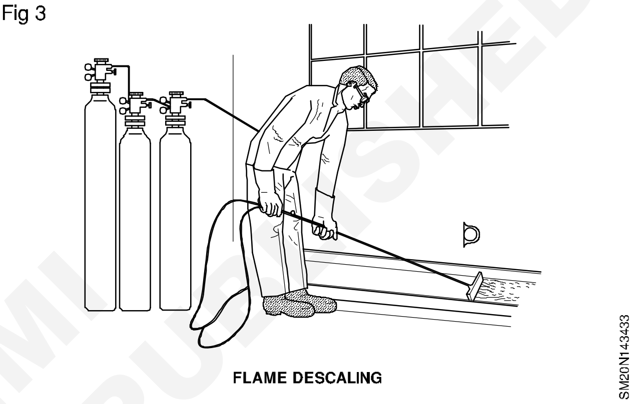


Fig 3



This process is excellent for removing rust. Any rust particles converted to powder can easily be brushed away before commencing to paint. For best reluts the primer should be applied when the steel is approximately 45ºC, that is the temperature at which the hand can hold the steel comfortably.

This method of surface prepartaion is often used for the heavily rusted steel work. It is not suitable for light steel work which may buckle and distort because of the intense localized heat developed

Corrosion and Surface Protection

Objectives: At the end of this lesson you shall be able to
- **define oxidation**
- **explain the prevention of oxidation by various methods.**

Corrosion or Rusting: When a metal is exposed to air, the oxygen in the air combines with the metal to form a chemical film over the surface of the metal. This chemical film is called oxide of the metal. The chemical reaction between the oxygen in the air and the metal is called oxidation. This is generally known as corrosion or rusting. Corrosion takes place on the surfaces of uncoated iron and steel. The rusting of metal is more severe in wet atmosphere.

Surface protection: The surface protection is classified according to the durability of coating to protect the surfaces from corrosion. This protection can be divided into three groups. They are (1) Temporary (2) Semi-permanent (3) Permanent.

1 TEMPORARY TREATMENT

(A) Applying oil or grease

This type of surface treatment is done very easily by coating lubricating oil or grease on the surface of the metal.

(B) Applying Enamels and Lacquers

A coloured or transparent finish can be done with enamels or lacquers.

Before applying opaque enamels or lacquers to metal, you must use a primer, or first coat. It will bind and adhere to the metal, providing a good base.

A zinc chromate primer is good for exterior finishing.

Methods of applying lacquer

1 Make sure that the object is clean and spots are removed.

2 Make sure that the surface is completed.

3 Now use a clean paper or cloth to handle the project.

4 Warm the metal in an oven if possible, because heating makes the lacquer flow smoothly.

5 Use a good brush and apply lacquer a little at a time.

6 Don't pass over an area again i.e second time.

7 Allow the object to dry for an hour or two.

8 Apply a second coat.

9 Clean the brush in lacquer thinner which is the solvent for lacquer.

Methods to apply enamel

1 Clean the job carefully.

2 Apply primer and allow it to dry.

3 Brush on enamel with even strokes.

4 allow it to dry for many hours.

5 Apply second and third coats as needed.

6 Clean the brush in paint thinner or lacquer thinner, because both are good solvent for enamels.

(C) Painting

This type of surface Treatment is done by painting surface to prevent direct contact of air and moisture and to give a good appearance. It is an easy and quick process. The paint may be applied by brush or by spraying. A complete paint system consists of (1) Primer (2) Putties or fillers (3) Under coats (4) Finished or Top coats.

Semi - Permanent Treatment

Objectives: At the end of this lesson you shall be able to
- **define oxidation**
- **describe various modes of oxidation.**

SEMI-PERMANENT TREATMENT

(A) Galvanising

Galvanising is a process of giving a protective coating of zinc on iron sheets and components to protect the surface from corrosion. The thickness of coating is 0.002 inch.

Process

The article to be galvanised should be cleaned properly either by mechanical or chemical process to avoid dust, oil and grease. The work is dipped into a pickling solution containing 30% sulphuric acid with water. Then the work is fluxed with Zinc Chloride if the base metal is iron or with suitable flux depending on the metal to be galvanised and then dipped in a molten bath of zinc, kept at 450^0C to 460^0C. After dipping, it is taken out, and brushed to remove extra deposit and washed with water.

(B) Tinning

It is similar to that of galvanising. The only difference is that the metal to be tinned is dipped in a molten bath of tin. Tinning is done to save both ferrous and non-ferrous metals from corrosion or rusting.

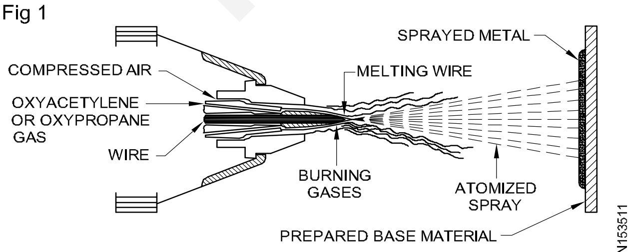
(C) Metallizing or Metal spraying

This is a flame spraying process, involving the use of metal wire. The wire is drawn through a gun and nozzle by power feed rolls.

The wire is melted in an oxygen fuel gas flame and atomised by compressed air blast. The air blast carries the metal particles to the surface object is shown in a Fig 1.

The metal particles mesh to produce a coating. Any type of metal can be sprayed with a metallizing gun. The metal coating is done on the piston rings used in cars. Metals are sprayed on glass, on cloth and paper to make condenser plates. Copper is sprayed on ceramics resistors and insulators.

Fig 1



THE METALLIZING PROCESS

(D) Sherardizing

When steel or iron is heated to a certain temperature in zinc dust, zinc is absorbed into the surface of the steel and makes rust proof. Nuts, both screws, springs and chains are protected by this method.

(E) Cladding

A thin sheet of corrosion resisting metal is placed on the steel which is to be protected. Copper, zinc and lead are frequently used for this purpose. A typical application of this process is cladding of steel with aluminium

3 Permanent treatment

(A) Electro plating

In electro plating, a thin layer of metal eg. Nickel, Chromium, Tin is deposited on the surface of another metal. eg. Iron and Steel electrically. This process is called as electro plating and is a finishing process. This is also called as electrolysis.

The metal to be plated is connected to the negative terminal and is called the cathode. The metal to be deposited or the plating metal is connected to the positive terminal i.e anode. Both the terminals are immersed in a electrolyte solution. The anode may be soluble in the case of Nickel, Copper or zinc or it may be insoluble in the case of chromium plating. Both the terminals are connected to power source which causes the current to flow in the circuit. In order to complete the circuit, the metal at anode flows to the metal to be plated at cathode through electrolyte. Thus the electro plating takes place. This solution is heated between 100^0C to 110^0C temperature. Low voltage, heavy current DC supply is used for electroplating.

(B) Anodising

Anodising is used to provide a decorative and corrosion resistant coating on aluminium and its alloys only.

Aluminium Anodizing

A thin coating of oxide on aluminium can protect the surface from corrosion. However a heavier coating can be done by a very simple electro-chemical process called Anodizing. This oxide film, about 0.01 inch (0.25 mm) is hard and can protect the surface from abrasive and corrosion action.

Anodizing process

1 The surface is thoroughly cleaned, rinsed and dried.

2 A finish is applied on the surface of the metal by brush with polish and buffing wheels or chemical finish can be given which causes etching.

3 The aluminium is cleaned and again rinsed with water.

4 The aluminium article is suspended in an electrolyte and current is passed through it. This makes a dense aluminium oxide coating to be built on the surface. The properties of the film depend on the alloy used on the electrolyte composition and concentration, temperature, current, time and voltage.

5 The object is neutralized to stop the process. Now it is ready for use or for dyeing.

6 A colour coating can be done on anodized aluminium by giving inorganic pigments to give an evenly coloured surfaces on aluminium. Organic dye stuffs produce better brilliant colour than inorganic. But these dyes are not colour fast to sunlight and they are not suitable for exterior use.

TABLE

Electroplating

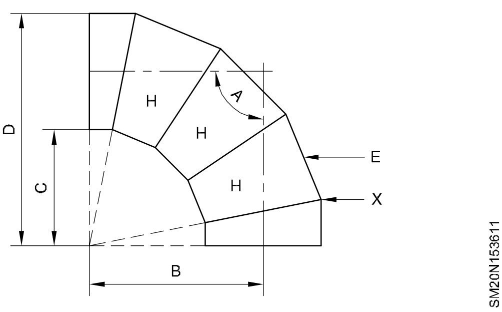
Metal	Uses	Remarks
Cadmium	Corrosion protection of iron and steel.	Used mainly where thin coatingsare needed
Nickel	Sometimes used as a decorative coating but is used more frequently as an under coating for chromium.	
Chromium	Used for decorative coatings. Hard chromium is used where wear resistance is required.	Has a high resistance to wear and tarnishing. It is usually plated over nickel which protects against corrosion.
Tin	Corrosive-resistant; coating particularly in the food industry.	
Zinc	Corrosion protection of iron and steel.	

Make the square section segmental bend pipe Development

Objectives: At the end of this lesson you shall be able to
- **identify different parts of segmental quarter bend pipe**
- **distinguish between the center line and the center section.**

Before developing the square section segmental quarter bend pipe, the following parts are helpful in developing pattern. See Fig 1.

Fig 1



Angle of bend: It is the amount of flow direction change as shown by 'A'.

Center line: It is the distance from the center point to the centre line as shown by 'B' and is usually twice the length of the square section.

Throat: It is related to the center line the radius and the length of a square shown by 'C'.

Heel: It is equal to the throat length plus the length of a square shown by 'D'.

Miter line: It is the line between two patterns as shown in the Fig by x.

Center section: It is equal to the pattern of two end section.

Formulae to find the angle of bend are as follows.

No. of spaces = (No. of section x 2)-2

No. of degrees per space = Angle of bend/No. of spaces.

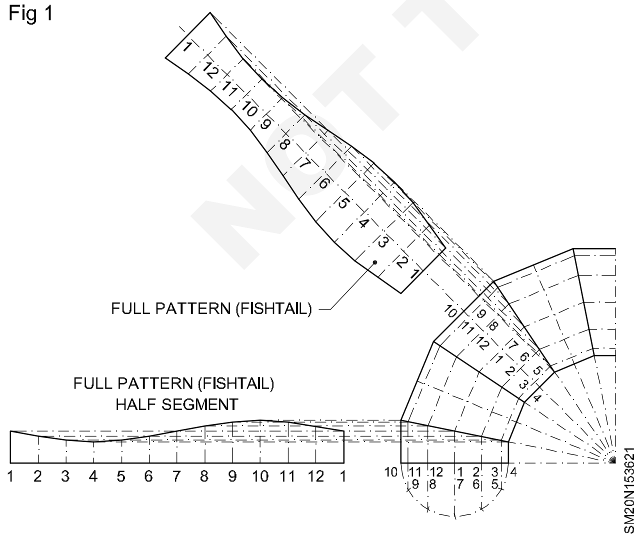
Segmental quarter bend (Lobster Back)

Objectives: At the end of this lesson you shall be able to
- **develop the pattern for segmental quarter bend lobster back.**

Let us study the method of development of pattern for segmental quarter bend lobster back. Refer Fig 1.

Draw the elevation of the bend.

Fig 1



Draw a semicircle on the end of the pipe and divide into six equal parts. These parts should be numbered as shown starting at the centre.

Project the points from the semicircle to the base line and then project them parallel to the bend segments.

Project the centre line of anyone segment and mark points 1 to 12 (equal to one division of the semicircle).

At these points draw lines at right angles to the centre line.

Project from the numbered points on the segment (parallel to the centre line) and mark the points where the projected lines meet those at right angles to the centre line.

Curves drawn through these points of intersection will give the pattern of the segment.

Three full segments and two half segments will be required to be joined to manufacture the bend illustrated.

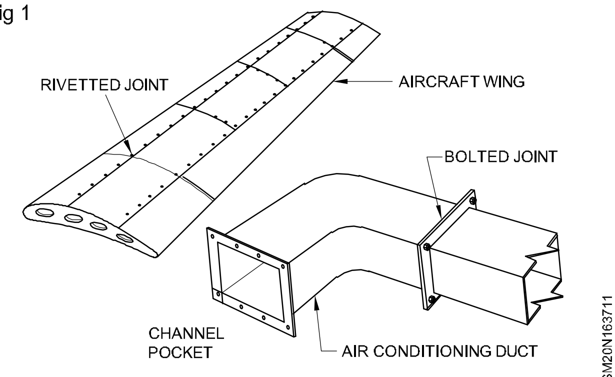
Need for Ducting

Objectives: At the end of this lesson you shall be able to
- **should know about the duct**

Duct :

Duct s like a pipe but different in shape which is mainly used for transmitting gases. This make in G.I sheet and Aluminium sheet.

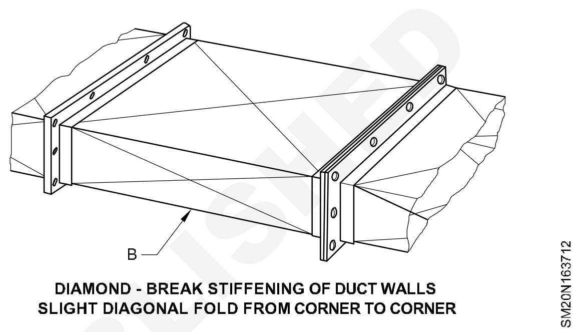
Fig 1



Need for ducting :

Ducting is mainly used to Transmit the air from the AC unit and vice versa. The air is mainly blowed through the ducting to the required space.

Fig 2



DIAMOND - BREAK STIFFENING OF DUCT WALLS
SLIGHT DIAGONAL FOLD FROM CORNER TO CORNER

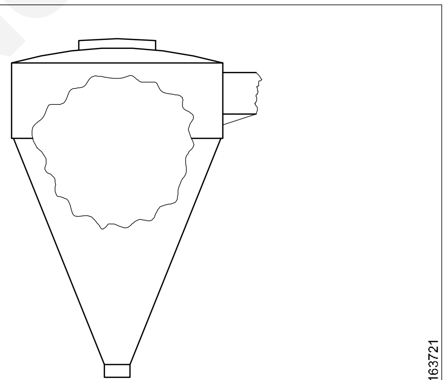
Dust cyclone, cyclone separator, gutters and cornices sheet metal

Objectives: At the end of this lesson you shall be able to
- **state the working and use of dust cyclone**
- **state the construction of cyclone seperator**
- **state the application of sheet metal in making gutters and cornices.**

Sheet metal is used for making few important articles used in industries. It is also used in making gutters and cornices used at the roof of the buildings. The dust cyclone, cyclone seperator and gutters and cornices are described below.

Dust cyclone collectors: The name "Dust cyclone" is used because they are used in many industries for the recovery and collection of dust, lint, wood shavings, saw dust, grains, cereals, livestock feeds etc. Cyclone collectors are very familiar in most industrial areas. They are popular because of their low cost, low power requirement, low maintenance and high efficiency. (Fig 1)

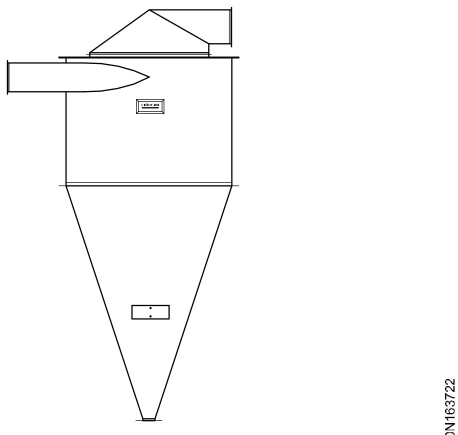
Fig 1



DUST CYCLONE

The dust cyclone collectors operate upon the principle of centrifugal force. The air carrying the particles is fed into the collector in such a manner as to create a "Cyclone". This causes the particles to fly to the outer side, while the air is exhausted from the centre of the cyclone. Intake, exhaust volumes and velocities can be regulated to control the action of the collector relative to various weights and sizes of particles.

Fig 2



CYCLONE SEPARATOR

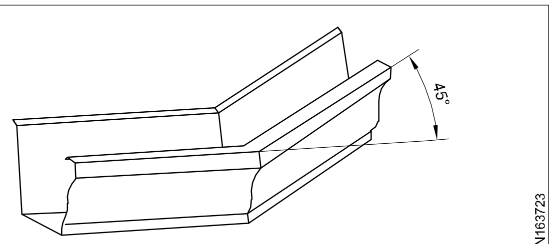
Cyclone separator: The cyclone separator shown in Fig 2 combines the usual development of cones and cylinders with an inserting reducer elbow in the form of a warped cone.

Gutters and Cornices: Sheet metal, formed in decorative strips and mitered at corners is used in several ways to improve the appearance and control run off on buildings.

The metal strips are known as mouldings and are used to create cornices, gutters, panels, pediments, formers, bays, finials etc.

Save gutters are used at the roof edge together run off, while roof gutters are placed at any convenient location on the roof. (Fig 3)

Fig 3



OGEE EAVE GUTTER ON A 45-DEGREE MITER

False ceiling :

False ceiling is a secondary ceiling also called as "drapped ceiling ". It is attached to the primary ceiling with parpet fastening in hanging position.

It is mainly used for interior decoration handling the air-conditioning ducts in house hotel. Industries, Trade centres and etc.

Safety precautions in handling oxy-acetylene gas welding plant

Objectives: At the end of this lesson you shall be able to
- **state the general safety precautions to be observed while handling oxy-acetylene gas welding equipment.**

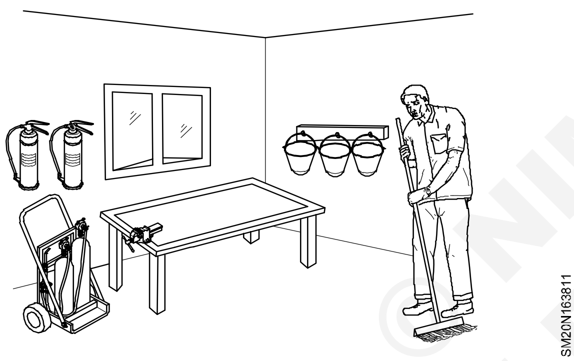
To be accident free one must observe safety rules in day-to-day working. 'Accidents starts when safety ends', so the saying goes.

In gas welding, the welder must follow certain safety precautions while handling gas welding plants in order to prevent accidents to others and himself. Observing the following precautions will help the gas welder to avoid accidents to a great extent.

Always keep fire extinguishing devices handy and in working order.

All inflammable materials should be kept away from the welding area. (Fig 1)

Fig 1

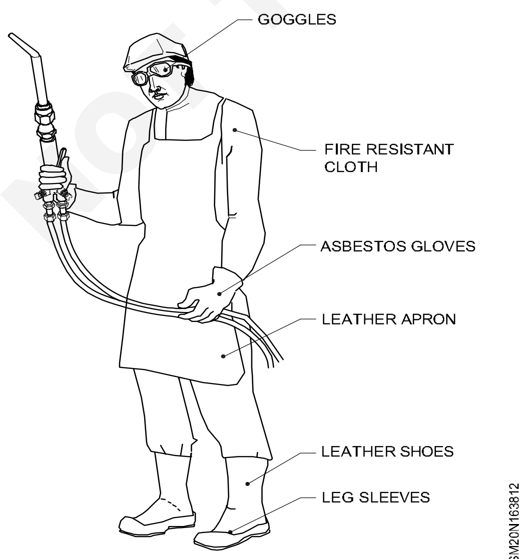


General safety precautions: Never use oil or grease in any part or assembly of a gas welding plant as it may cause an explosion.

Always wear goggles with filter lens during welding.

Wear fire-resistant clothes, asbestos gloves and an apron while welding. (Fig 2)

Fig 2



Never wear nylon or greasy clothes while welding.

Rectify the leakages noticed immediately as even a small leakage can lead to serious accidents.

While leaving the work area, make sure the place is free from any form of fire.

Safety concerning gas cylinders

Do not roll gas cylinders for shifting; always use a trolley to carry cylinders.

Do not drop the gas cylinders.

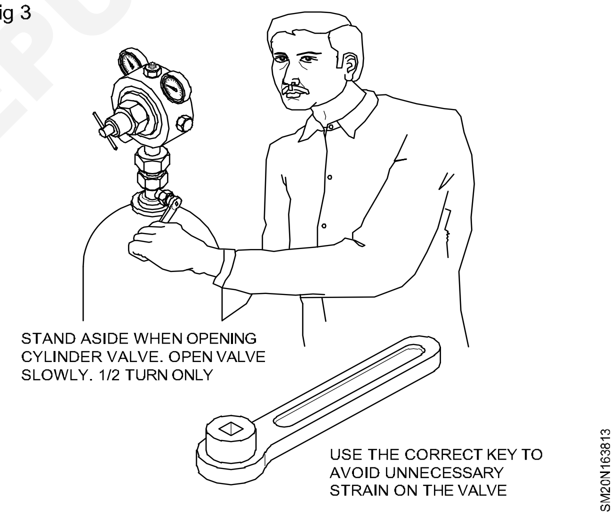
Close the cylinder valves when not in use or empty.

Keep the empty cylinders and full cylinders separately.

Always open the cylinder valves slowly and not more than one and a half turns.

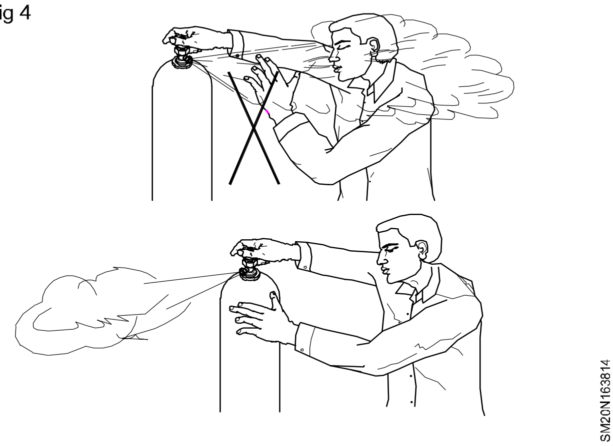
Use always the correct size cylinder keys. (Fig 3)

Fig 3



Stand aside when opening the cylinders. (Fig 4)

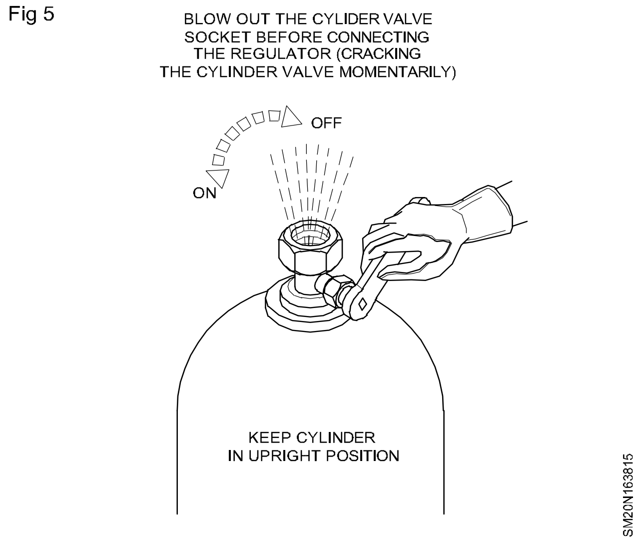
Fig 4



Do not remove the cylinder keys from the cylinders during welding. It will help to close the cylinders quickly in case of an emergency.

Always keep the cylinders in an upright position keeping in view safety and ease in handling. (Fig 5)

Fig 5



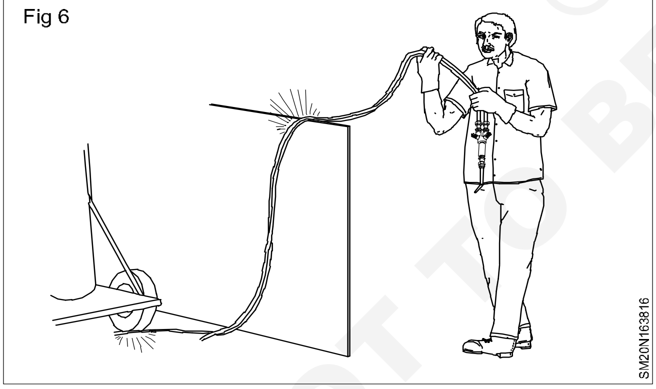
Always crack the cylinder valves to clean the valve socket before attaching the regulators.

Safety of rubber hose-pipes: use only the type of hose recommended for use in gas welding.

Use only black coloured hoses for oxygen and maroon coloured ones for acetylene gas.

Avoid damage to the hose-pipes caused by rubbing against hard or sharp edges (Fig 6)

Fig 6



Ensure that the hoses do not cross the gangways.

Do not add bits of hose together to make up the length.

Blow out the hose-pipes before connecting to the blow-pipe to remove dirt or dust.

Protect the regulators from water, dust, oil etc.

Never attempt to interchange oxygen and acetylene regulators while fitting as it can damage the threads.

Always remember the oxygen connection is right-hand threaded and the acetylene connections have left hand threads.

In the event of backfire shut both the blowpipe valves (oxygen first) quickly and dip the blowpipe in water.

While igniting the flame, point the blowpipe nozzle in a safe direction. (Fig 7)

While extinguishing the flame, shut off the acetylene valve first and then the oxygen to avoid backfire (Fig 8)

Fig 7

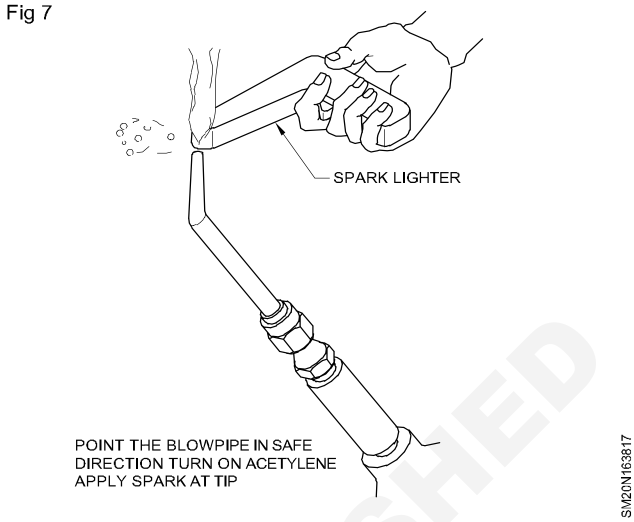
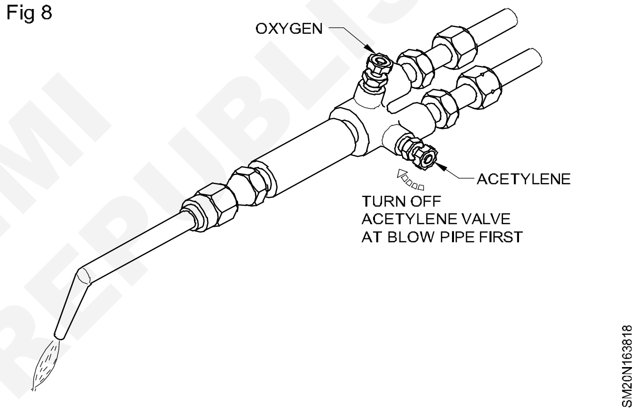
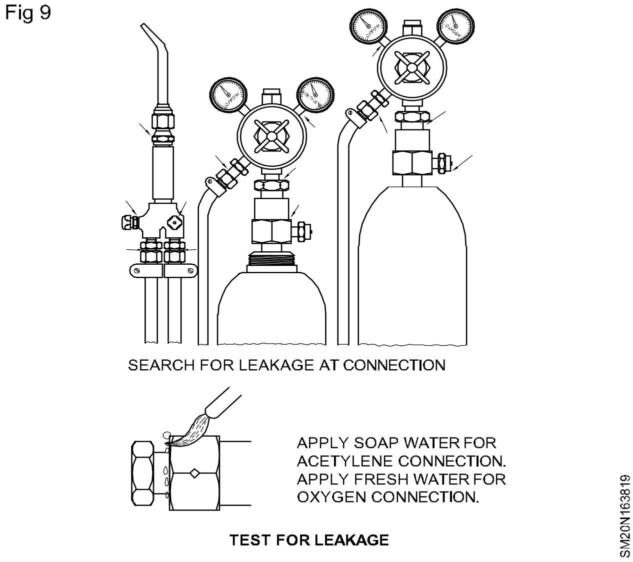


Fig 8



Check for leakage before using oxy-acetylene welding equipment. (Fig 9)

Fig 9



Use the spark lighter to ignite the flame to avoid fire hazards.

Toxic and poisonous fumes given out during welding of some materials should be collected and cleared so as to be prevented from inhaling.

Containers used for the storage of flammable materials should not be welded without thorough cleaning as otherwise the containers may explode.

Safety in manual metal arc welding

Objectives: At the end of this lesson you shall be able to
- **identify the safety apparels and accessories used in arc welding**
- **select the safety apparels and accessories to protect from burns and injuries**
- **learn how to protect yourself and others from the effect of harmful arc rays and toxic fumes**
- **select the shielding glass for eye and face protection.**

During arc welding the welder is exposed to hazards such injury due to harmful rays (ultra violet and infra red rays) of the arc, burns due to excessive heat from the arc and contact with hot jobs, electric shock, toxic fumes, flying hot spatters and slag particles and objects falling on the feet.

The following safety apparels and accessories are used to protect the welder and other persons working near the welding area from the above mentioned hazards.

1 Safety apparels

   a Leather apron

   b Leather gloves

   c Leather cape with sleeves

   d Industrial safety shoes

2 a Hand screen

   b Adjustable helmet

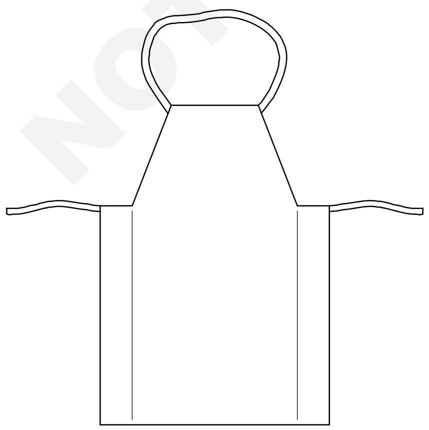
   c Portable fire proof canvas screens

3 Chipping/grinding goggles

4 Respirator and exhaust ducting

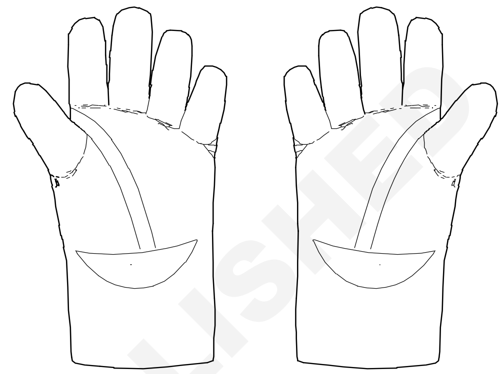
The leather apron, glooves, cape with sleeves and leg gaurd Fig 1,2, 3 and 4 are used to protect the body, hands, arms, neck and chest of the welder from the heat radiation and hot spatters from the arc and also from the hot slag particles flying from the weld joint during chipping off the solidified slag.

Fig 1



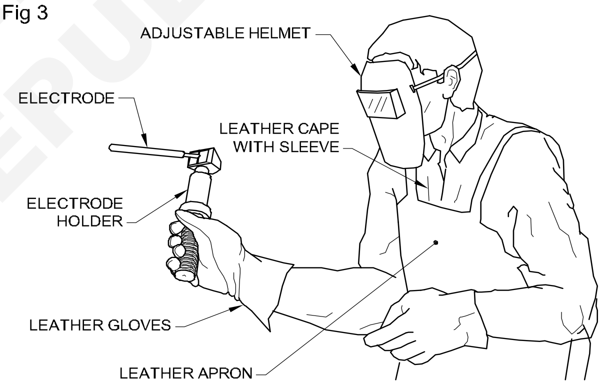
APRON

Fig 2



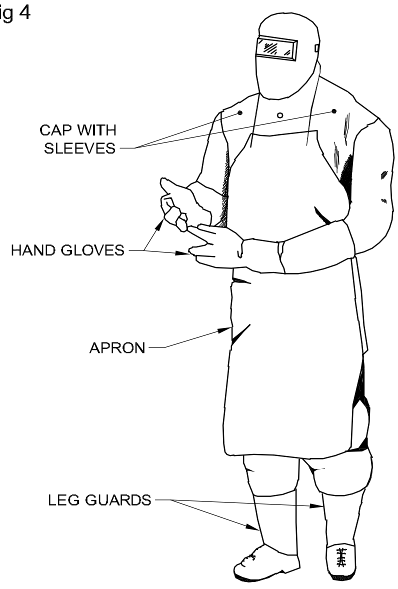
GLOVES

Fig 3



CAPE WITH SLEEVES

Fig 4



LEG GUARDS

All the above safety apparels should not be loose while wearing them and suitable size has to be selected by the welder.

The industrial safety boot (Fig.5) is used to avoid slipping, injury to the toes and ankle of the foot. It also protects the welder from the electric shock as the sole of the shoe is specially made of shock resistant material.

Welding hand screens and helmet: These are used to protect the eyes and face of a welder from arc radiation and sparks during arc welding.

A hand screen is designed to hold in hand. (Fig.6)

A helmet screen is designed to wear on the head. (Fig.7)

Screens are made of non-reflective, non-flammable, insulated, dull coloured, light material with coloured (filter) glasses fitted with plain glasses on both sides to see the arc and molten pool while welding.

Fig 5

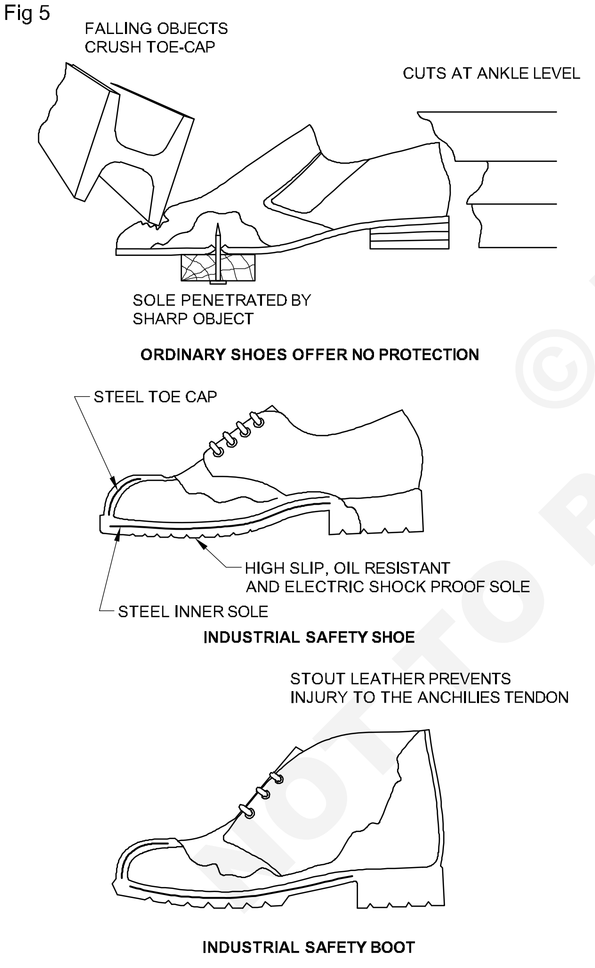


Fig 6

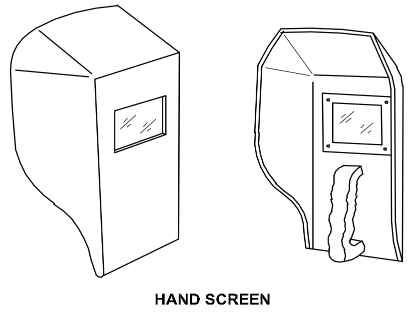
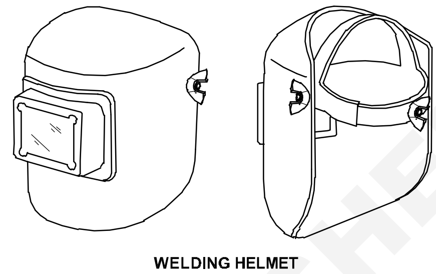
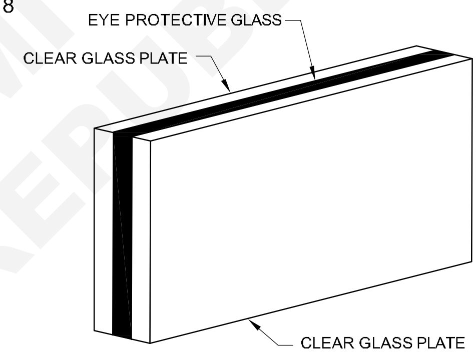


Fig 7



Clear glasses are fitted on each side of the coloured glass to protect it from weld spatters. (Fig.8)

Fig 8



The helmet screen provides better protection and allows the welder to use his both hands freely.

Coloured (filter) glasses are made in various shades depending on the welding current ranges used. (Table 1)

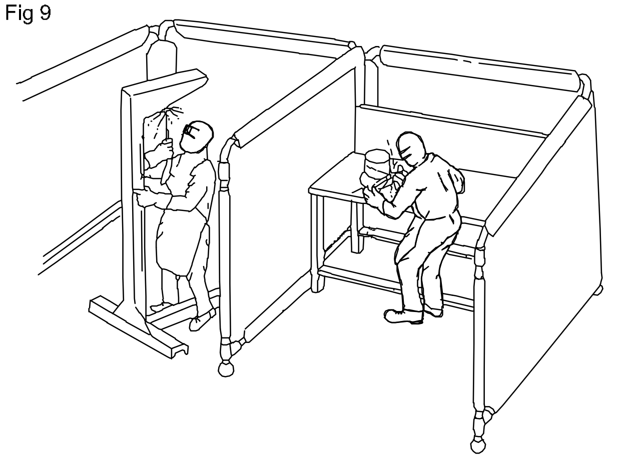
Table 1

Recommendations of filter glasses for manual metal arc welding

Shade No. of coloured glass	Range of welding current in amperes
8-9	Upto 100
10-11	100 to 300
12-14	Above 300

Portable fire proof canvas screens Fig.9 are used to protect the persons who work near the welding area from arc flashes.

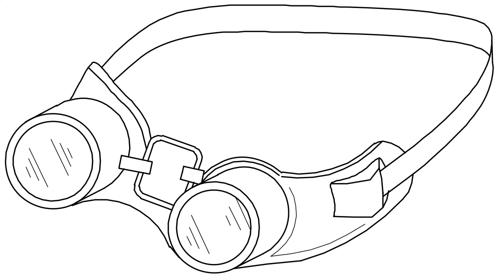
Fig 9



PORTABLE FIREPROOF CANVAS SCREENING

Plain goggles are used to protect the eyes while chipping the slag or grinding the job. Fig.10

Fig 10



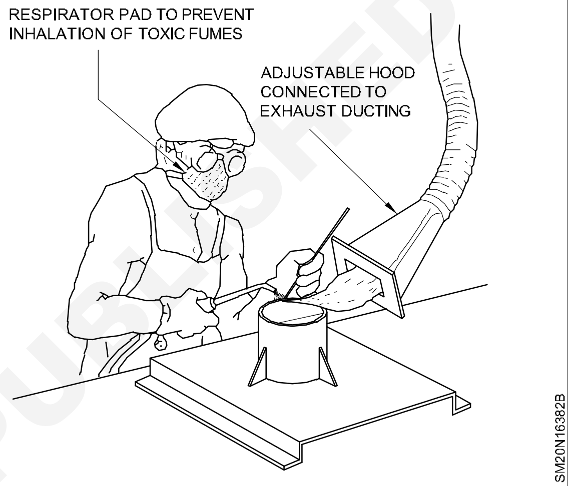
It is made of Bakelite frame fitted with clear glasses and an elastic band to hold it securely on the operator's head.

It is designed for comfortable fit, proper ventilation and full protection from all sides.

Sometimes toxic fumes and heavy smoke may be liberated (given out) from the weld while welding non-ferrous alloys like brass etc. Use a respirator and use exhaust ducts and fans near the weld area to avoid inhaling the toxic fumes and smoke.Fig.11.

Inhaling toxic fumes will make the welder to become unconcious and fall on the hot welded job/on the floor. This causes burns or injury.

Fig 11



Oxy-acetylene welding equipment and accessories

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

- **distinguish between the features of oxygen and acetylene gas cylinders**
- **compare the features of oxygen and acetylene gas regulators**
- **distinguish between the hose-connectors used in oxygen and acetylene regulators**
- **describe the function of hose-protectors**
- **state the functions of blowpipes and nozzles.**

Oxy-acetylene welding is a method of joining metals by heating them to the melting point using a mixture of oxygen and acetylene gases. (Fig 1)

Oxygen gas cylinders: The oxygen gas required for gas welding is stored in bottle-shaped cylinders. These cylinders are painted in black colour. (Fig 2) Oxygen cylinders can store gas to a capacity of 7 m^3 with the pressure ranging between 120 to 150 kg/cm^2. Oxygen gas cylinder valves are right hand threaded.

Fig 1

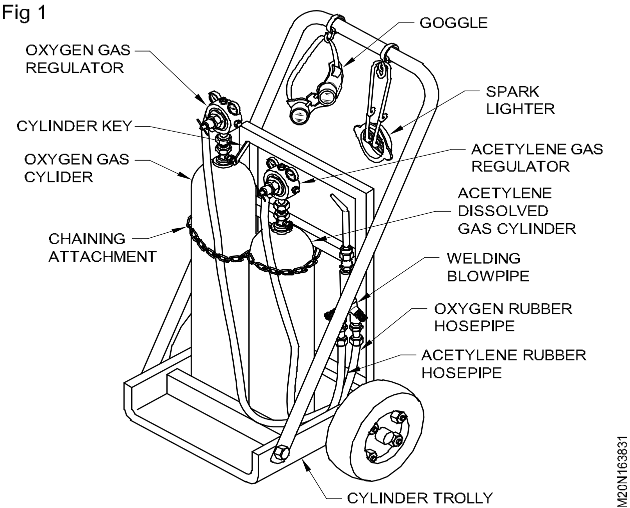
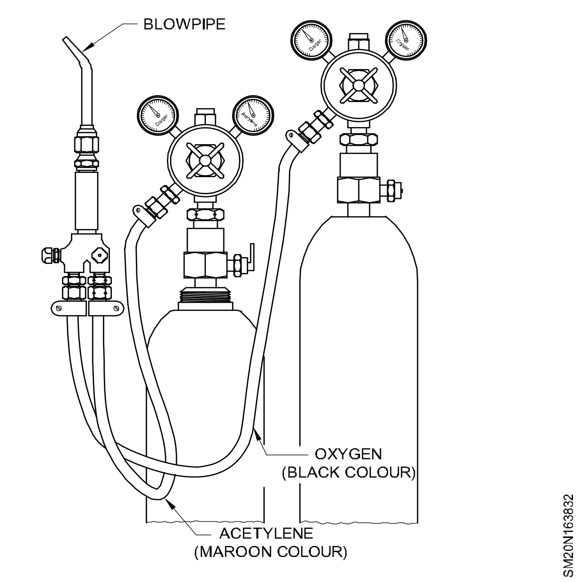


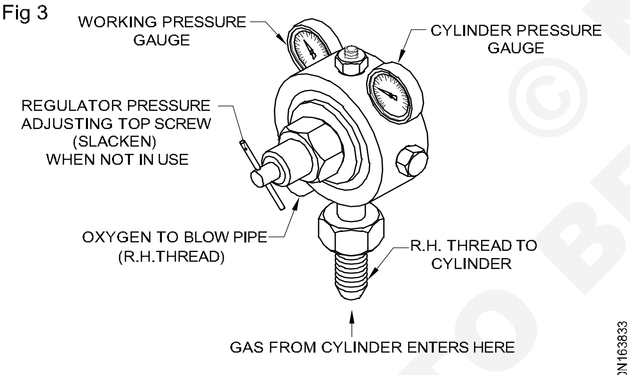
Fig 2



Dissolved acetylene cylinders: The acetylene gas used in gas welding is stored in steel bottles (cylinders) painted in maroon colour. The normal storing capacity of storing acetylene in dissolved state is 6m^2 with the pressure ranging between 15-16 kg/cm^2.

Oxygen pressure regulator: This is used to reduce the oxygen cylinder gas pressure according to the required working pressure and to control the flow of oxygen at a constant rate to the blowpipe. The threaded connections are right hand threaded. (Fig 3)

Fig 3

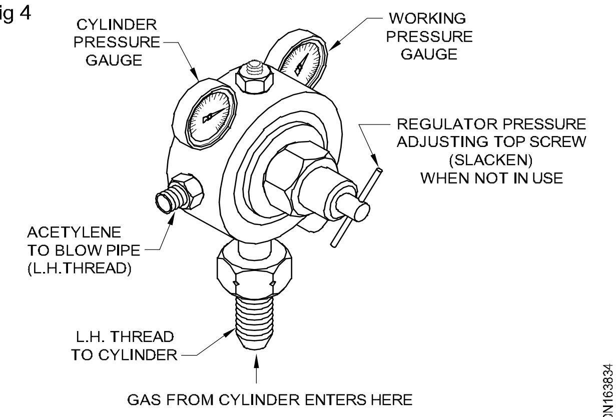


OXYGEN PRESSURE REGULATOR

Acetylene regulator: As with the case of oxygen regulator this also is used go reduce the cylinder gas pressure to the required working pressure and to control the flow of acetylene gas at a constant rate to the blowpipe. The threaded connections are left handed. For quickly identifying the acetylene regulator, a groove is cut at the corners of the nut. (Fig 4)

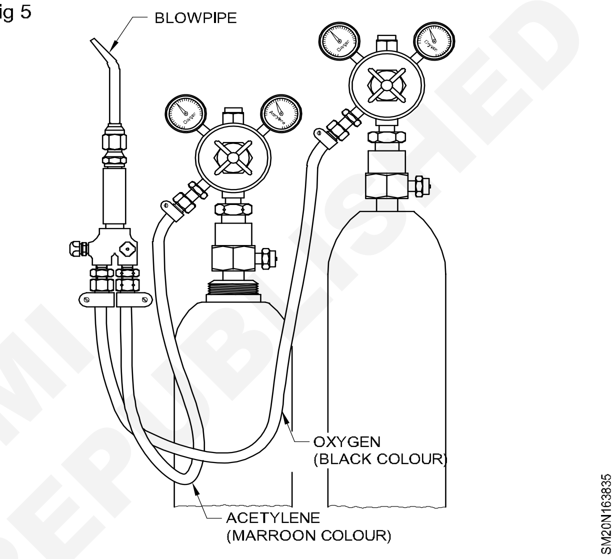
Rubber hose-pipes and connections: These are used to carry gas from the regulator to the blowpipe. These are made of strong canvas rubber having good flexibility. Hose-pipes which carry oxygen are black in colour and the acetylene hoses are of maroon colour. (Fig 5)

Fig 4



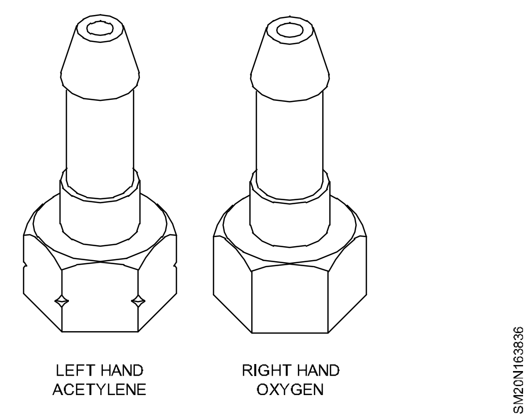
ACETYLENE PRESSURE REGULATOR

Fig 5



Rubber hoses are connected to regulators with the help of unions. These unions are right hand threaded for oxygen and left hand threaded for acetylene. Acetylene hose unions have la groove cut on the corners. (Fig 6)

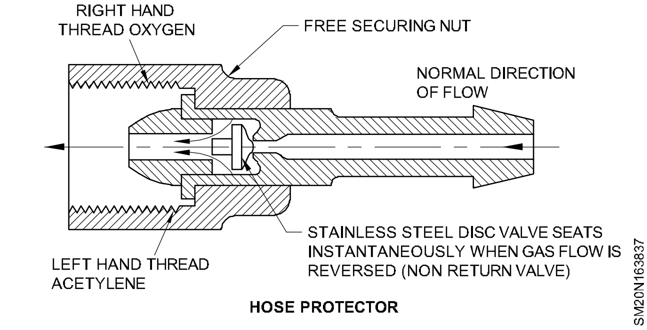
Fig 6



At the blowpipe end of the rubber hoses hose-protectors are fitted. The hose protectors are in the shape of a connecting union and have a non-return disc fitted inside to protect from flashback and backfire during welding. (Fig 7)

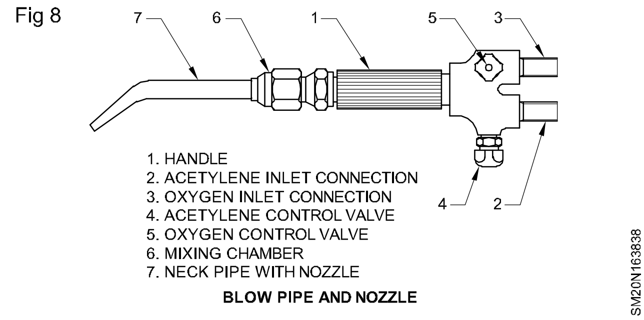
Blowpipe and nozzle: Blowpipes are used to control and mix the oxygen and acetylene gases to the required proportion. (Fig 8)

Fig 7



HOSE PROTECTOR

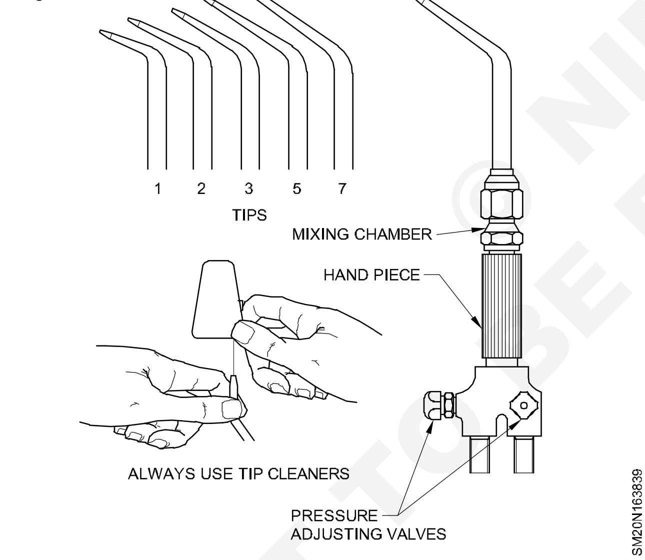
Fig 8



BLOW PIPE AND NOZZLE

A set of interchangeable nozzles of different sizes is available to produce smaller or bigger flames (Fig 9).

Fig 9



The size of the nozzle varies according to the thickness of the plates to be welded. (Table 1)

TABLE 1

Plate thickness		Nozzle size
mm	**Number**	**Litres/hr**
0.8	1	29
1.2	2	57
1.6	3	86
2.4	5	140
3.0	7	200
4.0	10	280
5.0	13	370
6.0	18	520
8.0	25	710
10.0	35	1000
12.0	45	1300
19.0	55	1600
25.0	70	2000
25.0	90	2500

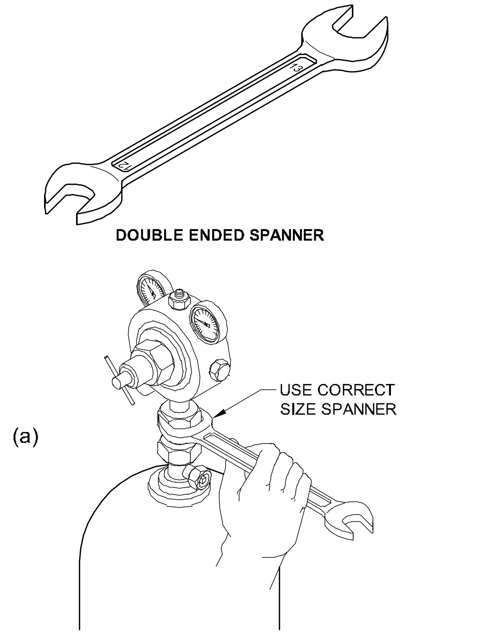
Gas welding hand tools

Objectives: At the end of this lesson you shall be able to
- **identify and name the hand tools used by a welder**
- **state their uses**
- **state the care and maintenance to keep the hand tools in good working condition.**

The following are the details of different hand tools used by a welder.

Double ended spanner: A double ended spanner is shown in Fig.1 and 1a. It is made of forged chrome vanadium steel. It is used to loosen or tighten nuts, bolts with hexagonal or square heads. The size of the spanner is marked on it as shown in Fig.1. In welding practice the spanners are used to fix the regulator onto the gas cylinder valves, hose connector and protector to the regulator and blow pipe, fix the cable lugs to the arc welding machine output terminals, etc.

Fig 1



Do not use the spanner as a hammer; use the correct size spanner to avoid damage to the nut/bolt head.

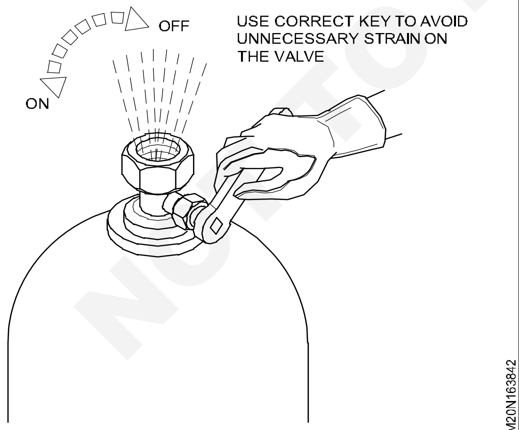
Cylinder key: A cylinder key is shown in Fig.2. It is used to open or close the gas cylinder valve socket to permit or stop the gas flow from the cylinder to the gas regulator.

Always use correct size key to avoid damage to the square rod used to operate the valve. The key must always be left on the valve socket itself so that the gas flow can be stopped immediately in case of flash back/back fire.

Nozzle or tip cleaner

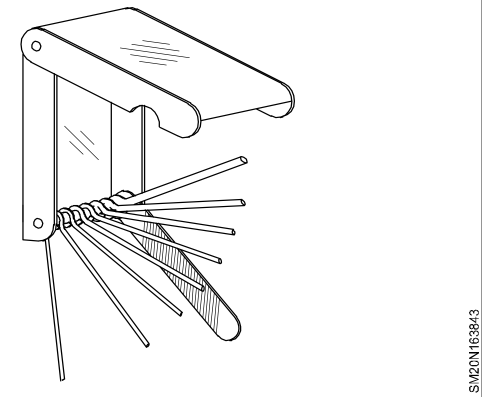
Cleaning the tip: All welding torch tips are made of copper. They can be damaged by the slightest rough handling-dropping, tapping or chopping with the tip on the work may damage the tip beyond repair.

Fig 2



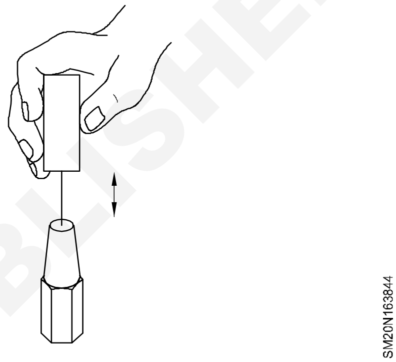
Tip cleaner: A special tip cleaner is supplied with the torch container. For each tip there is a kind of drill and a smooth file Fig.3.

Fig 3



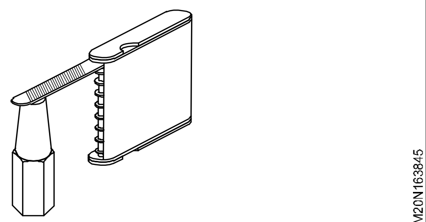
Before cleaning the tip, select the correct drill and move it, without turning, up and down through the hole in the tip Fig.4.

Fig 4



The smooth file is then used to clean the surface of the tip Fig.5. While cleaning, leave the oxygen valve partly open to blow out the dust.

Fig 5



Spark lighter: The spark lighter, as illustrated in Fig.6 & 7 is used for igniting the torch. While welding, form the habit of always employing a spark lighter to light a torch. Never use matches. The use of matches for this purpose is very dangerous because the puff of the flame produced by the ignition of the acetylene flowing from the tip is likely to burn your hand.

Fig 6

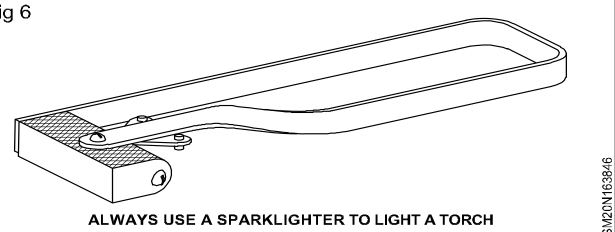
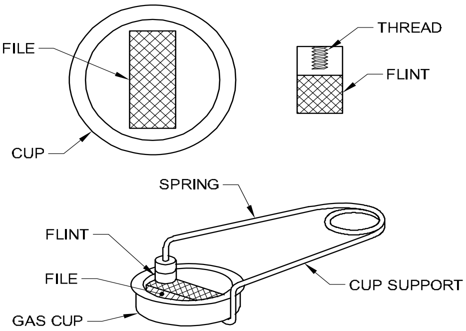
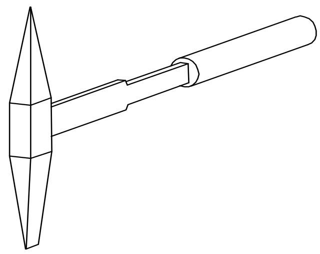


Fig 7



Chipping hammer: The chipping hammer (Fig.8) is used to remove the slag which covers the deposited weld bead. It is made of medium carbon steel with a mild steel handle. It is provided with a chisel edge on one end and a point on the other end for chipping off slag in any position.

Fig 8



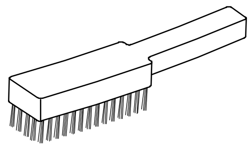
CHIPPING HAMMER

Care should be taken to maintain the sharp chisel edge and the point for effective chipping of slag.

Carbon steel wire brush: A carbon steel wire brush is shown in Fig.9. It is used for

- Cleaning the work surface from rust, oxide and other dirt etc. prior to welding.
- Cleaning the interbead weld deposits after chipping off the slag.
- General cleaning of the weldment.

Fig 9



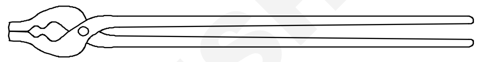
WIRE BRUSH

A stainless steel wire brush is used for cleaning a non ferrous and stainless steel welded joint.

It is made of bunch of steel wires fitted in three to five rows on a wooden piece with handle. The wires are hardened and tempered for long life and to ensure good cleaning action.

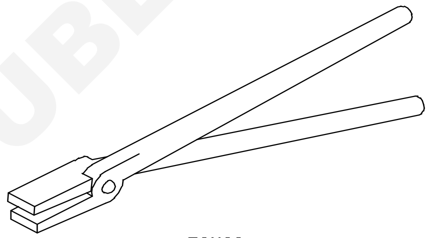
Tongs: Fig.10 and Fig.11 shows a pair of tongs used to hold hot work pieces and to hold the job in position.

Fig 10



TONGS

Fig 11



TONGS

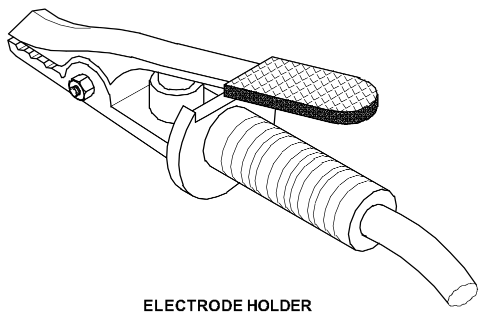
Arc welding accessories

Objectives: At the end of this lesson you shall be able to
- **identify the arc welding accessories**
- **explain the function of each accessory**
- **select the correct shade of glass for welding a seam according to current range.**

Arc welding accessories: Some very important items, used by a welder with an arc welding machine during the welding operation, are called arc welding accessories.

Electrode-holder (Fig 1): It is a clamping device used to grip and manipulate the electrode during arc welding. It is made of copper/copper alloy for better electrical conductivity.

Fig 1



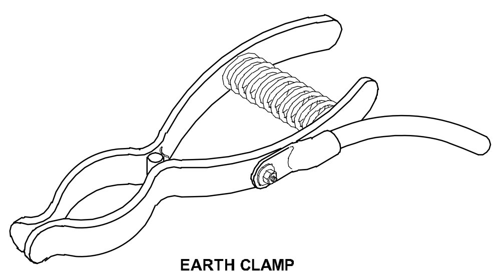
ELECTRODE HOLDER

Partially or fully insulated holders are made in various sizes i.e. 200 - 300 - 500 amps.

The electrode-holder is connected to the welding machine by a welding cable.

Earth clamp (Fig 2): It is used to connect the earth cable firmly to the job or welding table. It is also made of copper/ copper alloys.

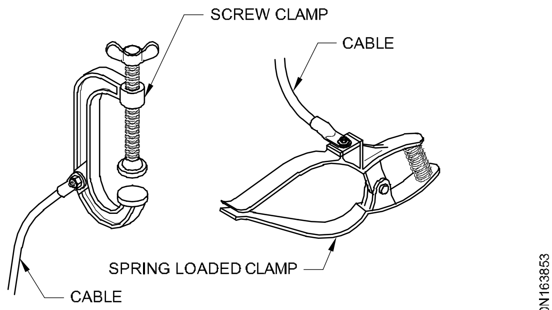
Fig 2



EARTH CLAMP

Screw or spring -loaded earth clamps are made in various sizes i.e. 200 - 300 - 500 amps. (Fig 3)

Fig 3



WORK CABLE ATTACHMENTS

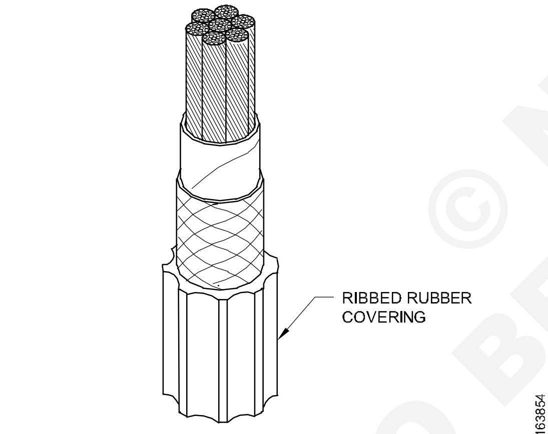
Welding cables/leads: These are used to carry the welding current from the welding machine to the work and back.

The lead from the welding machine to the electrode- holder is called electrode cable.

The lead from the work or job through the earth clamp is called earth (ground) cable.

Cables are made of super flexible rubber insulation, having fine copper wires and woven fabric reinforcing layers. (Fig 4)

Fig 4



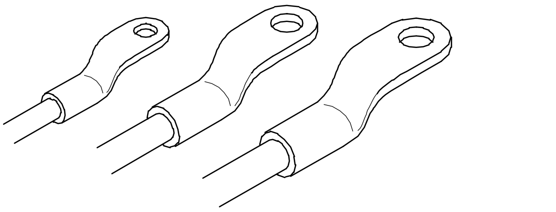
WELDING CABLE WITH
HEAVY RIBBED OUTER RUBBER COVERING

Welding cables are made in various sizes (cross-sections) i.e. 300, 400, 600 amps etc.

The same size welding cables must be used for the electrode and the job.

The cable connection must be made with suitable cable attachments (lugs). (Fig 5)

Fig 5



LUGS FOR WELDING LEADS
THE THREE SIZES WILL FIT CABLES FROM NO 6 TO 4/0. THEY MAY BE CONNECTED TO THE LEAD BY SOLDERING OR MECHANICAL CRIMPING

Loose joints or bad contacts cause overheating of the cables.

The length of the cable has considerable effect on the size to be used. (See Table 1.)

TABLE 1

Recommendations of copper cable for arc welding

Cable dia. (mm)	Lengths of cable in metres Current capacity in amperes 0 - 15	15 - 30	30 - 75
24.0	600	600	400
21.0	500	400	300
19.0	400	350	300
18.0	300	300	200
16.5	250	200	175
15.0	200	195	150
14.5	150	150	100
13.5	125	100	75

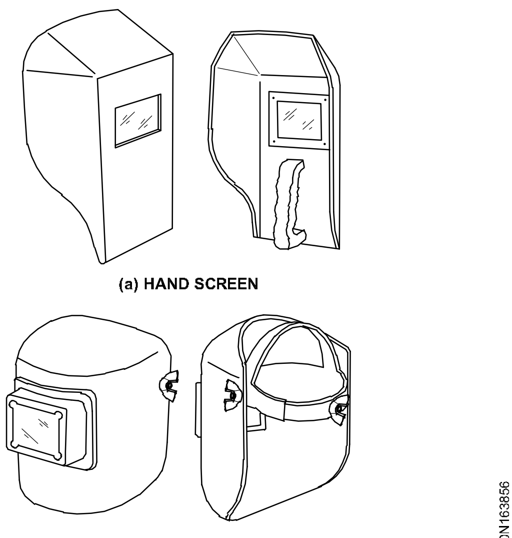
Voltage drop app. 4 volts with all connections clean and tight.

Welding hand screens and helmet: These are used to protect the eyes and face of a welder from arc radiation and sparks during arc welding.

A hand screen is designed to hold in hand. (Fig 6A)

A helmet screen is designed to wear on the head. (Fig 6B)

Fig 6



(a) HAND SCREEN

(b) HELMET SCREEN

Screens are made of non-reflective, non-flammable, insulated, dull coloured, light material with coloured (filter) glasses fitted with plain glasses on both sides to see the arc and molten pool while welding.

Clear glasses are fitted on each side of the coloured glass to protect it from weld spatters.

The helmet screen provides better protection and allows the welder to use his both hands freely.

Coloured (filter) glasses are made in various shades; to suit welding the current ranges. (Table 2)

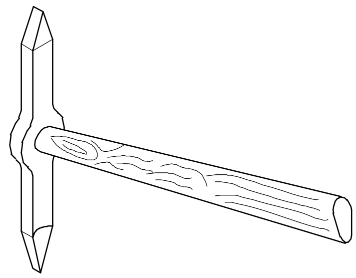
TABLE 2

Recommendations of filter glasses for manual metal arc welding

Shade No. of coloured glass	Range of welding current in amperes
8 - 9	Up to 100
10 - 11	100 to 300
12 - 14	Above 300

Chipping hammer (Fig 7): It is a welding tool used to remove the slag from the weld bead.

Fig 7



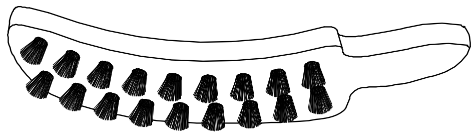
CHIPPING HAMMER

It is made out of medium carbon steel with a suitable handle.

It is provided with a chisel edge and a point for chipping off slag in any position.

Wire brush (Fig 8): It is used for

Fig 8



WIRE BRUSH

– cleaning the working surface prior to welding

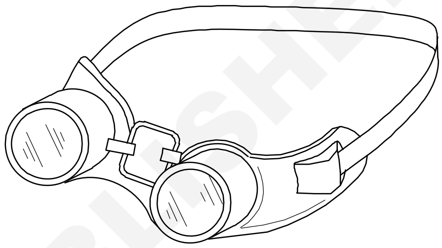
– general cleaning of the weldment.

It is made of steel wires fitted on a wooden piece in three to five rows.

The wires are hardened and tempered for long life to ensure good cleaning action.

Chipping goggles (Fig 9): It is used to protect the eyes while chipping the slag or grinding the job.

Fig 9



CHIPPING GOGGLES

It is made of Bakelite frame fitted with clear glasses and an elastic band to hold it securely on the operator's head.

It is designed for comfortable fit, proper ventilation and full protection from all sides.

Types of oxy-acetylene flames

Objectives: At the end of this lesson you shall be able to
- **name the different types of oxy-acetylene flames**
- **state the characteristics of each type of flame**
- **explain the uses of each type of flame.**

The oxy-acetylene gas flame is used for gas welding because

– it has a well controlled flame with high temperature

– the flame can be easily manipulated for proper melting of the base metal

– it does not change the chemical composition of the base metal/weld.

Three different types of oxy-acetylene flames as given below can be set.

– Neutral flame

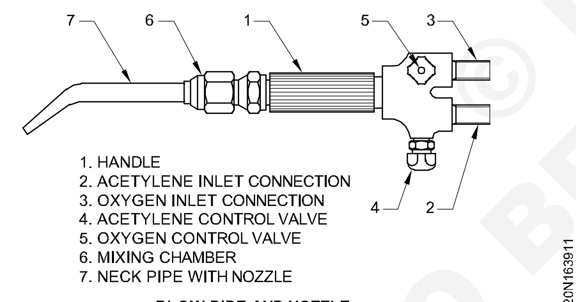
– Oxidising flame

– Carburising flame.

CHARACTERISTICS AND USES

Neutral flame (Fig 1): Oxygen and acetylene are mixed in equal proportion in the blowpipe.

Fig 1



BLOW PIPE AND NOZZLE

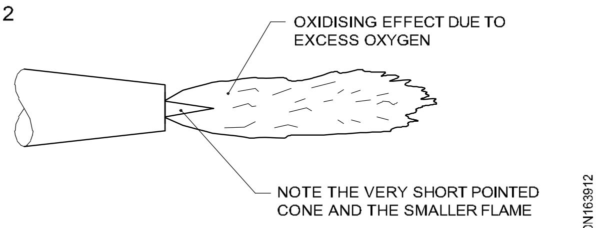
Complete combustion takes place in this flame.

This flame does not have a bad effect on the base metal/weld i.e. the metal is not oxidised and no carbon is available for reacting with the metal.

Uses: It is used to weld most of the common metals, i.e. mild steel, cast iron. stainless steel, copper and aluminium.

Oxidising flame (Fig 2): It contains an excess of oxygen over acetylene as the gases come out of the nozzle.

Fig 2



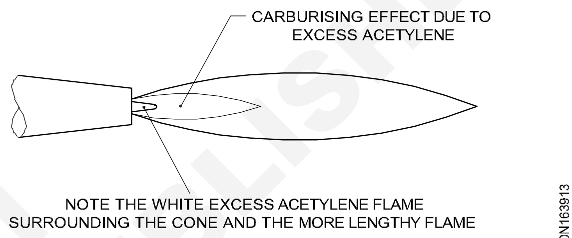
OXIDISING FLAME (EXCESS OXYGEN)

The flame has an oxidising effect on metals which prevents evaporation of zinc/tin in brass welding/brazing.

Uses: Useful for welding of brass and for brazing of ferrous metals.

Carburising flame (Fig 3): It receives an excess of acetylene over oxygen from the blowpipe.

Fig 3



CARBURISING FLAME (EXCESS ACETYLENE)

The flame has a carburising effect on steel, causing hard, brittle and weak weld.

Uses: Useful for stelliting (hard facing), 'Linde' welding of steel pipes, and flame cleaning.

The selection of the flame is based on the metal to be welded

The neutral flame is the most commonly used flame. (See the chart given below.)

	Metal	Flame
1	Mild steel	Neutral
2	Copper (de-oxidised)	Neutral
3	Brass	Oxidising
4	Cast iron	Neutral
5	Stainless steel	Neutral
6	Aluminium (pure)	Neutral
7	Stellite	Carburising

Gases used in welding and gas flame combinations

Objectives: At the end of this lesson you shall be able to
- **name the different types of gases used in welding**
- **compare the different types of gas flame combinations**
- **state the uses of the different gas flame combinations.**

In the gas welding process, the welding heat is obtained from the combustion of fuel gases in the presence of a supporter of combustion (oxygen).

Comparison of different gas flame combinations and their uses

Sl. No.	Fuel gas	Supporter of combu-stion	Name of the gas flame combina-tion	Temperature	Application/Uses
1	Acetylene	Oxygen	Oxy-acetylene flame	3100 to 3300^{0}C (Highest tempe-rature)	To weld all ferrous and non-ferrous metals and their alloys; gas cutting & gouging of steel; brazing bronze welding; metal spraying and hard facing.
2	Hydrogen	Oxygen	Oxy-hydrogen flame rature)	2400 to 2700^{0}C (Medium tempe- cutting of steel.	Only used for brazing, silver soldering and underwater gas
3	Coal gas	Oxygen	Oxy-coal gas flame	1800 to 2200^{0}C (Low temperature)	Used for silver soldering and underwater gas cutting of steel.
4	Liquid petroleum gas (LPG)	Oxygen	Oxy-liquid pet-roleum gas fla-me	2700 to 2800^{0}C (Medium temper-ature)	Used for gas cutting steel & heating purposes. (Has moisture and carbon effect in the flame.)
5	Acetylene	Air	Air-acetylene flame	1825 to 1875^{0}C (Low temperature)	Used only for soldering, brazing, heating purposes and lead burning.

(Oxy-acetylene gas flame combination is used in most gas welding processes because of the high temperature and heat intensity.)

Fluxes types and description

Objectives: At the end of this lesson you shall be able to
- **explain flux and its function**
- **describe the types of fluxes and their storage.**

Flux is a fusible (easily melted) chemical compound to be applied before and during welding to prevent unwanted chemical action during welding and thus making the welding operation easier.

The fuctions of fluxes: To dissolve oxides and to prevent impurities and other inclusions that could affect the weld quality.

Fluxes help the flow of filler metal into very small gap between the metals being joined.

Fluxes act as cleaning agents to dissolve and remove oxides and clean the metal for welding from dirt and other impurities.

Fluxes are available in the form of paste, powder and liquid.

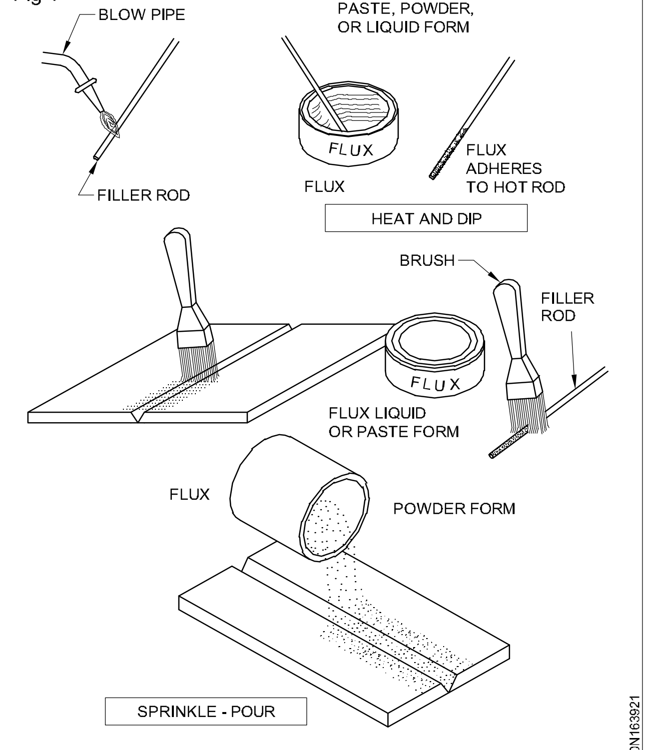
The method of application of flux is shown in Fig.1.

Storing of fluxes: Where the flux is in the form of a coating on the filler rod, protect carefully at all times against damage and dampness.Fig.2.

Seal flux tin lids when storing especially for long periods.(Fig.2)

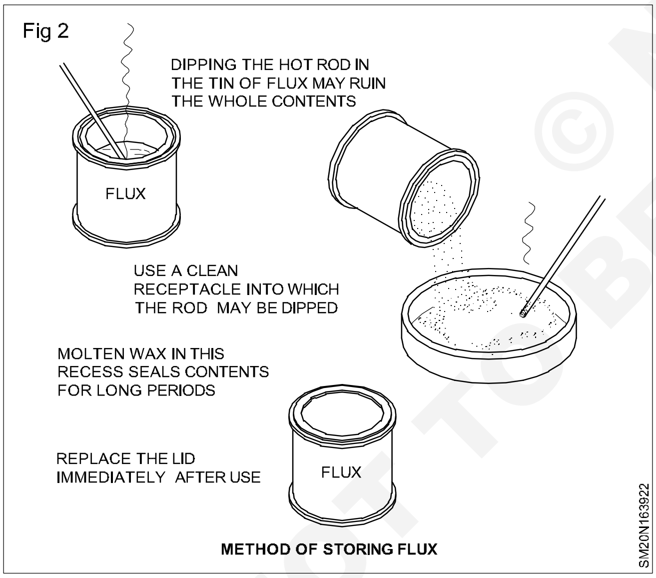
Though the inner reducing envelope of an oxy-acetylene flame offers protection to the weld metal, it is necessary to use a flux in most cases. Fluxes used during welding not only protect the weldment from oxidation but also from a slag which floats up and allows clean weld metal, to be deposited. After the completion of welding, flux residues should be cleaned.

Fig 1



METHOD OF APPLICATION

Fig 2



METHOD OF STORING FLUX

Removal of flux residues: After welding or brazing is over, it is essential to remove the flux residues. Fluxes in general are chemically active. Therefore, flux residues, if not properly removed, may lead to corrosion of parent metal and weld deposit.

Some hints for removal of flux residues are given below:

- Aluminium and aluminium alloys - As soon as possible after welding, wash the joints in warm water and brush vigorously. When conditions allow, follow up by a rapid dip in a 5 percent solution of nitric acid; wash again, using hot water to assist drying.

  When containers, such as fuel tanks, have been welded and parts are inaccessible for the hot water scrubbing method, use a solution of nitric and hydrofluoric acids. To each 5.0 litres of water add 400 ml of nitric acid (specific gravity 1.42) followed by 33 ml of hydrofluoric acid (40 percent strength). The solution used at room temperature will generally completely remove the flux residue in 10 minutes, producing a clean uniformly etched surface, free from stains. Following this treatment the parts should be rinsed with cold water and finished with a hot water rinse. The time of immersion in hot water should not exceed three minutes, otherwise staining may result; after this washing with hot water the parts should be dried. It is essential when using this treatment that rubber gloves be worn by the operator and the acid solution should preferably be contained in an aluminium vessel.

- Magnesium alloys - Wash in water followed quickly by standard chromating. Acid chromate bath is recommended.

- Copper and brass - Wash in boiling water followed by brushing. Where possible, a 2 percent solution of nitric or sulphuric acid is preferred to help in removing the glassy slag, followed by a hot water wash.

- Stainless steel - Treat in boiling 5 percent caustic soda solution, followed by washing in hot water. Alternatively, use a de-scaling solution of equal volume of hydrochloric acid and water to which is added 5 percent of the total volume of nitric acid with 0.2 percent of total volume of a suitable restrainer.

- Cast iron - Residues may be removed easily by a chipping hammer or wire brush.

- Silver brazing - The flux residue can be easily removed by soaking brazed components in hot water, followed by wire brushing. In difficult cases the work piece should be immersed in 5 to 10 percent sulphuric acid solution for a period of 2 to 5 minutes, followed by hot water rinsing and wire brushing.

Welding blowpipe

Objectives: At the end of this lesson you shall be able to
- **state the uses of the different types of blowpipes**
- **describe the working principle of each type of blowpipe**
- **explain its care and maintenance.**

Types

There are two types of blowpipes.

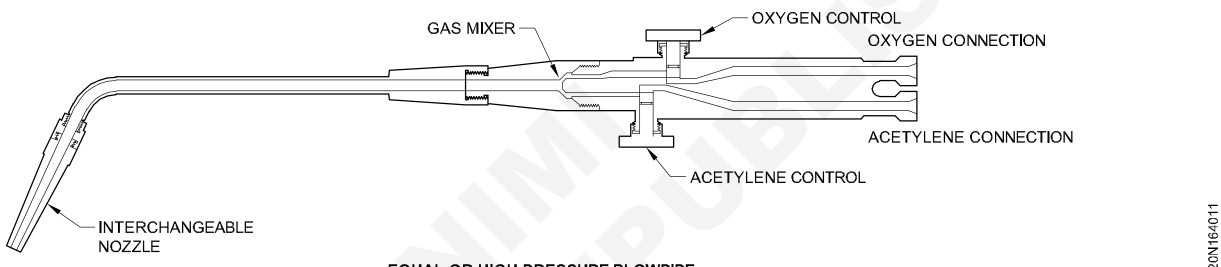
– High pressure blowpipe or non-injector type blowpipe

– Low pressure blowpipe or injector type blowpipe.

Uses of blow pipes: Each type consists of a variety of designs depending on the work for which the blowpipe is required. i.e., gas welding, brazing, very thin sheet welding, heating before and after welding, gas cutting.

Equal or High pressure blowpipe (Fig 1): The H.P. blowpipe is simply a mixing device to supply approximately equal volume of oxygen and acetylene to the tip, and is fitted with valves to control the flow of the gases as required. i.e. the blow pipes/gas welding torches are used for welding of ferrous and non-ferrous metals, joining thin sheets by fusing the edges, preheating and post heating of jobs, brazing, for removing the dents formed by distortion and for gas cutting using a cutting blow pipe.

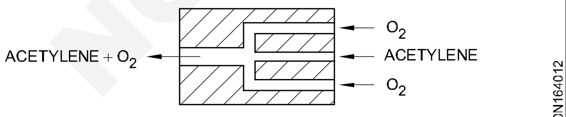
Fig 1



EQUAL OR HIGH PRESSURE BLOWPIPE

The equal pressure blow pipe (Fig.1) consists of two inlet connections for acetylene and oxygen gases kept in high pressure cylinders. Two control valves to control the quantity of flow of the gases and a body inside which the gases are mixed in the mixing chamber (Fig.2). The mixed gases flow through a neck pipe to the nozzle and then get ignited at the tip of the nozzle. Since the pressure of the oxygen and acetylene gases are set at the same pressure of 0.15 kg/cm^2 they mix together at the mixing chamber and flows through the blow pipe to the nozzle tip on its own. This equal pressure blow pipe/torch is also called as high pressure blow pipe/torch because this is used in the high pressure system of gas welding.

Fig 2 GAS PASSAGE IN THE GAS MIXING SECTION



EQUAL PRESSURE TYPE TORCH

A set of nozzles is supplied with each blowpipe, the nozzles having holes varying in diameters, and thus giving various sized flames. The nozzles are numbered with their consumption of gas in litres per hour.

> **Important caution: A high pressure blowpipe should not be used on a low pressure system.**

Low pressure blowpipe (Fig 3)

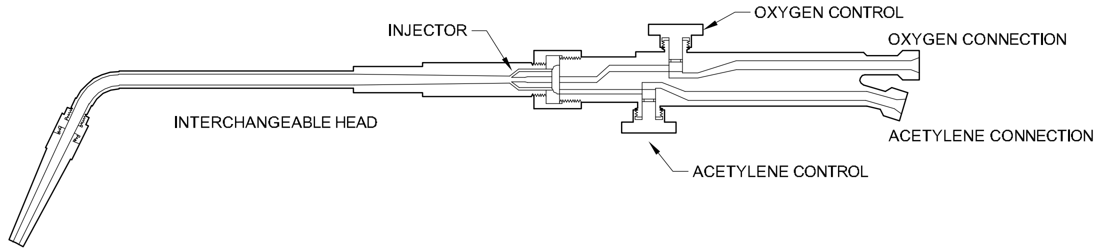
This blowpipe has an injector (Fig 3) inside its body through which the high pressure oxygen passes. This oxygen draws the low pressure acetylene from an acetylene generator into a mixing chamber and gives it the necessary velocity to get a steady flame and the injector also helps to prevent backfiring.

The low pressure blow pipe is similar to the equal pressure blow pipe except that inside its body an injector with a very small (narrow) hole in its centre through which high pressure oxygen is passed. This high pressure oxygen while coming out of the injector creates a vaccuum in the mixing chamber and sucks the low pressure acetylene from the gas generator (Fig.4)

It is usual for the whole head to be interchangeable in this type, the head containing both the nozzle and injector. This is necessary, since there is a corresponding injector size for each nozzle.

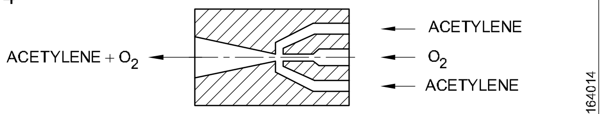
> **The L.P. blowpipe is more expensive than the H.P. blowpipe but it can be used on a high pressure system, if required.**

Fig 3



LOW PRESSURE BLOWPIPE

Fig 4



INJECTOR TYPE TORCH

Care and maintenance

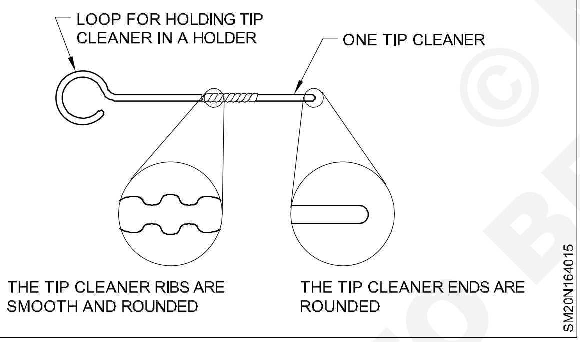
Welding tips made of copper may be damaged by careless handling.

Nozzles should never be dropped or used for moving or holding the work.

The nozzle seat and threads should be absolutely free from foreign matter in order to prevent any scoring/scratch on the fitting surfaces when tightening on assembly.

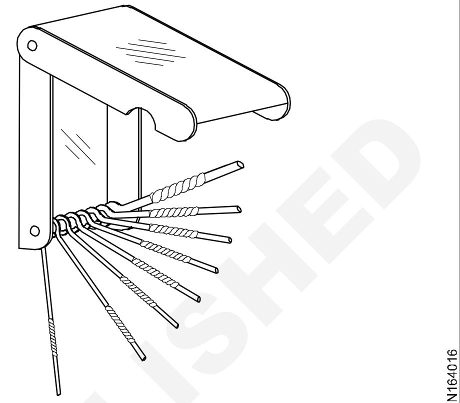
The nozzle orifice should only be cleaned with a tip cleaner specially designed for this purpose. (Figs 5,6 & 7)

Fig 5



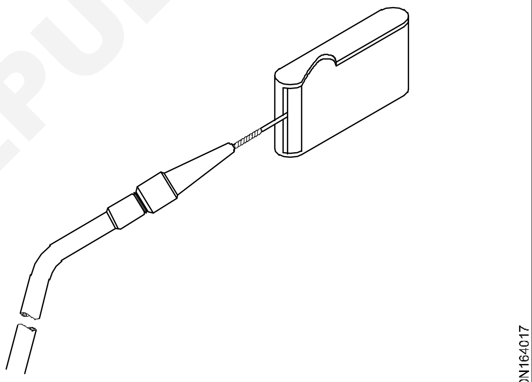
At frequent intervals the nozzle tip should be filed to remove any damage to the tip due to the excessive heat of the flame and the molten metal.

Fig 6



SET OF DIFFERENT SIZE TIP CLEANERS IN A HOLDER

Fig 7



METHOD OF TIP CLEANING

The inlet for acetylene has left hand thread and that for oxygen has right hand thread. Take care to fit the correct hose pipe with the blow pipe inlet. At frequent intervals, put off the flame and dip the blow pipe in cold water.

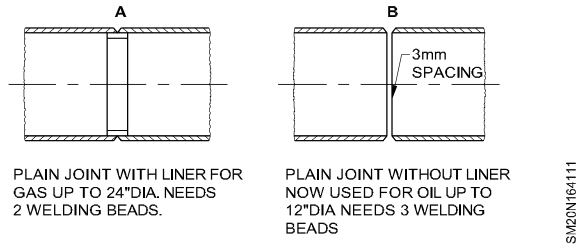
Various types of Pipe joints

Objectives: At the end of this lesson you shall be able to
- **explain the various types of pipe joints**
- **describe the factors to be considered for a pipe joint**
- **explain the method of cutting branch components (pipe development)**

Various types of pipe joints:

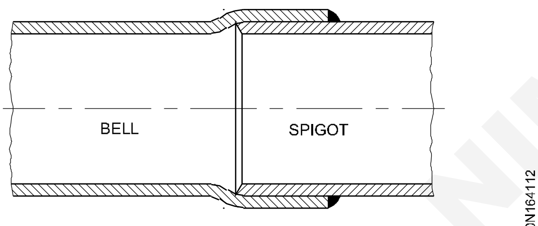
Square butt joint with liner and without liner (Fig 1).

Fig 1



Bell and spigot joint. (Fig 2).

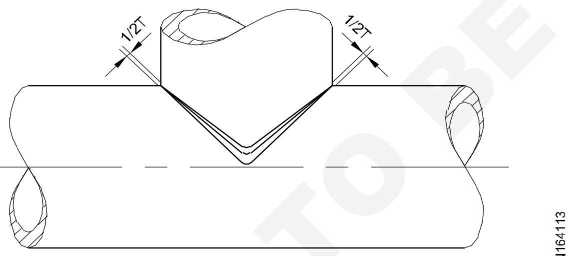
Fig 2



BELL AND SPIGOT JOINT

'Tee' joint. (Fig 3).

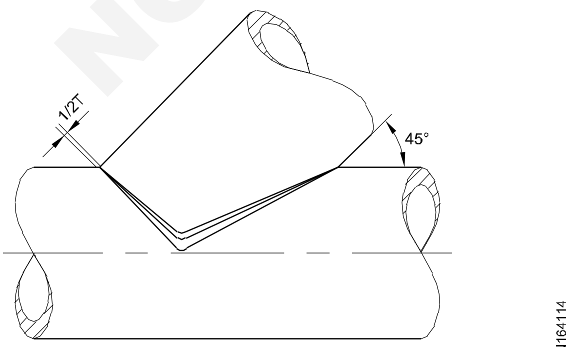
Fig 3



TEE JOINT

Branch joints. 45⁰. (Fig 4)

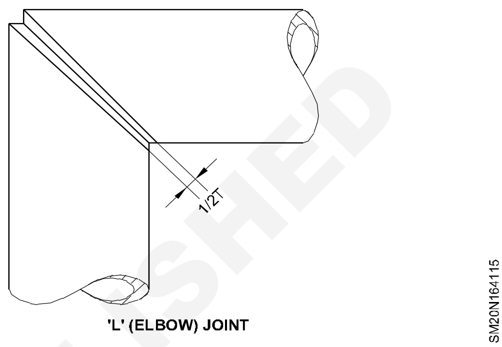
Fig 4



BRANCH JOINT

'L' elbow joint. (Fig 5)

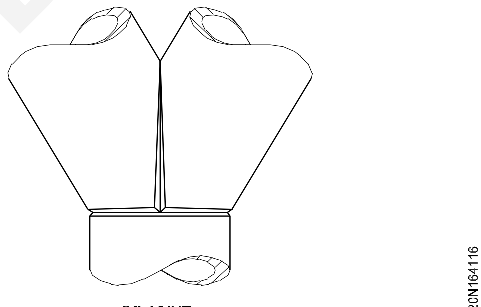
Fig 5



'L' (ELBOW) JOINT

'Y' joint. (Fig 6)

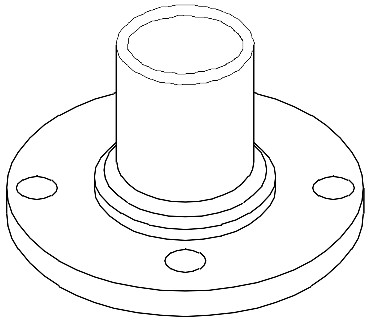
Fig 6



'Y' JOINT

Flange joint (A flange with a pipe). (Fig 7)

Fig 7



FLANGE JOINT (A FLANGE WITH A PIPE)

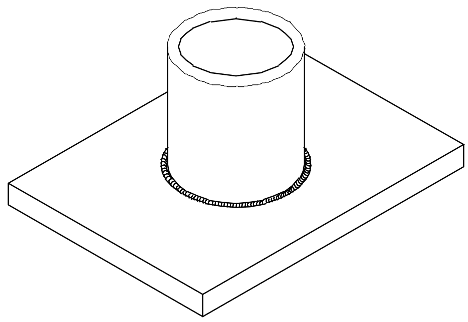
Flange joint (A sheet with a pipe). (Fig 8)

Gussel bend. (Fig 9)

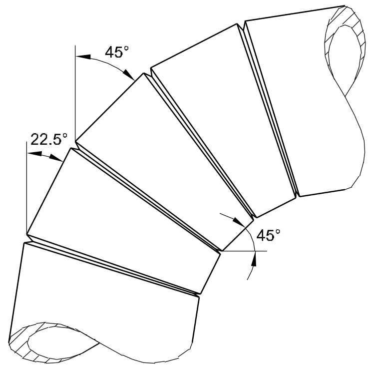
The factors to be considered for a pipe joint

Check the pipes for:

– specification of material and diameter (O.D/I.D) (Fig 10)



FLANGE JOINT (A SHEET WITH A PIPE)



GUSSET BEND

Material preparation method

Objectives: At the end of this lesson you shall be able to
- **state the necessity of preparing the materials to be welded**
- **state different methods used to cut mild steel sheets and plates to the required size before welding**
- **identify different tools and equipments used to prepare the mild steel sheets and plates.**

Necessity of materials prepartion for welding: While fabricating (producing or making) different components/ parts by welding, different sizes of plates, sheets, pipes, angles, channels with different dimensions are joined together to get the final objects. For example, a railway compartment, an aeroplane, an oil or water pipe line, a gate, a window grill, a stainless steel milk tank, etc. So these objects can be made to the required dimensions only by cutting them from the larger size sheets, plates, pipes etc. which are available in standard sizes, thickness, diameters and lengths in the market. Hence cutting and preparing the base metal to the required dimensions from the original material available in many store is necessary before welding them.

Also the base metals before cutting them to size will have impurities like dirt, oil, paint, water and surface oxides, due to long storage.

These impurities will affect the welding and will create some defects in the welded joint. These defects will make the joint weak and it is possible that the welded joint will break, if the weld defects are present in the welded joints.

So in order to get a strong welded joint, it is necessary to clean the surfaces to be joined and remove the dirt, oil, paint, water, surface oxide etc. from the joining surfaces before welding.

Different methods used to cut metals

1 By chiselling the sheets

2 By hacksawing

3 By shearing using hand lever shear

4 By using guillotine shear

5 By gas cutting

For thin sheets the first 4 methods are used. For thick materials method 2, 4 and 5 are used.

Tools and equipments used to cut metals

1 Cold chisel

2 Hacksaw with frame

3 Hand lever shear

4 Guillotine shear

5 Oxy-acetylene cutting torch

The cut edges of the sheet or plate are to be filed to remove burrs and to make the edges to be square (at 90^0 angle) with each other. For ferrous metal plates, which are more than 3mm thick, the edges can be prepared by grinding them on a bench/pedestal grinding machine.

Methods of cleaning the base metals before welding

Objectives: At the end of this lesson you shall be able to
- **state the importance of cleaning before welding**
- **explain the different methods of cleaning.**

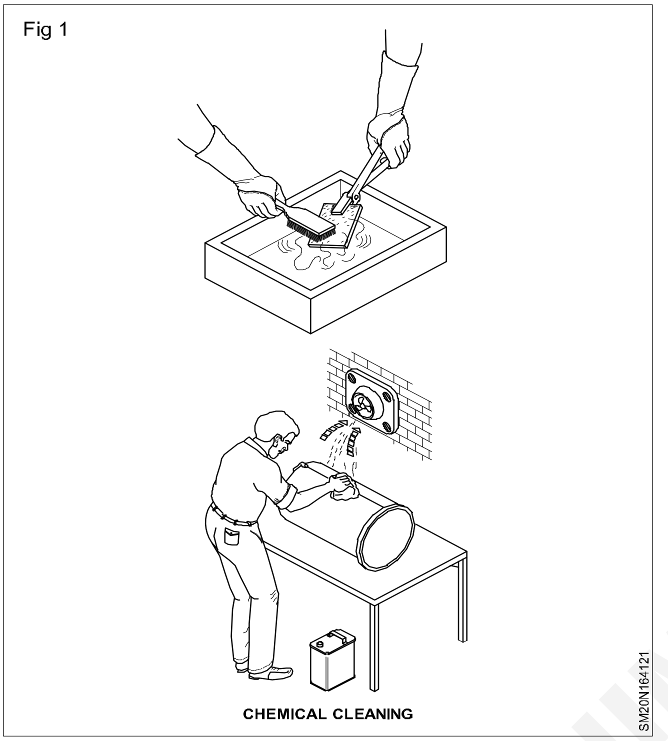
Every joint must be cleaned before welding to obtain a sound weld.

Importance of cleaning: The basic requirement of any welding process is to clean the joining edges before welding. The joining edges or surface may have oil, paint, grease, rust, moisture, scale or any other foreign matter.

If these contaminants are not removed the weld will become porous, brittle and weak. The success of welding depends largely on the conditions of the surface to be joined before welding. The oil, grease, paints and moisture on the sheets to be welded will give out gases while heated by arc or flame and these gases will get into the molten metal. They will come out of the metal when the molten metal cools to form the bead and create small pin holes on the surface of the bead. This is known as porosity and it weakens the joint.

Methods of cleaning: Chemical cleaning includes washing the joining surface with solvents of diluted hydrochloric acid to remove oil, grease, paint etc. (Fig.1)

Fig 1

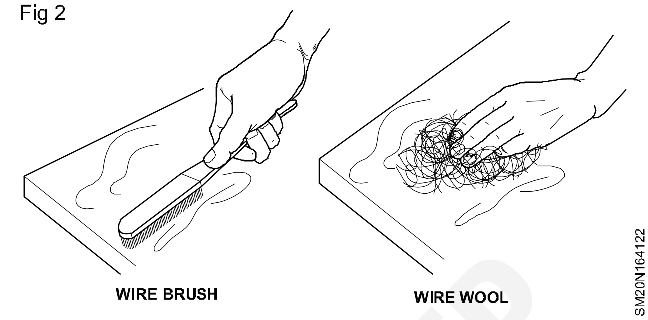


CHEMICAL CLEANING

Mechanical cleaning includes wire brushing, grinding, filing, sand blasting, scraping, machining or rubbing with emery paper. (Fig.2)

For cleaning ferrous metals a carbon steel wire brush is used. For cleaning stainless and non-ferrous metals, a stainless steel wire brush is used.

Fig 2



Faults in gas welding

Objectives: At the end of this lesson you shall be able to
- **name and define various weld defects**
- **identify the common faults in gas welding.**

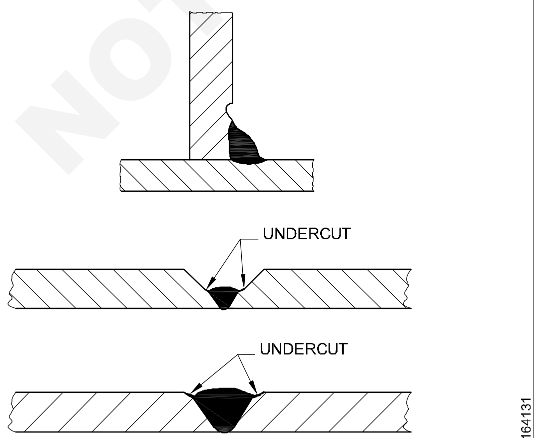
Definition

A fault is an imperfection in the weld which may result in failure of the welded joint while in service.

The following faults occur commonly in gas welding.

Undercut : A groove or channel formed along the toe of the weld on one side or on both sides. (Fig 1)

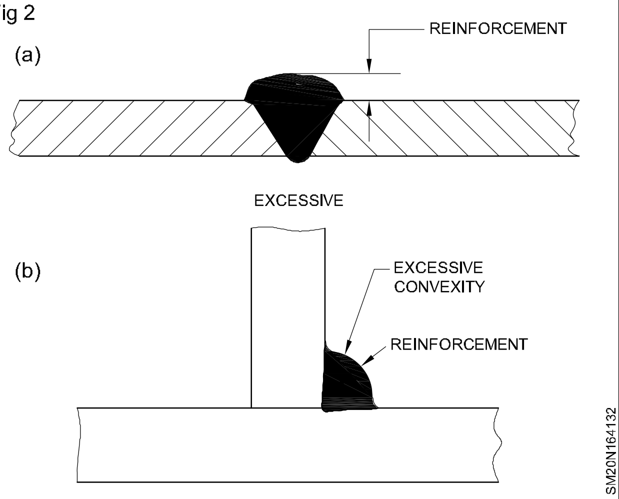
Fig 1



UNDER CUT

Excessive convexity: Too much weld metal added to the joint so that there is excessive weld reinforcement. (Fig 2)

Fig 2



Overlap : Metal flowing into the surface of the base metal without fusing it. (Fig 3)

Excessive penetration: Depth of fusion at the root of the grooved joint is more than the required amount. (Fig 4)

Fig 3

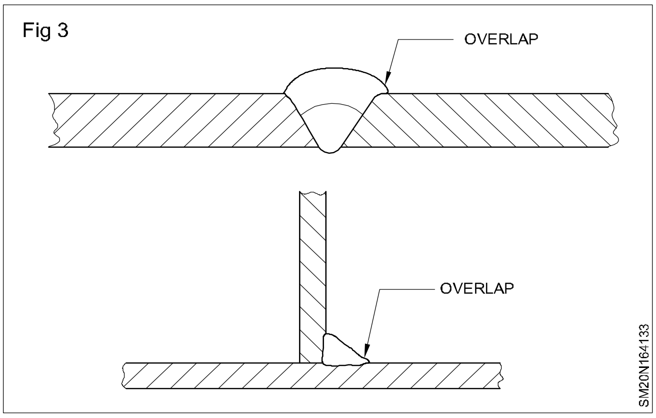
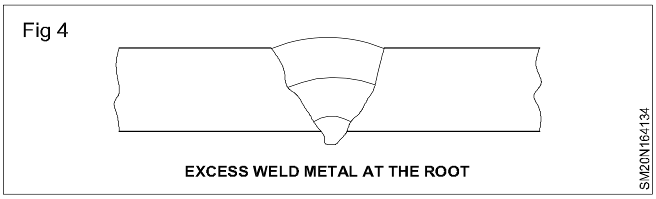
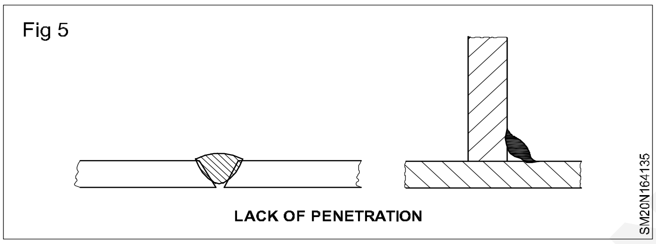


Fig 4



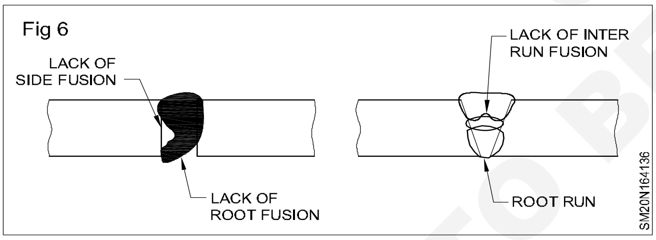
Lack of penetration: Required amount of penetration is not achieved, i.e. fusion does not take place up to the root of the weld. (Fig 5)

Fig 5



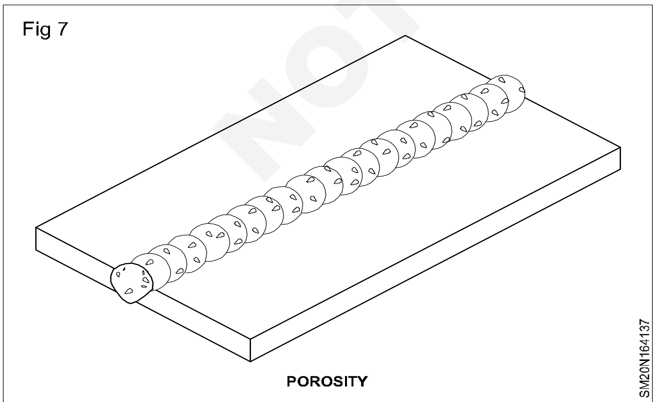
Lack of fusion: If there is no melting of the edges of the base metal at the root face or on the side face or between the weld runs, then it is called lack of fusion. Fig.6.

Fig 6



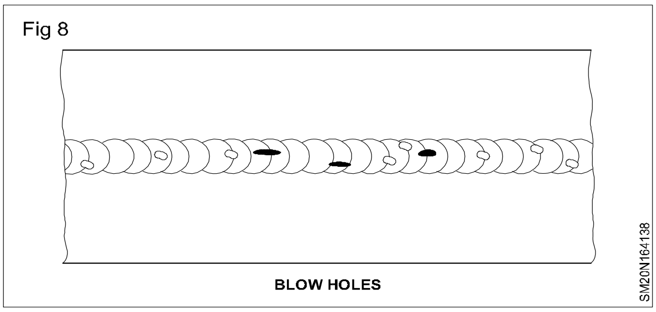
Porosity: Number of pinholes formed on the surface of the deposited metal. (Fig 7)

Fig 7



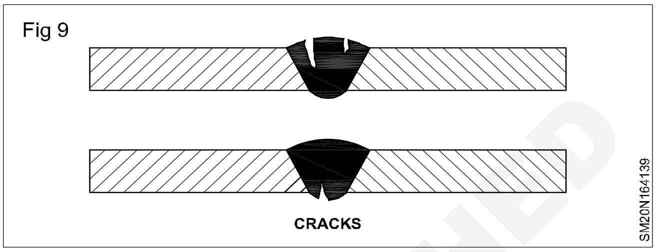
Blow-holes: These are similar to pinholes but have a greater diameter. (Fig 8)

Fig 8



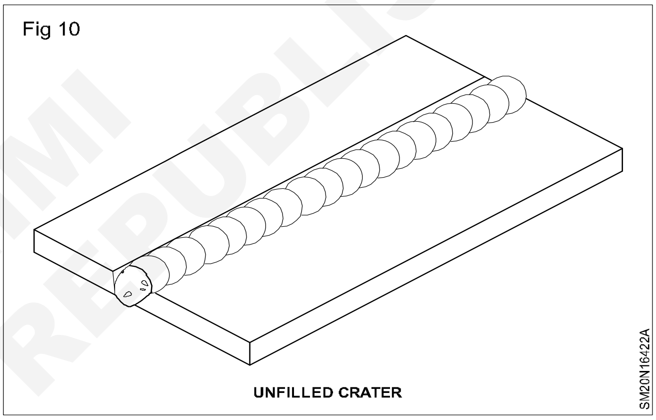
Cracks : A discontinuity in the base metal or weld metal or both. (Fig 9)

Fig 9



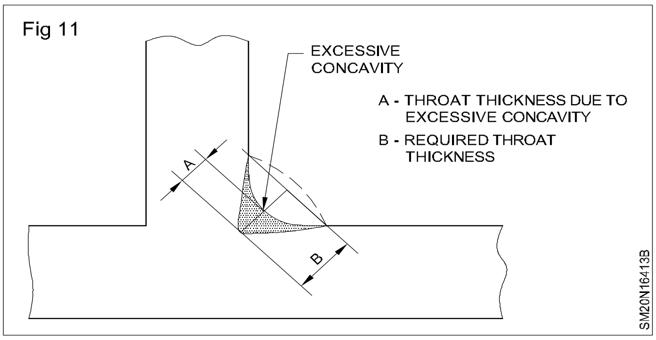
Unfilled crater : A depression formed at the end of the weld. (Fig 10)

Fig 10



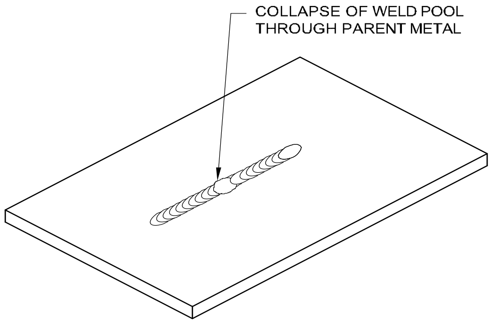
Excessive concavity/Insufficient throat thickness: Enough weld metal is not added to the joint so that there is insufficient throat thickness. (Fig.11)

Fig 11



Burn through: A collapse of the molten pool due to excessive penetration, resulting in a hole in the weld run. (Fig.12)

Fig 12



BURN THROUGH

Weld defects - Causes and remedies

Objectives: At the end of this lesson you shall be able to
- **explain the causes of weld defects**
- **state the remedies to prevent the defects.**

Welding defects: Possible causes and remedies

	Defect	Possible causes	Appropriate remedies
1	Fillet weld with insufficient throat thickness.	Incorrect angle of filler rod and blowpipe.	Maintain filler rod and blowpipe at the appropriate angles.
2	Excessive concavity in butt weld profile.	Excess heat build-up with too fast a speed of travel or filler rod too small.	Use the appropriate size nozzle and filler rod with the correct speed of travel.
3	Excessive penetration. Excess fusion of root edges.	Angle of slope of nozzle too large. Insufficient forward heat. Flame size and/or velocity too high. Filler rod too large or too small. Speed of travel too slow.	Maintain the nozzle at the correct speed of travel. Select correct nozzle size. Regulate flame velocity correctly. Use correct size of filler rod.
4	Burn through.	Excessive penetration has produced local collapse of weld pool resulting in a hole in the root run.	Maintain blowpipe at the correct angles. Check nozzle size, filler rod size. Travel at the correct speed.
5	Undercut along vertical member of fillet welded Tee joint.	Incorrect angle of tilt used in blowpipe manipulation.	Maintain blowpipe at the correct angle.
6	Undercut in both sides of weld face in butt joint.	Wrong blowpipe manipulation; incorrect distance from plate surface, excessive lateral movement. Use of too large a nozzle.	Use correct nozzle size, speed of travel and lateral blowpipe manipulation.
7	Incomplete root penetration in butt joint (single vee or double vee).	Incorrect set up and joint preparation. Use of unsuitable procedure and/or welding technique.	Ensure joint preparation and set up are correct. Appropriate procedure and/or welding technique must be used.
8	Incomplete root penetration in close square Tee joint.	Incorrect set up and joint preparation. Use of unsuitable procedure and/or welding technique.	Ensure joint preparation and set up are correct. Appropriate procedure and/or welding technique must be used.

9	Lack of root penetration.	Incorrect joint preparation and set up. Gap too small. Vee preparation too narrow. Root edges touching.	Prepare and set up the joint correctly.
10	Lack of fusion on root and side faces of double Vee butt joint.	Incorrect set up and joint preparation. Use of unsuitable welding technique.	Ensure the use of correct joint preparation, set up and welding technique.
11	Lack of inter-run fusion.	Angles of nozzle and blowpipe manipulation incorrect.	Correct the angles of slope and tilt. Use blowpipe manipulation to control uniform heat build-up.
12	Weld face cracks in butt and fillet welds.	Use of incorrect welding procedure. Unbalanced expansion and contraction stresses. Presence of impurities. Undesirable chilling effects. Use of incorrect filler rod.	Use correct procedure and filler rod. Ensure uniform heating and cooling. Check suitability and surface preparation of material before welding. Avoid draughts and use appropriate heat treatment.
13	Surface porosity and gaseous intrusions.	Use of incorrect filler rod and technique. Failure to clean surfaces before welding. Absorption of gases due to incorrectly stored fluxes, unclean filler rod. Atmospheric contamination.	Clean plate surfaces. Use correct filler rod and technique. Make sure the flame setting is correct to avoid gas contamination.
14	Crater at end of weld run. Small cracks may be present.	Neglect to change the angle of blowpipe, speed of travel or increase the rate of weld metal deposition as welding is completed at the end of the seam.	Reduce the angle of the blowpipe progressively with speed of travel to lower the heat input and deposit, and deposit sufficient metal to maintain the toe of the weld pool at the correct level until it has completely solidified.

Defects in Arc welding - definition, causes and remedies

Objectives: At the end of this lesson you shall be able to
- **define common weld defects in arc welded joints**
- **describe the causes, remedies and corrections of weld defects.**

A sound or good weld will have uniformly rippled surface, even contour, bead width, good penetration and no defects.

Definition of a defect: A defect is one which does not allow the finished joint to withstand the required strength (load).

Causes for weld defects means that the reasons or wrong actions taken which creates the defect.

A remedy can be

a Preventing the defect by taking proper actions before and during welding.

b Taking some corrective actions after welding to rectify a defect which has already taken place.

Undercut: A groove or channel formed in the parent metal at the toe of the weld. (Figs 1, 2 & 3)

Causes

Current too high.

Use of a very short arc length.

Welding speed too fast.

Overheating of job due to continuous welding.

Faulty electrode manipulation.

Wrong electrode angle.

REMEDIES

(a) Preventive action

Ensure

– proper current is set

– correct welding speed is used

– correct arc length is used

– correct manipulation of electrode is followed.

(b) Corrective actions

– deposit a thin stringer bead at the top of the weld using a 2mm ϕ electrode to fill up the undercut.

Overlap

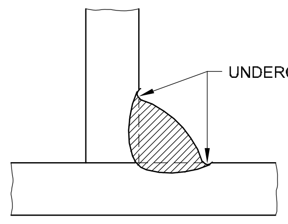
An overlap occurs when the molten metal from the electrode flows over the parent metal surface without fusing into it. (Fig 4)

CAUSES

Low current.

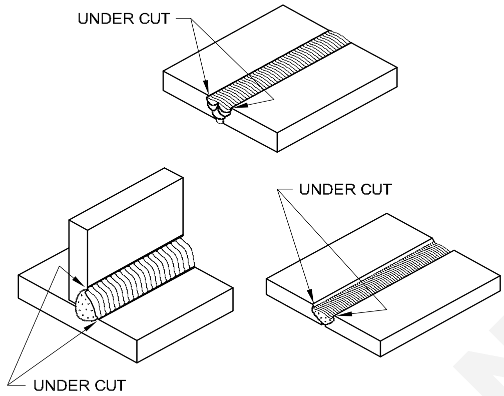
Slow arc travel speed.

Fig 1



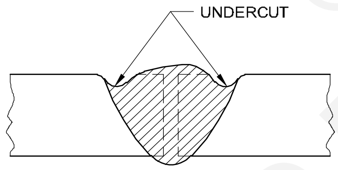
TEE-JOINT FILLET WELD

Fig 2



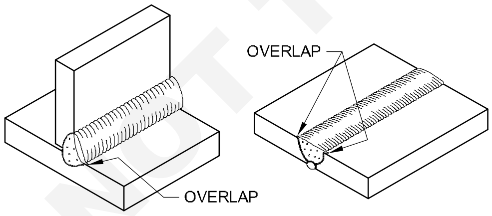
A SCHEMATIC DIAGRAM OF UNDERCUTS IN FILLET AND BUTT WELDS.

Fig 3



SQUARE-BUTT WELD

Fig 4



SCHEMATIC DIAGRAM OF OVERLAP IN FILLET AND BUTT WELDS

Long arc.

Too large a diameter electrode.

Use of wrist movement for electrode weaving instead of arm movement

REMEDIES

(a) Preventive actions

Correct current setting.

Correct arc travel speed.

Correct arc length.

Correct diameter electrode as per metal thickness.

Proper manipulation of electrode.

(b) Corrective actions

Remove the overlap by grinding without an undercut.

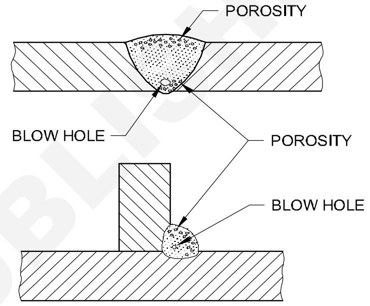
Blowhole and Porosity

Blow hole or gas pocket is a large diameter hole inside a bead or on the surface of the weld caused by gas entrapment. Porosity is a group of fine holes on the surface of the weld caused by gas entrapment. (Fig 5)

CAUSES

Presence of contaminants/impurities on the job surface or on electrode flux, presence of high sulphur in the job or electrode materials. Trapped moisture between joining surfaces. Fast freezing of weld metal. Improper cleaning of the edges.

Fig 5



REMEDIES

(a) Preventive actions

Remove oil, grease, rust, paint, moisture, etc. from the surface. Use fresh and dried electrodes. Use good flux-coated electrodes. Avoid long arcs.

(b) Corrective action

If the blowhole or porosity is inside the weld then gouge the area and reweld. If it is on the surface then grind it and reweld.

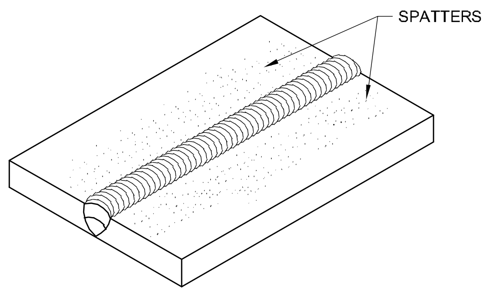
Spatter

Small metal particles which are thrown out of the arc during welding along the weld and adhering to the base metal surface. (Fig.6)

CAUSES

Welding current too high. Wrong polarity (in DC). Use of long arc. Arc blow. Uneven flux coated electrode.

Fig 6



REMEDIES

(a) Preventive actions

Use correct current.

Use correct polarity (DC).

Use correct arc length.

Use good flux-coated electrode.

(b) Corrective actions

Remove the spatters using a chipping hammer and wire brush.

Edge of plate melted off

Edge of plate melted off defect takes place in lap and corner joints only. If there is excess melting of one of the plate edges resulting in insufficient throat thickness then it is called edge of plate melted off defect. (Fig.7)

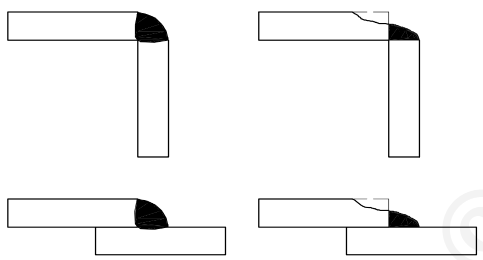
CAUSES

Use of oversize electrode.

Use of excessive current.

Wrong manipulation of the electrode i.e excessive weaving of electrode.

Fig 7



EDGE OF PLATE MELTED OFF

SM20N164147

REMEDIES

(a) Preventive action

Select correct size electrode.

Set correct current.

Ensure correct manipulation of electrode.

(b) Corrective action

Deposit additional weld metal to increase throat thickness.

Crack

A hairline separation exhibits in the root or middle or surface and inside of the weld metal or parent metal. (Fig 8)

CAUSES

Wrong selection of electrode.

Presence of localized stress.

A restrained joint.

Fast cooling.

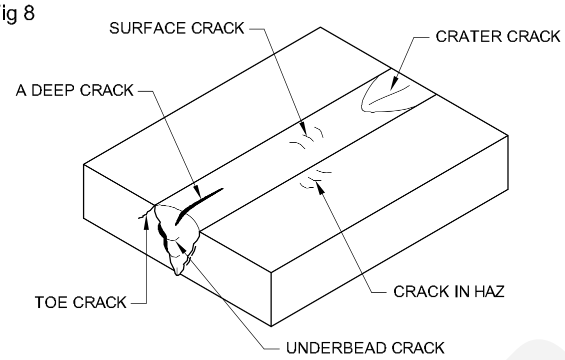
Improper welding techniques/sequence.

Poor ductility.

Absence of preheating and post-heating of the joint.

Excessive sulphur in base metal.

Fig 8



DIFFERENT TYPES OF CRACKS

SM20N164148

REMEDIES

(a) Preventive actions

Preheat and post-heating to be done on copper, cast iron, medium and high carbon steels.

Select a low hydrogen electrode.

Cool slowly.

Use fewer passes.

Use proper welding technique/sequence.

Cracks

(b) Corrective actions

- For all external cracks to a smaller depth, take a V groove using a diamond point chisel upto the depth of the crack and reweld (with preheating if necessary) using low hydrogen electrode. Cool the job slowly.
- For internal/hidden cracks gouge upto the depth of the cracks and reweld (with preheating if necessary) using low hydrogen electrode. Cool the job slowly.

Incomplete penetration

Failure of weld metal to reach and fuse the root of the joint. (Fig 9)

CAUSES

Edge preparation too narrow - less bevel angle.

Welding speed too much.

Key- hole not maintained during welding the root run of a grooved joint.

Less current.

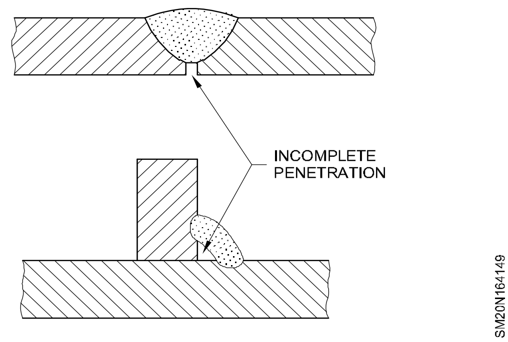
Use of larger dia. electrode.

Inadequate cleaning or gouging before depositing sealing run.

Wrong angle of electrode.

Insufficient root gap.

Fig 9



REMEDIES

(a) Preventive actions

Correct edge preparation is required.

Ensure correct angle of bevel and required root gap.

Use correct size of electrode.

Correct welding speed is required.

Maintain a key-hole throughout the root run.

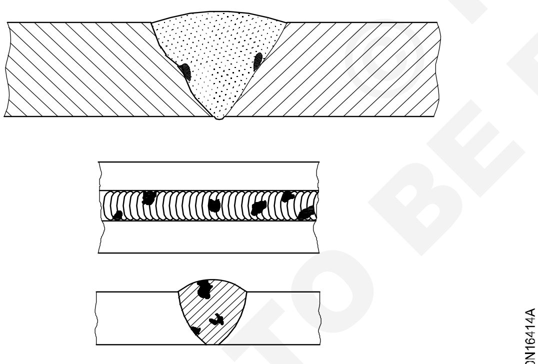
Correct current setting is required.

(b) Corrective actions

For butt welds and open corner welds gouge the root of the joint and deposit the root run from the bottomside of the joint. For a Tee & lap fillet welds blow of the full weld deposit and reweld the joint.

Slag inclusion: Slag or other non-metallic foreign materials entrapped in a weld. (Fig 10)

Fig 10



SLAG INCLUSION IN BUTT WELD

CAUSES

Incorrect edge preparation.

Use of damaged flux coated electrode due to long storage.

Excessive current.

Long arc length.

Improper welding technique.

Inadequate cleaning of each run in multi-run welding.

REMEDIES

(a) Preventive actions

Use correct joint preparation.

Use correct type of flux coated electrode.

Use correct arc length.

Use correct welding technique.

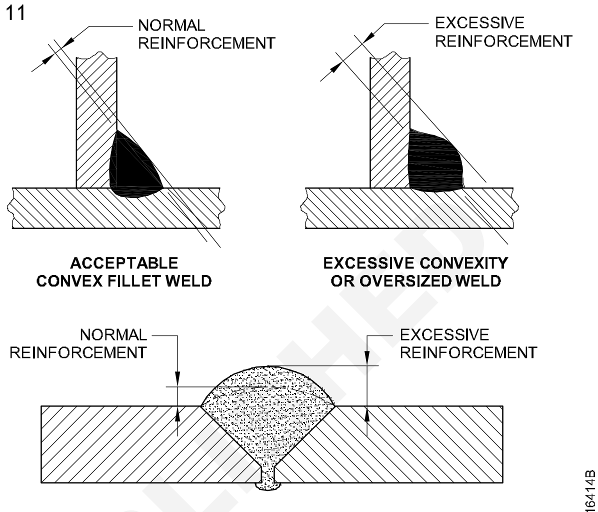
Ensure thorough cleaning of each run in multi-run welding.

(b) Corrective actions

For external/surface slag inclusion remove them using a diamond point chisel or by grinding and reweld that area. For internal slag inclusions use gouging upto the depth of the defect and reweld.

Excessive convexity (Fig.11)

Fig 11



EXCESSIVE CONVEXITY OR
OVERSIZED WELD OR EXCESSIVE REINFORCEMENT

This defect is also called as oversize weld or excessive reinforcement. It is the extra weld metal deposited in the final layer/covering run.

Excessive concavity/Insufficient throat thickness

If the weld metal deposited into a butt or fillet weld isbelow the line joining the toes of the weld then this defect is called excessive concavity or insufficient throat thickness.Fig.12

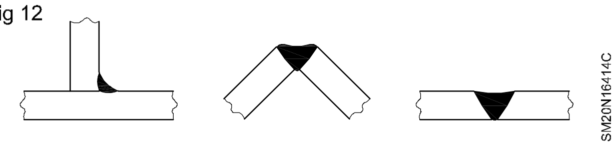
CAUSES

- Incorrect bead profile due to improper weaving of electrode.
- Use of small dia. electrode.
- Excessive speed of welding.
- Wrong welding sequence when using stringer beads to fill the groove.
- Sagging of weld metal is not controlled in horizontal position.
- Electrode movement is not uniform.
- Improper electrode angle between the plate surfaces.

Remedies

- Lack of fusion.
- Mismatch.
- Uneven/irregular bead appearance.
- Excessive root penetration.

Fig 12



Importance of trade with development of industrial economy of the country

Objectives : At the end of this lesson you shall be able to
- **state what is countersinking**
- **list the purposes of countersinking**
- **state the angles of countersinking for the different applications**

The industrial growth benefits the development of the economy in the country and also solves the unemployment problems. For industrial growth one of the factor is the source of skilled manpower. The industry gains the benefit of quality products by appropriate manpower.

Sheet metal work application involves in manufacturing of components of house hold items building construction, furniture, automobile, shipping, Aircraft, railway etc. The manufacturing industries of the above fields are in the need of high volume of skilled sheet metal worker.

Even though the industries are equipped with automatic machines and special purpose machines for the production of items in mass production, the operator who operaters the machines should have the knowledge of sheet metal operations, so that we can visually inspect products of its accuracy and finish.

Hence the skilled sheet metal worker's contribution to the industries will enhance in production of quality products. The quality products will attract the market. The demands of the market is the backbone of industry growth, which boost the economy of the country.

Types of Sheet Metal Fabrication

1.	Edge stiffening	a) Single hem	b) Double hem	c) Wire edge
2.	Types of seams	a) Grooved seam d) Butt seam g) Snap lock	b) Pittsburgh seam e) Lap seam h) Double seam	c) Dovetail seam f) Slip joint seam h(i) Plain dovetail seam h(ii) Flange dovetail seam h(iii) Beaded dovetail seam
3	Riveting			
4.	Soldering			
5.	Brazing			
6.	Welding	a) Arc	b) Gas	
7.	Power press operation	: Shearing, perforating, Drawing, Cupping, Blanking, Notching Squeezing, coining, piercing, Lancing, punching, bending Embossing, Flatening, angle bending, Curling, Forming, plunging		

Review of Types of Sheet Metal Fabrication

Objectives: At the end of this lesson you shall be able to
- **state the meaning of various terms used in sheet metal work.**

1 **Beading**: The process of raising a strip of metal around the end of a round pipe.

2 **Braising**: The process of stretching a piece of metal by hitting it with a round head hammer, as in forming a bowl.

3 **Brake**: A machine that the sheet metal worker uses for bending and folding edges on metal.

4 **Burring**: The process of turning an edge on a circular piece of metal.

5 **Clips**: Special strips of sheet metal bent in a manner to connect two pieces of sheet metal duct.

6 **Crimping**: The process of corrugating the end of a round pipe to make it smaller so it will fit into the end of another pipe.

7 **Edges**: Bends on the edges of sheet metal to eliminate sharp edges and provide stiffening.

8 **Forming**: The process of rolling sheet metal into pipe or making bends to form objects.

9 **Layout work**: The process of developing the pattern for a sheet metal object.

10 **Longitudinal seam**: A seam running the long length of a pipe.

11 **Miter**: The joining of two pieces at an evenly divided angle.

12 **Nibble**: Nibble to piece metal along or on its edge.

13 **Pattern**: The shape of an object to be made out of sheet metal as it appears when marked out on the flat sheet. Also, the exact size and shape that a piece of sheet metal must be in order to be formed into the object desired.

14 **Pierce**: To cut out interior waste stock from a metal part with a die.

15 **Planish**: To make a metal surface smooth by hammering it over a stake or block.

16 **Press brake**: A power machine used by the sheet metal worker to form sheet metal.

17 **Press forming**: Creating sheet metal products using dies to cut and shape the metal and presses to power the dies. Also called stamping.

18 **Seams**: Various types of bent and hooked edges used to join two pieces of sheet metal. For lighter sheet metal, mechanical joints are used. In medium and heavy gage metal, a riveted or welded seam is used.

19 **Seam welding**: A kind of resistance welding in which rollers are used instead of electrodes.

20 **Sheet metal screws**: Special screws used for joining sheet metal. Also called self-tapping because the screws tap their own threads in the drilled hole.

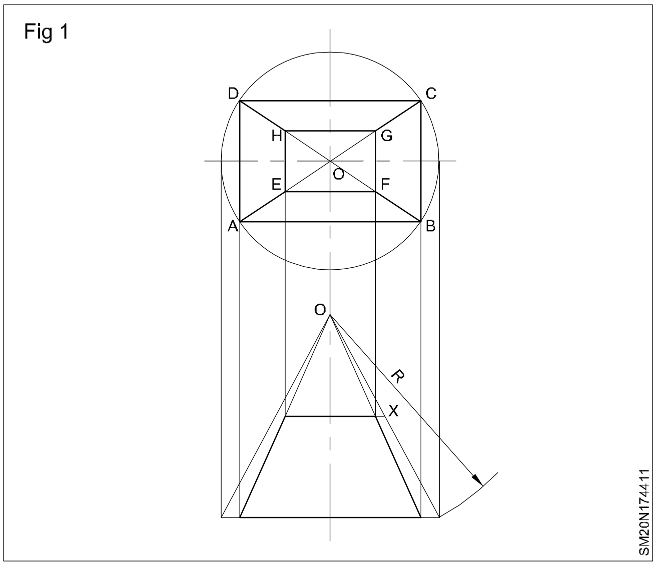
21 **Overlapping parts**: Resistance to electricity generates heat producing the weld.

Methods of developments

Objective: At the end of this lesson you shall be able to
- **develop the pattern layout for the frustum of a pyramid by radial line method.**

Refer Fig 1&2 for pattern layout development.

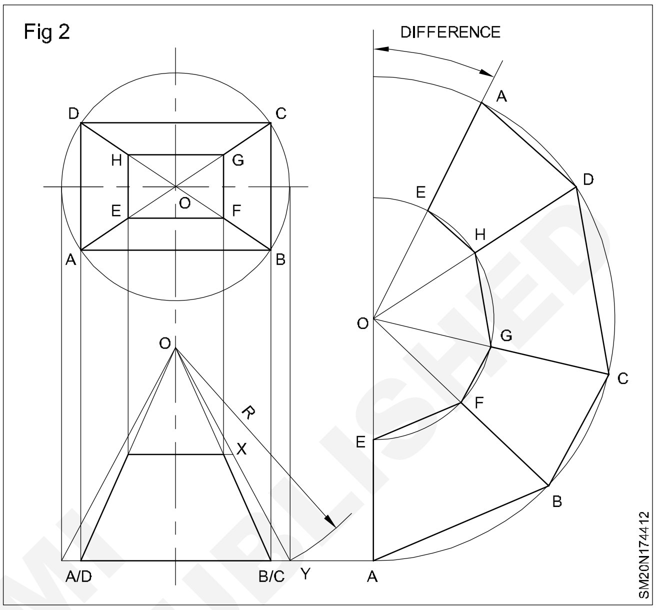
Fig 1



Draw a plan and elevation view of the frustum of a pyramid.

Draw a Semi-circle from a point 'O' to a radius of OX and OY shown in the Fig using a divider. Draw a straight line shown in DH. Mark lines DC, CB, BA and AD on the outer circle using a divider.

Fig 2



Mark lines of HG, GH, FE and EH on the inner Semi-circle using a divider.

Join all the points on the outer and Inner semi-circle using steel rule and a scriber shown in the pattern. DCBADHEFGHD is the pattern for a frustrum of the pyramid.

Round to elliptical transition

Objectives: At the end of this lesson you shall be able to
- **develop and layout the pattern for articles of different cross section**
- **arrange the triangles by different methods on warped surfaces to develop the pattern by triangulation method.**

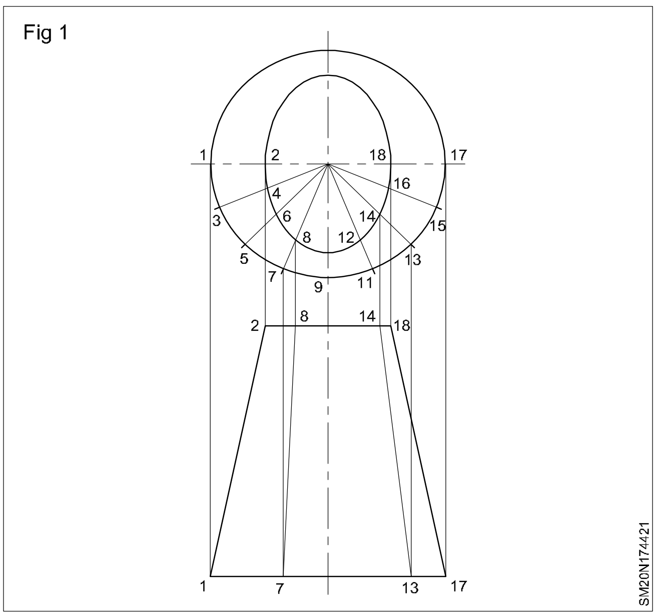
Fig 1 shows a conical form which is because of the change in opening shapes a warped surface. Such a shape is called warped cone. Figure 1 shows a transition from round to elliptical pipe.

The elements 1-2, 3-4, 5-6, 7-8, ... 13 to 14 etc all intersect the central axis of the cone. But each element intersect at a different point. Therefore the cone does not have a common apex and hence should be developed by triangulation method. The numbering procedure is shown in Fig 2. True length diagrams and pattern development are similar to that of previous skills.

Two true length diagrams are constructed one is for the slant length 1-2, 3-4, 5-6 etc and the other is for diagonal lengths. 2-3, 4-5, 6-7 etc. Such an arrangement is required in order to select them when they have all been constructed or to refer back to when checking.

The warped cone elements are spaced uniformly on the base circle but the spacing on the elliptical opening is not

Fig 1



uniform. Care should be taken to use the true spacings for each curve as taken from the plan view when developing the pattern layout.

Fig 2

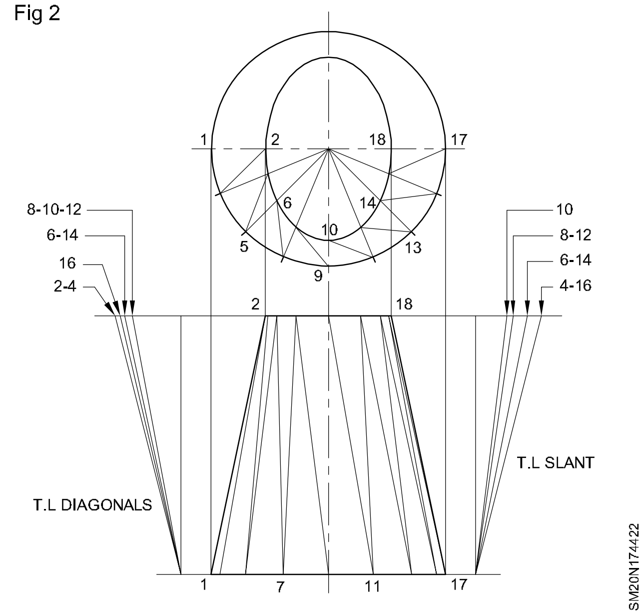
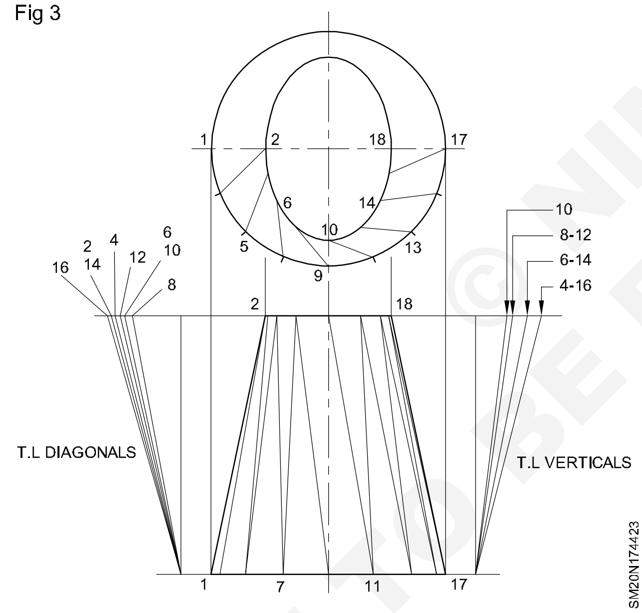
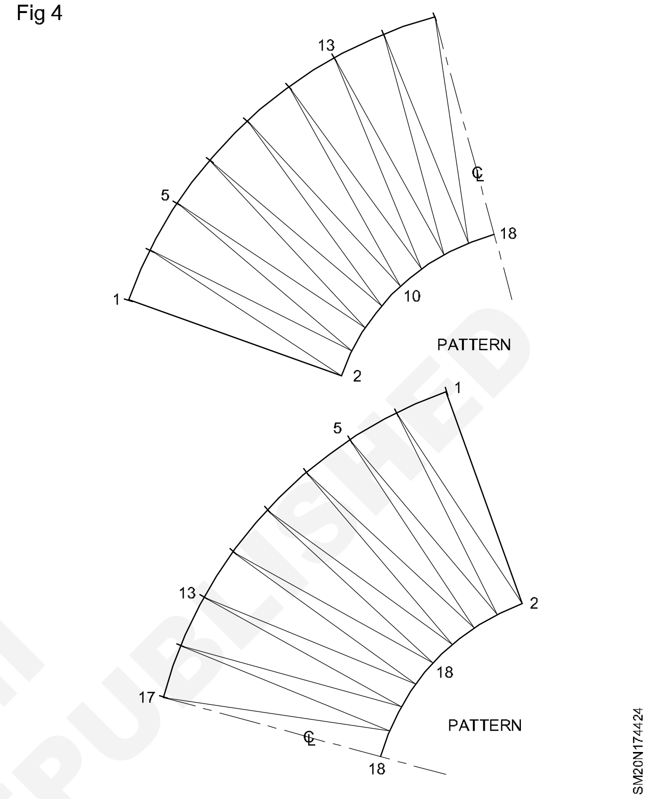


Fig 3



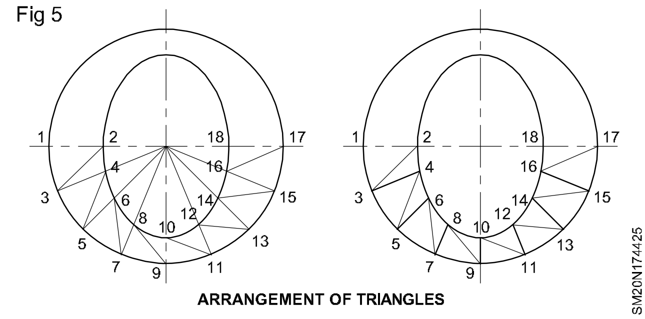
The more common arrangement of lines on the surface of the article is shown in Fig 3. In this example both the circular and the elliptical openings are equally spaced so as to provide the same number of spaces at each opening. This is a more convenient arrangement for pattern development as two compasses or bow instruments may be set separately for each spacing and the settings used repeatedly. Similar patterns are shown in Fig 4.

Fig 4



The pattern development shape will be the same by both methods. The only difference being that the arrangement of triangles on the warped conical surface are different. (Fig 5)

Fig 5



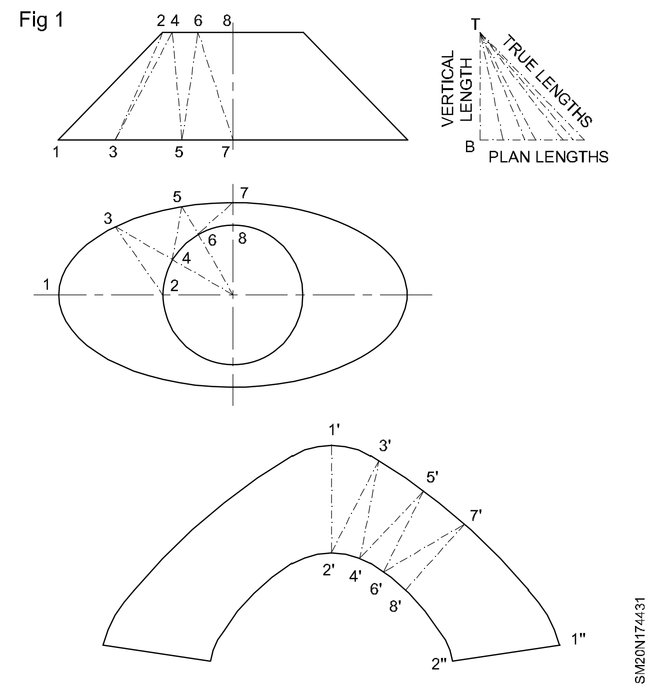
Oval to circle transformer

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

• **develop the pattern for oval to circle transformer by triangulation method.**

To develop the pattern for the oval to circle transformer, first draw the plan and elevation as shown of Fig 1. In the plan divide one quarter of the circle into three equal parts and also the corresponding quarter of the oval similarly. One quarter will be enough since the plan is symmetrical about both axes. Number the points from 1 to 8. A zig-zag line drawn between these points can divide that part of the surface to triangles. Project a line vertically in the elevation, and extend the base line along which to mark off the plan lengths.

Fig 1



For first triangle, take the plan length 1,2 and mark it off from B at right angles to the vertical height. Take the diagonal true length line and set off 1',2' in the pattern development. Next take the plan length 2,3 and mark it off at right angles to the vertical height. Take the true length of diagonal and from 2' in the pattern draw an arc through point 3'. Take 1,3 true length directly from the plan and from point 1' in the pattern describe an arc cutting the previous arc in point 3'. Join 1', 3' and 2',3'.

For the second triangle 3,4 length from plan can be taken and mark it off at right angles to the vertical height; take the diagonal true length and from point 3' in the pattern, draw an arc through point 4'. Then take the true length 2,4 direct from the plan and from point 2' in the pattern swing an arc cutting the previous arc in point 4'.

Join 3',4' and 2’4'. For the third triangle, repeat this procedure with plan lengths 3,5 and 4,5 and again for the fourth triangle with plan lengths 4,5 and 5,6. The removing two triangles which form the quarter pattern are similarly obtained from the plan lengths 5,7; 6,7 and 6,8; 7,8. The full pattern may be completed by repeating or duplicating this quarter in the type shown in figure. The examples at (b) and (c) are given as additional exercises for practice.

The Grouping of similarities: The art of pattern development is intimately associated with the craft of sheet metal work. Since accuracy is one of the essential conditions of modern production, the use of geometry to the solution of problems of pattern drafting is an economical method of ensuring success. The grouping of similarities is a valuable aid in bringing out the fundamental principles. Term “similarities” refers here to similarities of method of development only. In this first course of triangulation, the problems done are transformers which lie between two parallel planes. Upto this point have been those which transform from a square at one end to a another similar square placed diagonally at the other, and these were followed by the tall boy type, in which transforms from a square at one end to a circle at the other.

Fig 2

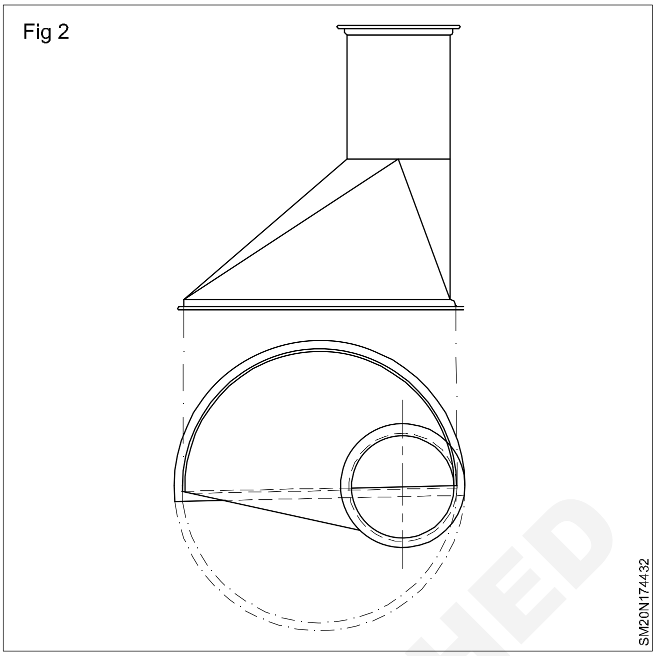
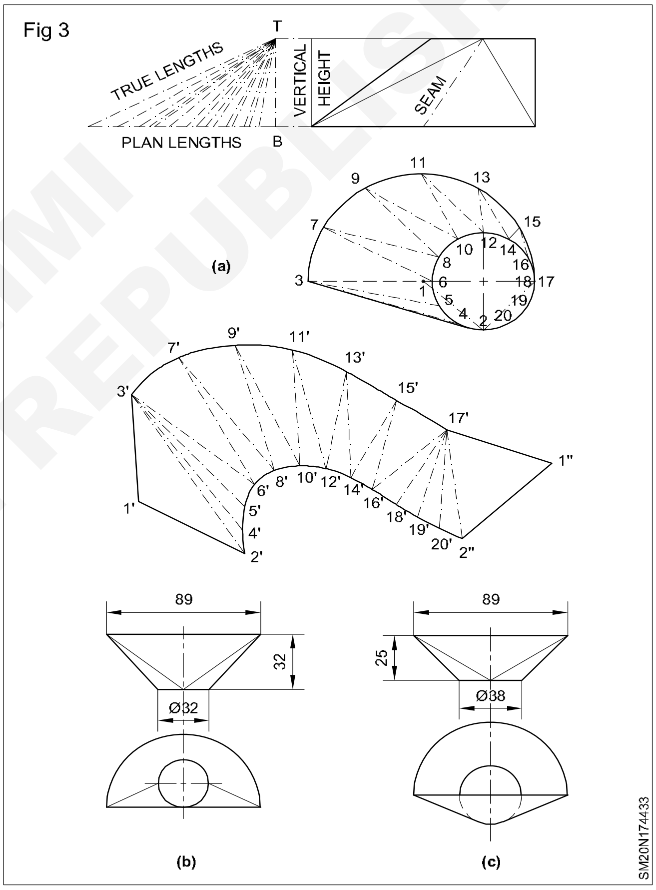


Fig 3



Those now follow in progressive order are such as transform from an oval or other curved outline at one end to a circle at the other, and those which transform from a semicircle at one end a a circle at the other, and those which transform from a combined rectangle and semi-circle to a circle at the other.

In practice, those problems find use in many forms of hoods and hoppers. The figure 1 shows, in elevation and plan, a connecting piece which fits at the base on one half of the top end of a round body, and transforms to a circular pipe above. The development of the pattern for this type is shown at Fig 3.

Stove - Chimney connection

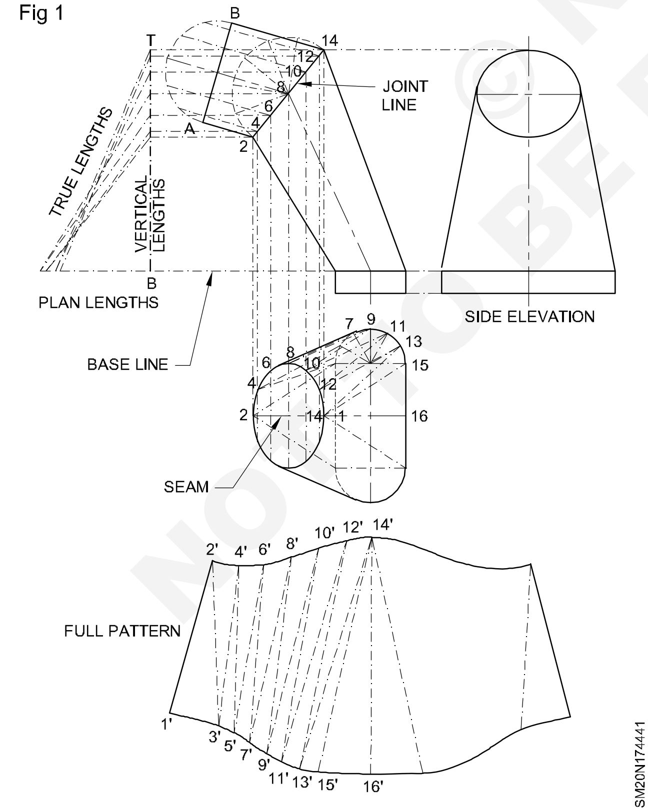
Objective : At the end of this lesson you shall be able to
- **develop the pattern for stove chimney connection by triangulation method.**

The outlets from gas and coke stoves often takes the shape of a rectangular stump with semi-circular ends. These outlets may be connected to circular chimneys or fuels. The connecting piece commonly of sheet metal, is a transformer from the one shape to the other.

The problem shown in Fig 1 is a typical of a chimney connections, from the stove in the cabin of a canal boat. As a rule the outlet stump is on the top of the stove, and the chimney, usually a short one, passes up through the roof or out through the cabin side. The latter case is shown in Fig 1, in which the short, horizontal piece at the top of the transformer is the end of the chimney is a cylindrical pipe inside the cabin.

The joint line 2,14 in the elevation is obtained by dividing the angle between the centre lines of the cylindrical pipe and the transforming piece. Since this cuts the cylindrical pipe at an angle, the exact shape at the joint is an ellipse. To get the true shape of this ellipse, describe a semi-circle on the cross section at AB, divide it into six equal parts and from the points on semi-circle project liens perpendicularly back to AB and on to the joint line. From the points obtained on the joint line, draw lines at right angles to it and cut them off equally in length to the corresponding distances between the line AB and the half circle. Points should thus be given through which to draw in the half

Fig 1



ellipse as shown above the joint line 2,14. The plan, omitting the cylindrical pipe, is that the merely transforming piece. The elliptical joint line also forms an ellipse in the plan, and is obtained by dropping vertical lines from the joint line 2,14 of the elevation to cut the centre line 2,14 in the plan and marking off distances above and below the centre line equal to those between the line AB and the semi-circle.

In preparing to develop the pattern, divide half of the plan into triangles as shown in the diagram, starting at the seam 1,2 on the shorter side of the transformer, and number the points in accordance with the prescribed method. It can be seen that the consecutive numbers pass alternately from bottom to top and top to bottom by forming the zig-zag line, which is clearly seen in the pattern. It is better to the number the points 2,4,6,8,10,12,14 along the joint line in the elevation to correspond with those points on the ellipse in the plan. Then erect a vertical height line BT and project all the points 2,4,6,8,10,12,14 to it horizontally.

For the first triangle in the pattern, take the plan length 1,2 and mark it off along the base line from point B. Then take the true length diagonal upto the point on the vertical height line with point 2 on the joint line. With this distance in the compasses mark off the line 1', 2' in any convenient position in the pattern. Then take the plan length 2,3 and mark it off from B along the base line. Take the true length diagonal, again upto the point level with 2, and from point 2' in the pattern, draw off an arc through point 3'. Now take true length 1,3 direct from the plan and from point 1' in the pattern describe an arc cutting the previous arc in point 3'. Join 1', 3' and 2',3'. For the second triangle take the plan length 3,4 and mark it off from B along the base line. Next take the true length diagonal this time upto the point on the vertical height line level with 4 on the joint line.

From point 3' in the pattern describe an arc through point 4'. Now, to complete this second triangle, the distance 2',4' in the pattern will be obtained from the division on the ellipse above joint line, since those distances are the true required spacings. Take the distance 2,4 from the ellipse and from point 2' in the pattern, draw an arc cutting the previous arc in point 4'. For the third triangle, take the plan length 4,5 and triangulate it against the vertical height. Take the true diagonal length up to the point level with 4, and from point 4' in the pattern describe an arc through point 5'. Next take the true distance 3,5 direct from the plan, and from point 3' in the pattern swing an arc cutting the previous arc in point 5'.

The remaining pattern should be easily followed from this point by picking carefully the correct plan lengths and true distances. It is better to observe before passing on that all those plan lengths which pass from top to bottom and bottom to top, such as 1,2,2,3,3,4,4,5 and so on will be triangulated against the vertical height.

All those plan lengths on the bottom edge, such as 1,3,3,4,5,7,7,9 and so on, should be used direct from the plan as they are true lengths already. All those spacings around the top edge such as 2,4,4,6,6,8,8,10 and so on shall be obtained from the true divisions on the ellipse above the joint line. Only half of the pattern is shown in the figure which is developed. As the pattern is symmetrical about the line 14',16' the other half is a repetition in the reverse order on the other side of that line.

Pattern development for square to rectangle transformer

Objective : At the end of this lesson you shall be able to
- **develop the pattern for square to rectangle transformer by triangulation method.**

Figure 1 shows the pattern development for square to rectangle transformer.

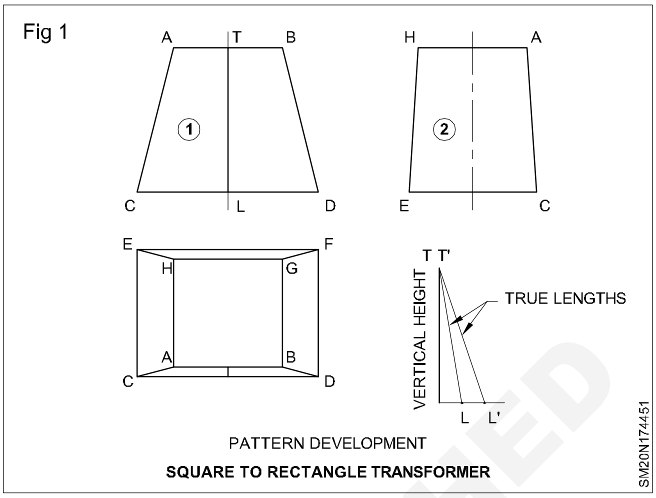
Method: Draw the plan and letter the points as shown.

Draw a vertical height line equal to the vertical height of the transformer.

Obtaining true lengths: To obtain true lengths from T down to L and T^1 to L^1 step off plan length TL with dividers and mark it off horizontally from the vertical height line. Mark this point L. Repeat this process using plan length T^1L^1 and mark the point L^1.

Pattern development: Draw a vertical centre line and take plan length TB. With centre on the vertical line swing arcs on both sides of the centre line.

Draw a horizontal line to join these arcs and mark points A,T and B. Take true length TL and step it off on the vertical centre line below point T. Mark this point L. Draw a horizontal line through point L. Take plan length LD or LC and with centre at point L swing arcs on both sides of the centre line. Mark points C,L and D.

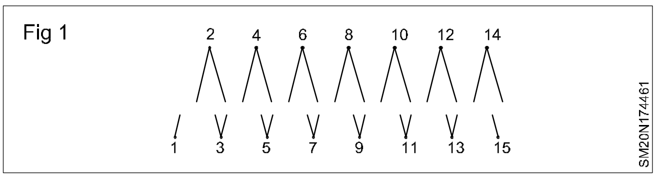


Join up points A to C and B to D. This gives the pattern for the part marked (1). This process is repeated for part marked (2) to obtain the patterns required. Since the sides opposite one another are identical, two off each of the patterns are required to complete the transformer.

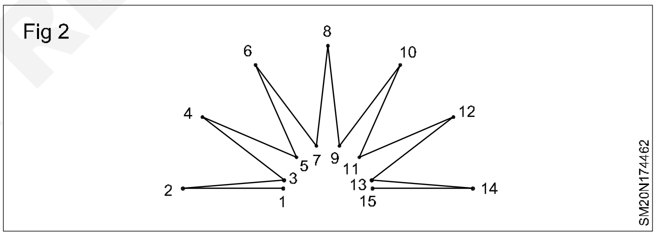
Method of numbering the points

Objective : At the end of this lesson you shall be able to
- **follow the suitable and easier method of numbering the points in pattern development by triangulation method.**

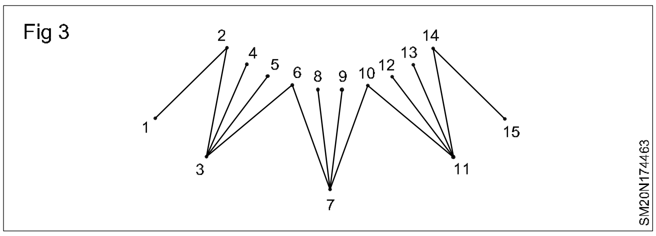
One of the best aids to clear development in triangulation is the good method of numbering the points of division in the plan, elevation and side view. Many methods are in use, but we prefer one in which the consecutive numbers 1,2,3,4... and so on, can be used right round the body from joint to joint in cases of triangulation methods. The arrangement of the lines forming the triangles makes a continuous zigzag line on the surface between the top and bottom edges of the body sides as shown in Fig 1. Examples of this type can be seen on square to square transformers. The zigzag line need not be regular in form as in Fig 2. The main point to observe is that beginning at the joint with 1 to 2, the consecutive numbers are placed alternately at top and bottom sides, similar to the zig zag line forming the triangle around the body. This is a simple method of numbering and has the advantage that of the job of development in the pattern be left for a time it can be picked up with confidence at the required spot where it is left off.



Square to round transformers introduce a little different on this arrangement, the principle shown at Fig 3. From this illustration it will be observed that the continuous zig zag line is formed by 1,2,3,6,7,10,11,14,15. But there are also other lines radiating from points 3,7 and 11 as 3,4 and 3,5.



The procedure in a case like this, is to start at 1 and follow up in zig zag form with 2,3 and 4. From point 4, there is no return to the base, other than back to 3. Retrace back to 3 and go to point 5. Again retrace back to 3, and proceed to point 6. It is now easy to get back to the base from 6 to 7. From point 7 the procedure is repeated as from point 3, but this time with 7,8; 7,9 and 7,10 and then back to 11. This is repeated again from point 11. It will be found that this numbering method can be followed in all cases, and will be of considerable advantage to deal with complicated problems.



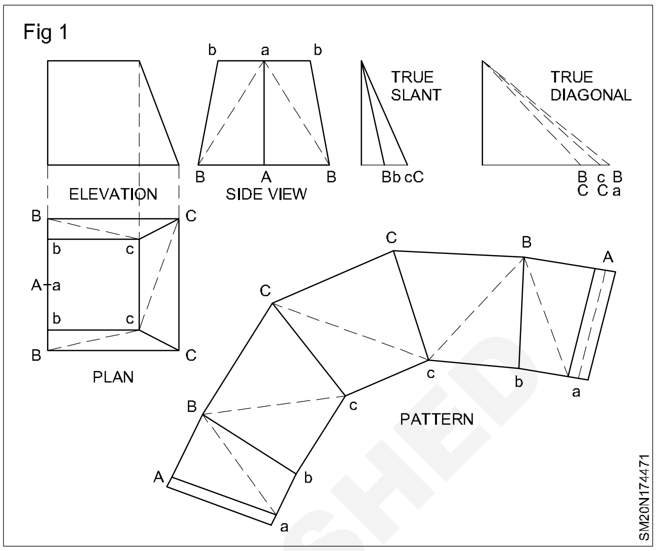
Square to square transformer with flat back

Objective : At the end of this lesson you shall be able to
- **develop the pattern for square to square transformer with flat back by triangulation method.**

Fig 1 shows pattern development for square to square transformer with flat back.

In the triangulation method the letters given in Elevation sideview can be used properly and in the next triangulation method events. The letters can be drawn as shown in the figure to the points starting from Aab, Bbc

Fig 1



The square-to-circle transformer

Objective : At the end of this lesson you shall be able to
- **develop the pattern for square to circle transformer by triangulation method.**

The common problem in sheet metal work, particularly in duct and pipe work, is that of the square-to-circle transformer, often called a tall boy. Its main object is to transform a square or rectangular pipe to a round pipe or to connect a round pipe to a square or rectangular hole, such as a centrifugal fan outlet. This type of transformer also takes the form of hoods over furnaces and hearths to collect the fumes which rise up through the pipe at the top. (Refer Fig 1 (a) and (b)). In common practice it is encountered in a variety of ways, almost much numerous to mention.

Fig 1

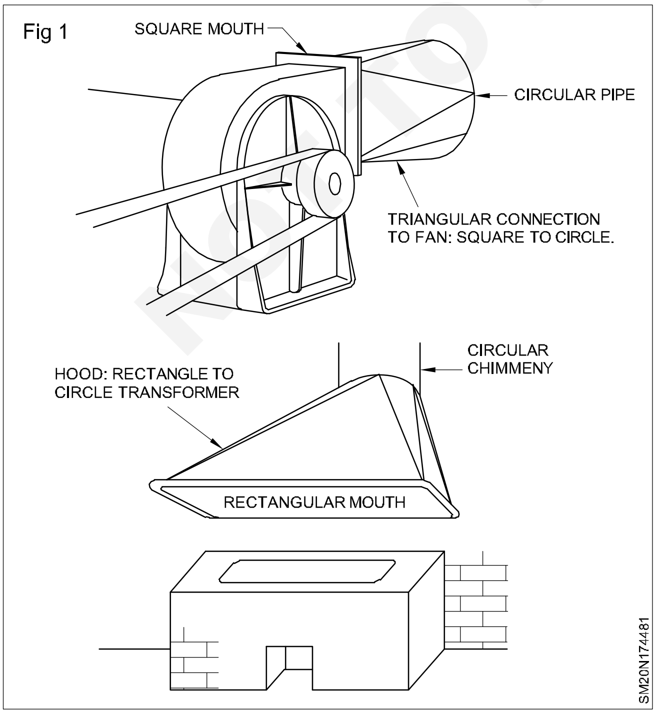
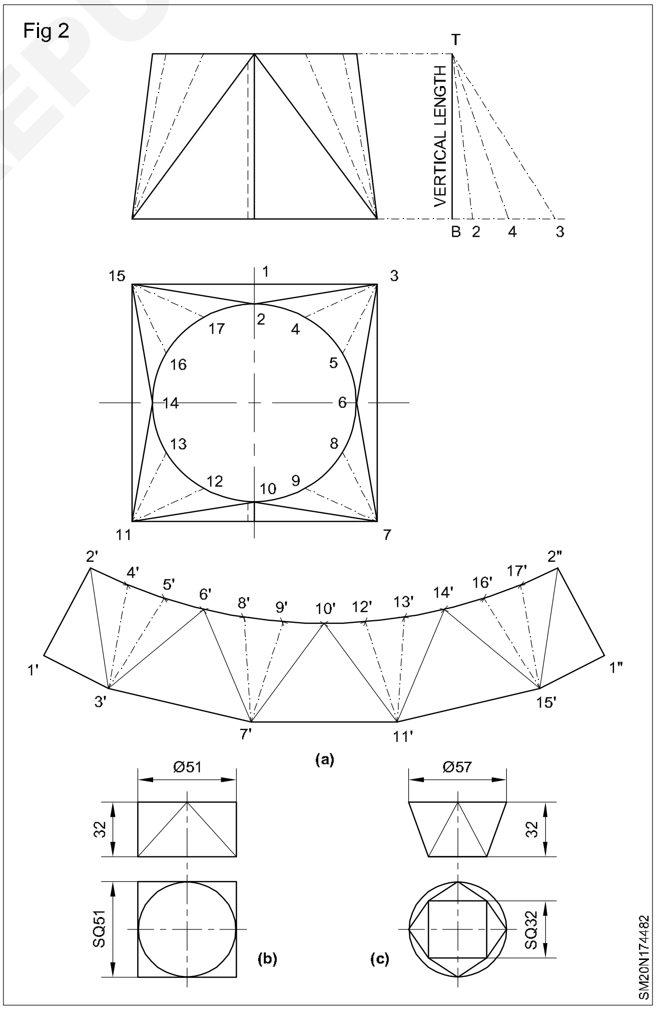


Fig 2



The simplest example of this type is such that as shown in Fig 2, in which the centre of the circle in the plan coincides with that of the square, and in which the width of the square is bigger than the diameter. The method of developing the pattern, is the same for every case, whether the circle is of the same size or larger than the square, or whether the circle is off-centre one way or both ways with that of the square.

For developing the pattern, divide the circle in the plan into twelve equal parts. Assuming the seam to be up in the middle of one side as at 1,2 Fig 2, give number to the points, beginning at the seam as shown at 1,2,3,4....,15,16,17, 1,2. From the elevation, project a vertical height line and extend the base line sufficiently to accommodate the longest plan length.

For the first triangle, take the plan length 1,2 by the help of compasses and mark it off from B along the base line at right angles to the vertical height. Take the true length diagonal from 2 to the top T of vertical height and set off 1^1 2^1, in the pattern. It can be seen that this first line in the pattern may be set off anywhere and in any position, and the rest of the pattern will follow accordingly. But a little care and foresight are usually needed to place the first line so that the pattern following up will not run off the sheet or the paper. Take 2,3 from the plan, mark it off from B along the base line at right angles to the vertical height. Take the true length diagonal from 3 to the top T and from point 2^1 in the pattern swing off an arc through point 3^1.

Next take the true distance 1,3 from the plan and from the point 1 in the pattern make an arc cutting the previous arc in point 3^1. Then join 2^1,3^1 and 1^1,3^1.

For the second triangle, take 3,4 from the plan, mark them off along the base line, take the true length diagonal and from point 3^1 in the pattern swing an arc through the point 4. Then take the true length 2,4 direct from the plan and from point 2^1 in the pattern make an arc cutting the previous arc in point 4^1. Then join 3^1,4^1.

For the third triangle, repeat this procedure with the plan lengths 3,5 and 4,5 and again for the fourth triangle with plan lengths 3,6 and 5,6. For the fifth triangle, repeat the process with plan lengths 6,7 and 3,7 but in this case the triangle is reverse in position. The remainder of the pattern should now be quite easy to follow, as it is a repetition of these processes right through. The line from 2' to 2" should be a curve and not a series of short straight lines.

Introduction to aluminium fabrication and its application

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

Aluminium fabrication is employed widely in fatories, manufacturing industries, construction of buildings etc.

The advantages of aluminium fabrication using various sections is, because it is light weight, resistant to corrosion and easy to process.

Aluminium fabrication using various sections are, frames, doors, windows, partitions, false ceiling, structure glazing, composite panel work etc. Various shapes of aluminium sections are manufactured by extrution method. These sections also provided with suitable ribs to withstand loads.

Aluminium fabrications are made by different operations like cutting, grinding, drilling, shaping, etc to fit to the specific need of the structure to be made.

Another important factor of using aluminium sections is, it is recyclable. The sections can be melted down and reprocessed in the extrusion process.

The above information is only a introduction about application of aluminium fabrication. In recent days wide applications are implemented and being used.

Ferrous Metal and Non- Ferrous Metal

Types of metals

The metals is of two types:

1 Ferrous metal 2 Non-ferrous metal

1 Ferrous metals : The metals that contains major part of iron and contain carbon sre called ferrous metals such as pig iron, mild steel, nickel etc., they have iron properties such as rusting, magnetisations etc.

2 Non-ferrous metals : The metals that do not contains iron or carbon and do not have the property of iron are called non-ferrous metals such as copper, aluminum etc.

Ferrous and Non ferrous alloys

Alloying metals and ferrous alloys

An alloy is formed by mixing two or more metals together by melting.

For ferrous metals and alloys, iron is the main constituent metal. Depending on the type and percentage of the alloying metal added, the property of the alloy steel will vary.

Metals commonly used for making alloy steels

Nickel (Ni)

This is a hard metal and is resistant to many types of corrosion rust.

It is used in industrial applications like nickel, cadmium batteries, boiler tubes, valves of internal combustion engines), engine spark plugs etc. The melting point of nickel is 1450°C. Nickel can be magnetised. In the manufacture of permanent magnets a special nickel steel alloy is used. Nickel is also used for electroplating. Invar steel contains about 36% nickel. It is tough and corrosion resistant. Precision instruments are made of Invar steel because it has the least coefficient of expansion.

Nickel-steel alloys are available containing nickel from 2% to 50%.

Chromium (Cr)

Chromium, when added to steel, improves the corrosion resistance, toughness and hardenability of steel. Chromium steels are available which may contain chromium up to 30%.

Chromium, nickel, tungsten and molybdenum are alloyed for making automobile components and cutting tools.

Chromium is also used for electroplating components. Cylinder liners are chrome-plated inside so as to have wear resistance properties. Stainless steel contains about 13% chromium. Chromium-nickel steel is used for bearings. Chrome-vanadium steel is used for making hand tools like spanners and wrenches.

Manganese (Mn)

Addition of manganese to steel increases hardness and strength but decreases the cooling rate.

Manganese steel can be used to harden the outer surface for providing a wear resisting surface with a tough core. Manganese steel containing about 14% manganese is used for making agricultural equipment like ploughs and blades.

Silicon (Si)

Addition of silicon for alloying with steel improves resistance to high temperature oxidation.

This also improves elasticity, and resistance against corrosion. Silicon alloyed steels are used in manufacturing springs and certain types of steel, due to its resistance to corrosion. Cast iron contains silicon about 2.5%. It helps in the formation of free graphite which promotes the machineability of cast iron.

Tungsten (W)

The melting temperature of tungsten is 3380° C. This can be drawn into thin wires.

Due to this reason it is used to make filaments of electric lamps.

Tungsten is used as an alloying metal for the production of high speed cutting tools. High speed steel is an alloy of 18% tungsten, 4% chromium and 1% vanadium.

Stellite is an alloy of 30% chromium, 20% tungsten, 1 to 4% carbon and the balance cobalt.

Vanadium (Va)

This improves the toughness of steel. Vanadium steel is used in the manufacture of gears, tools etc. Vanadium helps in providing a fine grain structure in tool steels.

Chrome-vanadium steel contains 0.5% to 1.5% chromium, 0.15% to 0.3% vanadium, 0.13% to 1.10% carbon.

This alloy has high tensile strength, elastic limit and ductility. It is used in the manufacture of springs, gears, shafts and drop forged components.

Vanadium high speed steel contains 0.70% carbon and about 10% vanadium. This is considered as a superior high speed steel.

Cobalt (Co)

The melting point of cobalt is 1495°C. This can retain magnetic properties and wear- resistance at very high temperatures. Cobalt is used in the manufacture of magnets, ball bearings, cutting tools etc. Cobalt high speed steel (sometimes known as super H.S.S.) contains about 5 to 8% cobalt. This has better hardness and wear resistance properties than the 18% tungsten H.S.S.

Molybdenum (Mo)

The melting point of molybdenum is 2620°C. This gives high resistance against softening when heated. Molybdenum high speed steel contains 6% of molybdenum, 6% tungsten, 4% chromium and 2% vanadium. This high speed steel is very tough and has good cutting ability.

Cadmium (cd)

The melting point of cadmium is 320°C. This is used for coating steel components.

Alloying Metals and Non Ferrous Alloys

Non-ferrous Metals And Alloys

Copper and its alloys

Metals without iron are called non-ferrous metals. Eg. Copper, Aluminium, Zinc, Lead and Tin.

Copper

This is extracted from its ores 'MALACHITE' which contains about 55% copper and 'PYRITES' which contains about 32% copper.

Properties

Reddish in colour. Copper is easily distinguishable because of its colour.

The structure when fractured is granular, but when forged or rolled it is fibrous.

It is very malleable and ductile and can be made into sheets or wires.

It is a good conductor of electricity. Copper is extensively used as electrical cables and parts of electrical apparatus which conduct electric current.

Copper is a good conductor of heat and also highly resistant to corrosion. For this reason it is used for boiler fire boxes, water heating apparatus, water pipes and vessels in brewery and chemical plants. Also used for making soldering iron.

The melting temperature of copper is 1083° C.

The tensile strength of copper can be increased by hammering or rolling.

Copper Alloys

Brass

It is an alloy of copper and zinc. For certain types of brass small quantities of tin or lead are added. The colour of brass depends on the percentage of the alloying elements. The colour is yellow or light yellow, or nearly white. It can be easily machined. Brass is also corrosion-resistant.

Brass is widely used for making motor car radiator core and water taps etc. It is also used in gas welding for hard soldering/brazing. The melting point of brass ranges from 880 to 930°C.

Brasses of different composition are made for various applications.

Bronze

Bronze is basically an alloy of copper and tin. Sometimes zinc is also added for achieving certain special properties. Its colour ranges from red to yellow. The melting point of bronze is about 1005°C. It is harder than brass. It can be easily machined with sharp tools. The chip produced is granular. Special bronze alloys are used as brazing rods.

Bronze of different compositions are available for various applications.

Lead and its alloys

Lead is a very commonly used non-ferrous metal and has a variety of industrial applications.

Lead is produced from its ore 'GALENA'. Lead is a heavy metal that is silvery in colour when molten. It is soft and malleable and has good resistance to corrosion. It is a good insulator against nuclear radiation. Lead is resistant to many acids like sulphuric acid and hydrochloric acid.

It is used in car batteries, in the preparation of solders etc. It is also used in the preparation of paints.

Lead Alloys

Babbit metal

Babbit metal is an alloy of lead, tin, copper and antimony. It is a soft, anti-friction alloy, often used as bearings.

An alloy of lead and tin is used as 'soft solder'.

Zinc and its alloys

Zinc is a commonly used metal for coating on steel to prevent corrosion. Examples are steel buckets, galvanized roofing sheets, etc.

Zinc is obtained from the ore-calamine or blende.

Its melting point is 420^o C.

It is brittle and softens on heating; it is also corrosion-resistant. Due to this reason it is used for battery containers and is coated on roofing sheets etc.

Galvanized iron sheets are coated with zinc.

Tin and tin alloys

Tin

Tin is produced from cassiterite or tinstone. It is silvery white in appearance, and the melting point is 231^o C. It is soft and highly corrosion-resistant.

It is mainly used as a coating on steel sheets for the production of food containers. It is also used with other metals, to form alloys.

Example: Tin with copper to form bronze. Tin with lead to form solder. Tin with copper, lead and antimony to form Babbit metal.

Aluminium

Aluminium is a non-ferrous metal which is extracted from 'BAUXITE'. Aluminium is white or whitish grey in colour. It has a melting point of 660^o C. Aluminium has high electrical and thermal conductivity. It is soft and ductile, and has low tensile strength. Aluminium is very widely used in aircraft industry and fabrication work because of its lightness. Its application in the electrical industry is also on the increase. It is also very much in use in household heating appliances.

Uses of copper and Alloy

III. Copper

The copper occurs in practically all important countries of the world. Its principal ores are cuprite Cu_2O, Copper glance Cu_2S, Copper phrites $CuFeS_2$, Malachite $CuCO_3$, $Cu(OH)_2$ and Azurite $2CuCo_3$, $Cu(OH)_2$

The approximate content of copper in the above principle ores is as follows.

Cuprite or red oxide of copper............................. 88%

Copper glance..80%

Copper phrites..35%

Malachite or green carbonate of copper................56%

Azurite or blue malachite....................................55%

Manufacture: The copper is manufactured by a laborious method and the treatment to be adopted largely depends on the quality of copper ores. Following is the general outline of the modern process of copper manufacture:

1 The ores, usually pyrites, are cleaned and crushed and they are then calcined in a reverberatory furnace.

2 The calcined ores are mixed with silica and a small quantity of coke. The mixture is then smelted in a blast furnace.

3 The melted metal is oxidized in the Bessemer converter. It gives blister copper.

4 The impurities contained in blister copper are removed by melting it in a reverberatory furnance in presence of air.

5 The slag is removed and pure copper to the extent of about 99.70 percent is obtained.

6 Very pure copper or 100 per cent copper is obtained by the process of electrolysis.

Properties: Following are the properties of copper

1 It becomes brittle just below its melting point.

2 It can be worked in hot or cold condition, but it cannot be welded.

3 It has a peculliar reddish brown colour.

4 It is a good conductor of heat and electrcity.

5 It is attacked by steam at white heat.

6 It is not attacked by dry air, but moist air gives a green coating to the copper surface.

7 It is not attacked by water at any temperature.

8 It is malleable, ductile and extremely soft.

9 It is melts at 1083ºC and its boiling point is 2300ºC.

10 Its specific gravity is 8.92.

Uses

The market forms of copper are ingots, sheets, tubes and wires. It is extensively used for making electric cables, alloys, household utensils, electroplating, lighting conductors, dowels in stone masonry, blocks for printing, etc. It is mainly used in the manufacture of alloys of which brass and bronze are important.

Copper alloys

These alloys are broadly divided into two categoires

1 Brasses

2 Bronzes

Brasses: The brass is an alloy of copper and zinc and minor percentages of other elements, except tin, may be added . This is the most widely used copper alloy. It is stronger than copper and is used in structural applications. It also possesses good corrosion resistance. It can be cast into moulds, drawn into wires, rolled into sheets and turned into tubes. Very often 1 to 3% of lead is added to brass for improving its machining properties.

Following are the common varieties of brass

i **Cartridge brass:** It consists of 70% copper and 30% zinc. It is ductile and it possesses high tensile strength. It is used for cartridges, tubes, springs, etc.

ii **Delta metal:** It contains 60% copper, 37% zinc and 3%

iron. Its resistance to corrosion is high. It may even be used in place of mild steel to resist corrosion.

iii **Low brass:** It contains 80% copper and 20% zinc. It is moderately strong and it is used for pump lines, ornamental metal work and musical instruments.

iv **Muntz metal or yellow metal:** It contains 60% copper and 40% zinc. It has high strength. It is used for casting, condenser tubes, etc. and is a very popular alloy for hot working processes.

v **Naval brass:** This is an exception to the general rule for brass. It contains about 1 per cent of tin. When one per cent tin is added to the muntz metal, it is called the naval brass and when it is added to the cartridge metal, it is called the admiralty metal . It is used for marine and engineering castings such as condenser tubes, pump parts, motor boat shafting, etc.

vi **Red brass or red metal:** It contains 85% copper and 15% zinc. It resists firmly the action of corrosion and is superior to copper for handling water. It is used for plumbing lines, electrical sockets, etc.

vii **White brass:** It contains 10% copper and 90% zinc. It is more or less similar to zinc except that addition of copper makes it hard and strong. It is used for ornamental work.

viii **Yellow brass :** It contains 65% copper and 35% zinc. Its specific gravity is 8.47. It is very strong and it is also known as the common high brass or standard brass. It is used for plumbing accessories, lamp fixtures, grillwork, screws, rivets, tubes, etc.

Bronzes: The bronze is an alloy of copper and tin and minor percentages of other elements, except zinc may be added.

Following are the common varieties of bronze

i **Bell metal :** It contains 82% copper and 18% tin It is hard and brittle. It possesses resonance. It is used for making bells.

ii **Gun metal:** It contains 88% copper, 10% of tin and 2% of zinc. It thus contains zinc and forms and exception to the general rule of bronze. It is tough, strong and hard. It resists the corrosion sea water. It is suitable for sound castings. It is used for bearings, bolts, nuts, bushings and for many items in naval construction and it is so called because this alloy was used for casting into cannons in the middle ages.

iii **Manganese bronze:** It contains 56 to 60 per cent copper and remaining is zinc. Following other elements are also added.

Manganese ....1% maximum

Aluminium....................................0.05% to 1%

Lead..0.40% to maximum

Iron..0.40% to 1%

This alloy resists corrosion by sea water and it is also not attacked by dilute acids. It is used for various ship fittings, shafts, axles, etc.

iv **Phosphor bronze:** It contains 89% copper 10% tin and 1% phosphorus. This alloy is hard and strong. It resists the corrosion by sea water.It is used for subaqueous construction and because of high endurance limit, it can also be used for springs, gears, bearings, etc.

v Speculum metal: It contains 67% copper and 33% tin. It is silvery in colour. It has a high reflective surface, when polished.

Magnesium alloys

These alloys are light and they can be easily worked. They are used to construct aeroplanes, chair frames, engine parts. etc. Following are two important magnesium alloys:

1 Dow metal

2 Electron metal.

1 **Dow metal:** It contains 4 to 12% aluminium, 0.1 to 0.4% manganese and the rest is magnesium.

2 **Electron metal:** It contains 4% zinc, small percentages of copper, iron and silicon and rest is magnesium.

Nickel alloys

Following are two important nickel alloys

1 Monel metal

2 Nickel silver

Monel metal

This nickely alloy contains about 65% nickel, 30% copper and 5% other metals like iron and manganese. It possesses great resistance to corrosive liquids, acids, etc. It retains its physical properties at considerable high temperatures. This alloy is available in different grades and each grade has specific uses. It is mainly used for making tanks in food, textile and chemical industries, valves, tubes, propeller shafts of ships, etc.

Nickel silver

This is also known as the german silver. It is a brass to which the nickel is added. Its usual composition is as follows:

Copper .... 50 to 80%

Zinc.................. 10 to 30%

Nickel .... 20 to 30%

This alloy is of silvery white colour and it offers great resistance to the atmospheric corrosion and organic acids. It is used for making scientific instruments, utensils, typewriter parts, musical instruments, automobile fittings, marine fittings, food-handling equipment, etc.

Elbow between round and conical pipe

Objective : This shall help you to
- **develop the pattern for elbow between round and conical pipe.**

To develop and layout the pattern for a conical and cylindrical elbow pipe.

Develop the pattern step by step 1 to 7 as shown in Fig 1

Fig 2

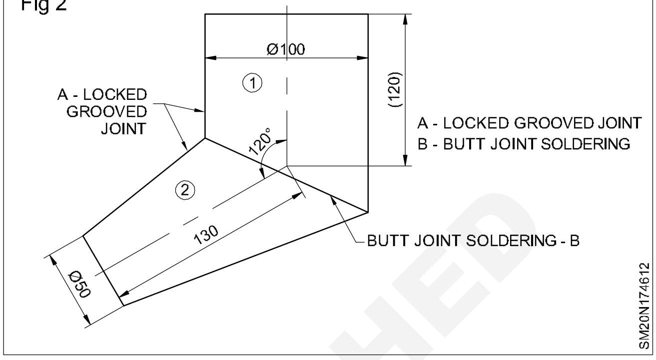
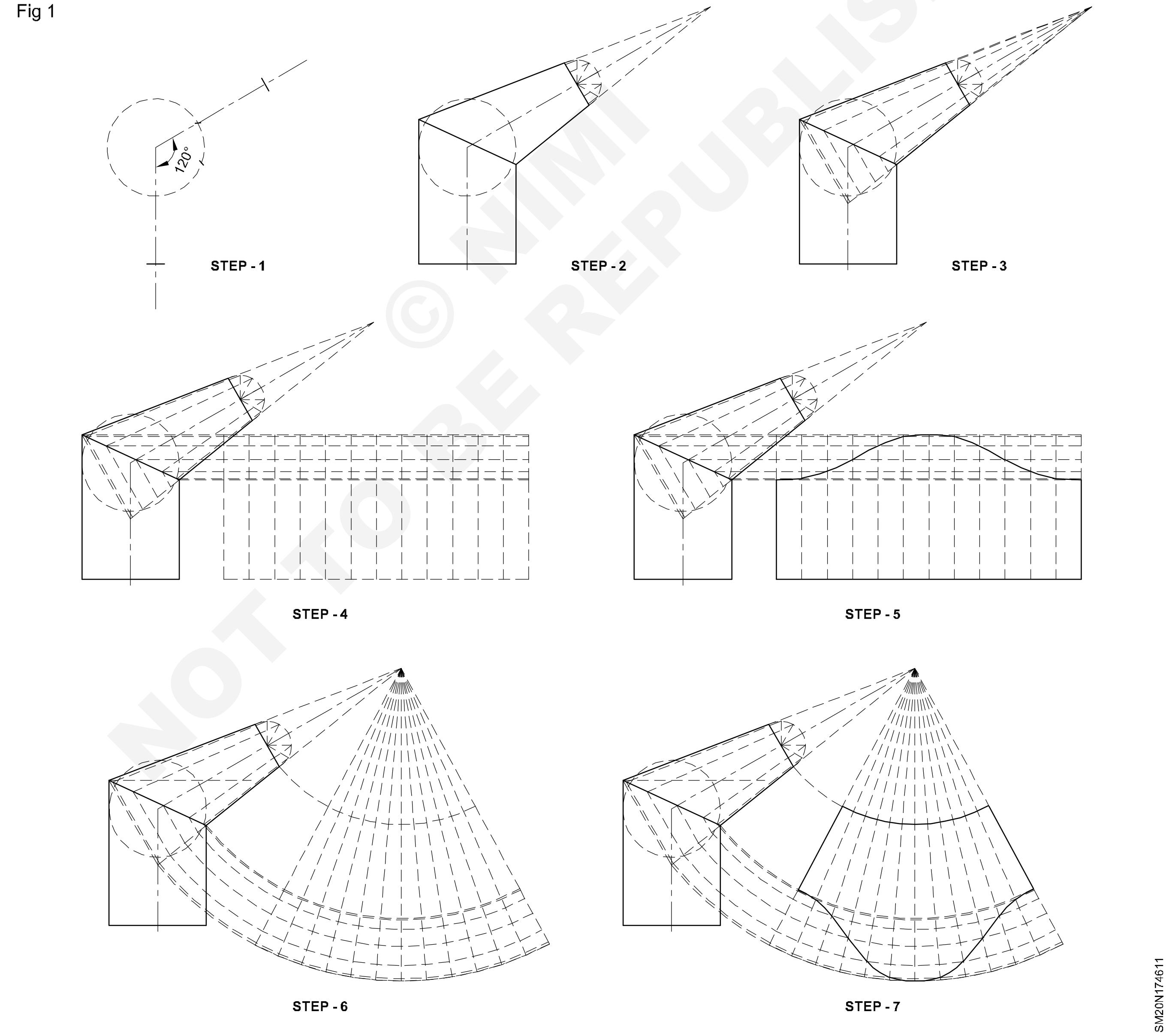


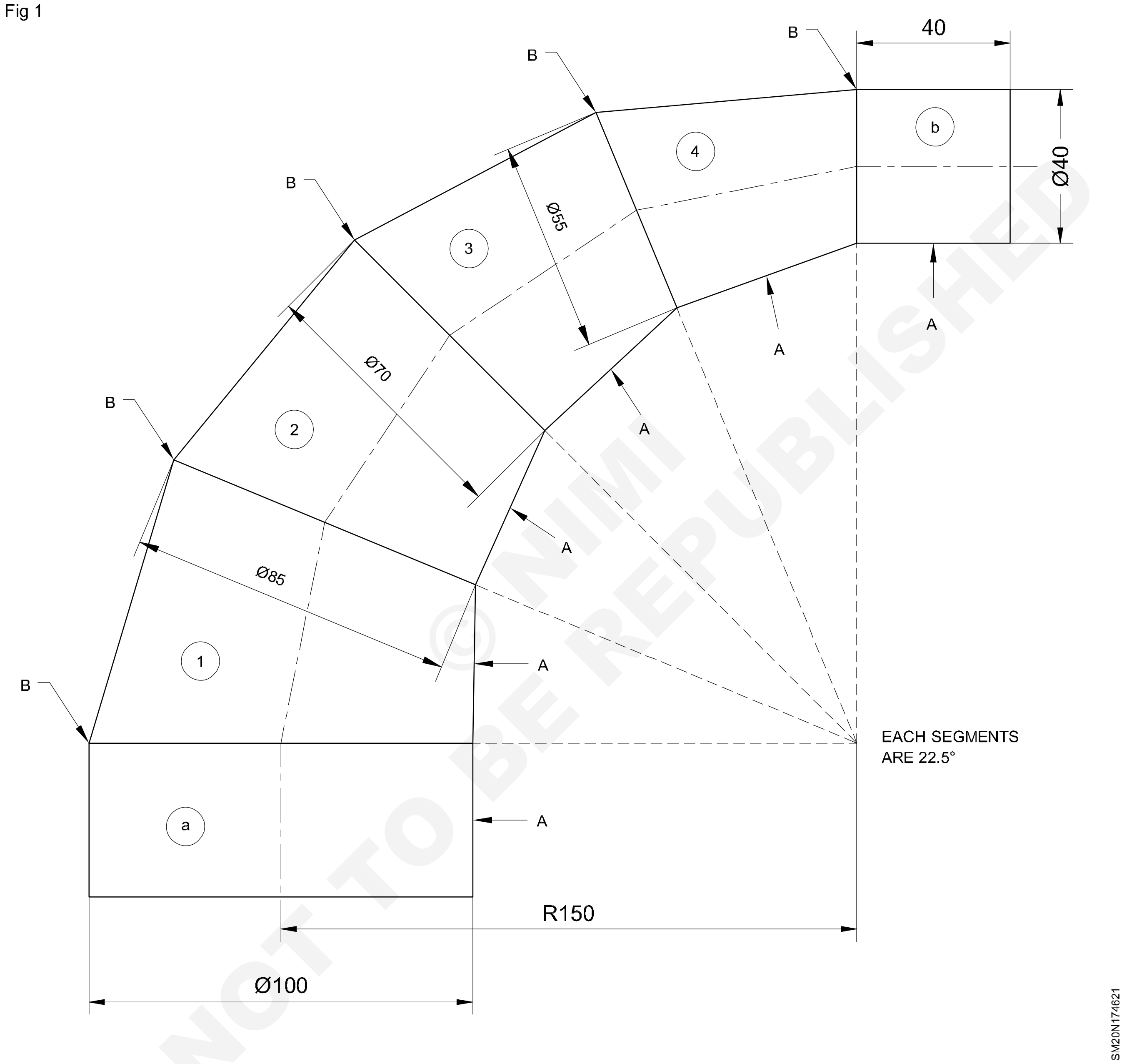
Fig 1



Make a tapered lobster back bend 90º from oblique cone

Objectives: At the end of this exercise you shall be able to
- **describe and layout the pattern for a tapered lobster back from the oblique cone in four segments by radial line development method**
- **form the segments of a tapered lobster back from oblique cone using funnel stake and wooden mallet and joining by locked grooved joint**
- **join all the segments with two cylindrical pipes by soft soldering.**

Fig 1



Job sequence

- Develop and layout the pattern for all four segments of tapered lobster back from oblique cone and end pipes **a** and **b** using radial line development method and cut.
- Form segments 1 to 4 using funnel stake and wooden mallet and end pipe a and b using round mandrel and wooden mallet as per drawing and join with locked grooved joint.
- First join segments 1 to 4 one by one by soldered butt joint and finally join pipe a and pipe b at their respective ends by soft soldering.
- Finish a tapered lobster back by smooth file, emery etc, if necessary.

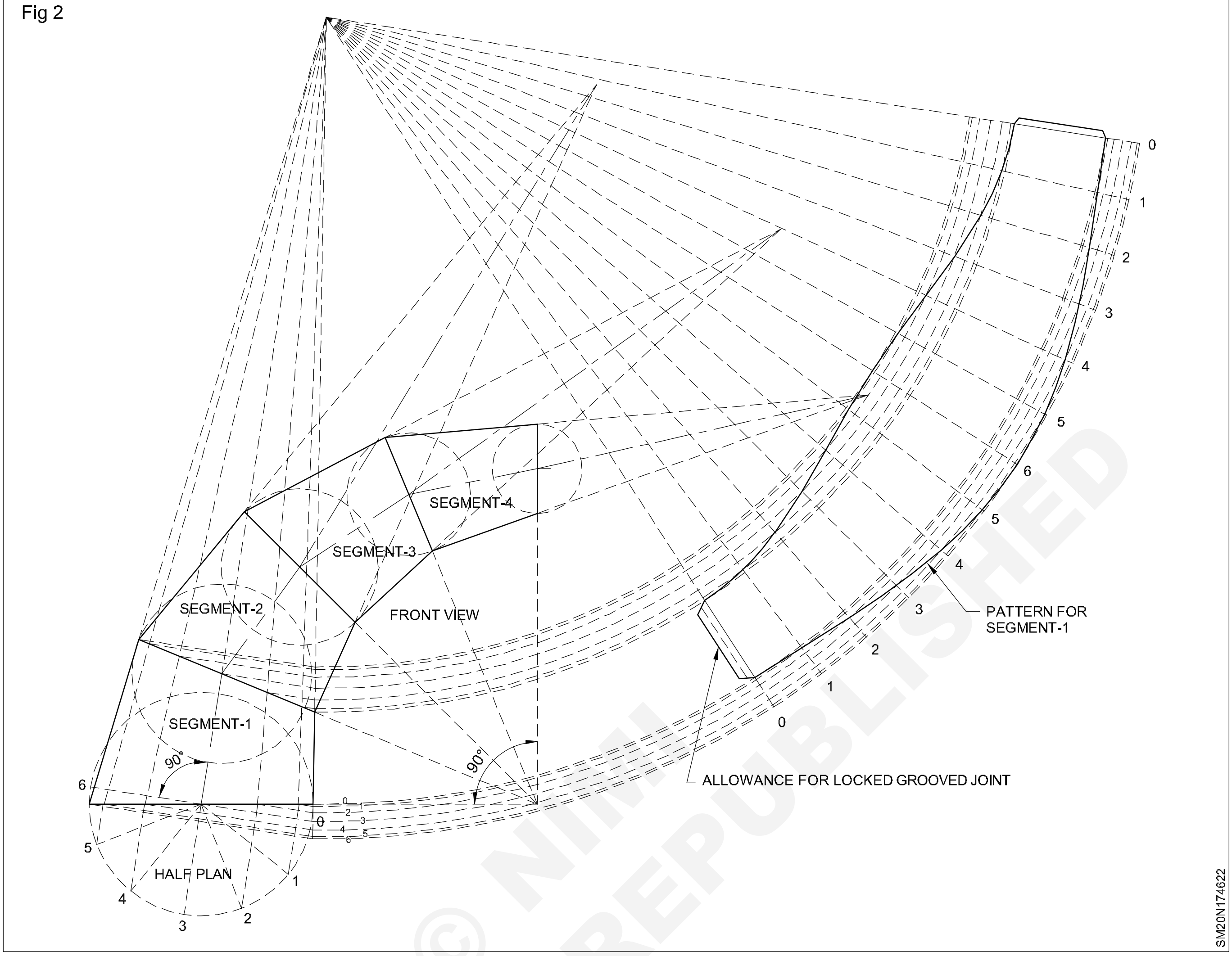

SEGMENT-4
SEGMENT-3
SEGMENT-2
FRONT VIEW
SEGMENT-1
90°
90°
HALF PLAN
0
1
2
3
4
5
6
PATTERN FOR SEGMENT-1
ALLOWANCE FOR LOCKED GROOVED JOINT
SM20N174622

Fig 2

Chemical and Physical Properties of Aluminium

Objective : This shall help you to
- properties and uses of Aluminium
- properties of aluminium and its alloys

I. Aluminiu

The aluminium occurs in abundance on the surface of earth. It is available in various forms such as oxides, sulphates, silicates, phosphates, etc. But it is commercially produced mainly from bauxite (Al_2O_3, $2H_2O$) which is hydrated oxide of aluminium.

Manufacture: The aluminium is extracted from bauxite ores as follows:

1 The bauxite is ground and then it is purified.
2 It is then dissolved in fused cryolite which is a double fluoride of aluminium and sodium, AlF_3, 3NaF,
3 This solution is then taken to an electric furnace and the aluminium is separated out by electrolysis.

Properties: Following are the properties of aluminium:

1 It is a very good conductor of heat and electricity.
2 It is a silvery white metal with bluish tinge and it exhibits bright lustre on a freshly broken surface.
3 It is a non-magnetic substance.
4 It is rarely attacked by nitric acid, organic acid or water. It is highly resistant to corrosion.
5 It is light in weight, malleable and ductile.
6 It is very soft.
7 It melts at 660ºC and its boiling point is 2056ºC
8 It possesses great toughness and tensile strength.
9 It readily dissolves in hydrochloric acid.
10 Its specific gravity is about 2.70

Uses of aluminium

This metal is chiefly used for making parts of aeroplane, cooking utensils, electric wires, window frames, glazing bars, corrugated sheets, structural members, foils, posts, panels, balustrades, bathroom fittings, precision surveying instruments, furniture, etc. Its other uses can be mentioned as follows:

1 It is used as a reducing agent in the manufacture of steel.
2 It is used for making aluminium alloys, automobile bodies, engine parts and surgical instruments.
3 It is used in the casting of steel.
4 It is used in the manufacture of electrical conductors.
5 It is used in the manufacture of paints in powder form.

Welding of aluminium and its alloys

Objective : This shall help you to
- properties of aluminium and its alloys

Properties of aluminium and its alloys

Silvery white in colour.

Weighs only about one third as much as the commonly used low carbon steel.

Highly resistant to corrosion.

Possesses great electrical and thermal conductivity.

Very ductile, adaptable for forming and pressing operations.

Non-magnetic.

Melting point of pure aluminium is 659°C

Aluminium oxide has a higher melting point (1930°C) than aluminium.

Types

Aluminium is classified into three main groups.

– Commercially pure aluminium
– Wrought alloys
– Aluminium cast alloys

Commercially pure aluminium has a purity of at least 99% the remaining 1% consisting of iron and silicon.

Aluminium

Aluminium that have wide usage in different industries like Pharmaceutical, Chemical, Food, Agriculture and many more. The salient features like durable finish standards, withstand high temperature and abrasion resistant are available in standard sizes.

Widely used in the following sectors:

1 Aircraft fittings
2 Fuse parts
3 Missile parts
4 Worm gears and keys
5 Aircraft
6 Aeroscope
7 Defense applications

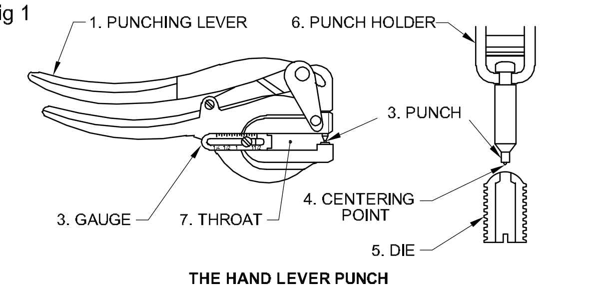
Aluminium sheet & plate aluminium in its various forms is stocked in a range of strengths varying utility sheet is used for all general sheet metal work sech as flashings, ductwork, lining walls etc. Also primarily for spinning and deep drawing operations such as utensils, ornaments, etc.

Hand punch machine

At the end of this lesson you shall be able to
- **state what is a hand lever punch**
- **state the constructional features and principal parts.**

Hand lever punch (Fig 1)

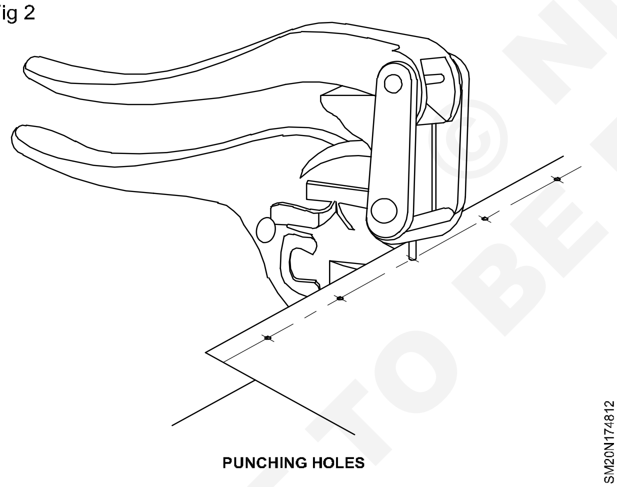
Fig 1



THE HAND LEVER PUNCH

It is used for punching small holes near the edges of thin sheets. (20 to 24 SWG) In this tool a die and a punch of the required hole size is fixed. Sheet is placed in between the punch and the die. The punch is forced by a lever by hand into the die to get the required sized hole. That is why it is called a hand lever punch. (Fig 2)

Fig 2



PUNCHING HOLES

PRINCIPLE PARTS

1 **Punching lever**

2 **The punch**

3 **The gauge:** It acts as a stopper and enables to punch

holes at equal distances. It can be adjusted to set the

distances from the edges of the sheet.

4 **Centering point:** It locates the centres of the holes.

The centering point is provided on the punch itself.

5 **Die:** It is threaded outside and a slot is provided at the bottom side to facilitate changing it, with the help of a screw driver.

6 **The punch holder:** It is provided with flanges which helps it to be fitted into the recess of the punch.

7 **Throat:** It governs the distance from the edge of the sheet to the hole to be punched.

Drilling machines (Portable types)

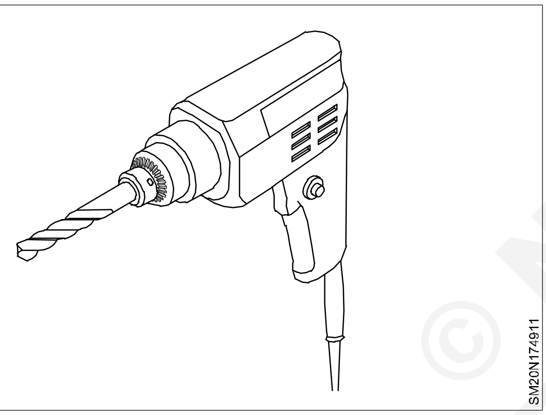
Objectives: At the end of this lesson you shall be able to
- **identify the different types of portable drilling machines**
- **state their distinctive features and uses.**

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

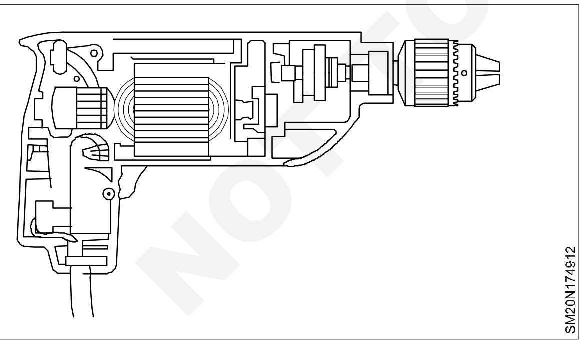
Electric hand drill (light duty) (Fig 1): These are available in different forms. The electric hand drill has a small electrical motor for driving the drill. On the end of the spindle, a drill chuck is mounted. Electric hand drills used for light duty will have, usually, a single speed.

Fig 1



Electric hand drill (heavy duty) (Figs 2 and 3): This drill has an additional feature; the drill speed can be varied through a system of gears. This is particularly useful for drilling larger diameter holes.

Fig 2



Pneumatic hand drill (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.

Fig 3

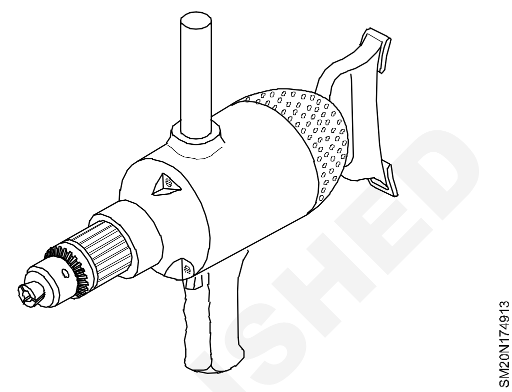


Fig 4

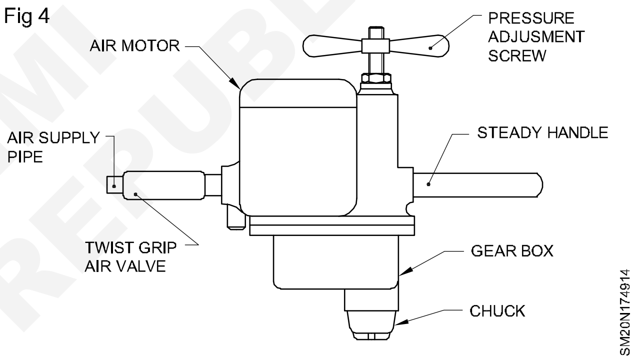
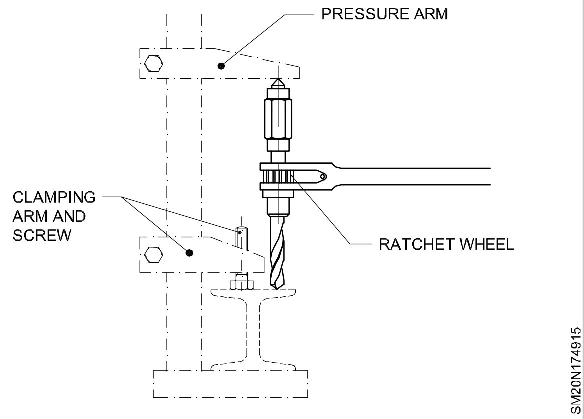
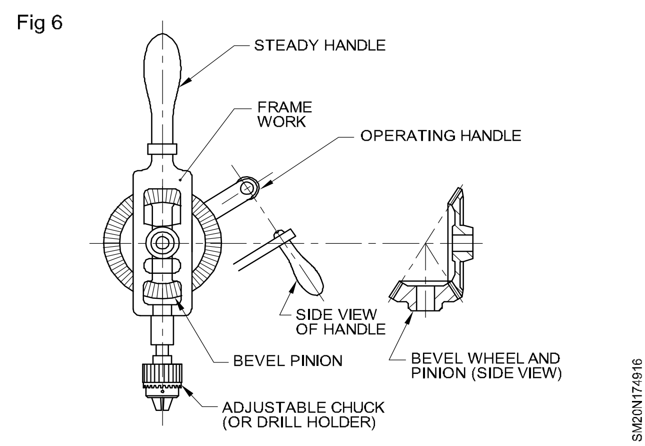


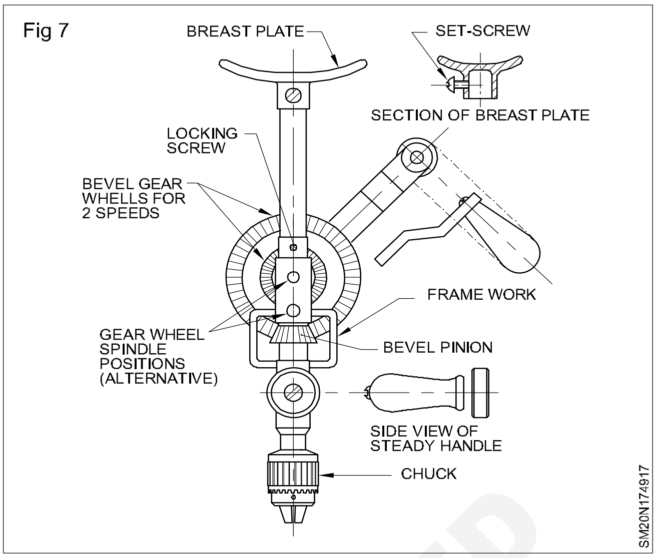
Fig 5



The bevel gear type drilling machine (Fig 6) is used for drilling small diameter holes upto 6 mm.

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.





Drilling machines

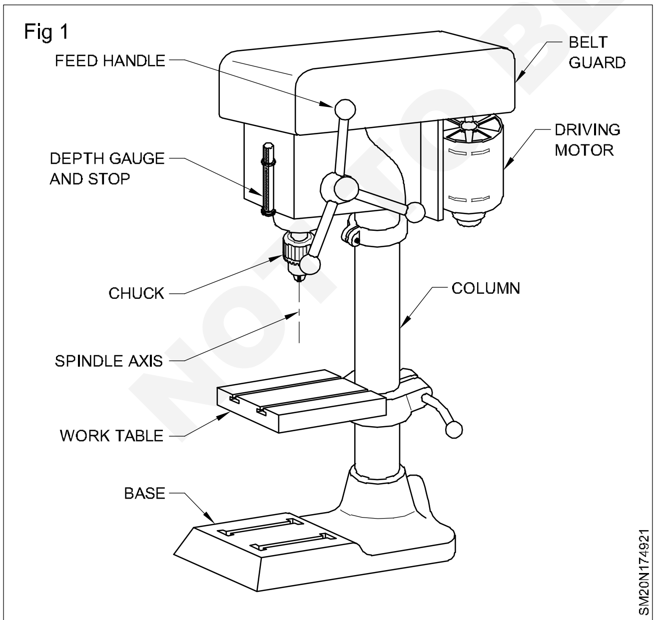
Objectives: At the end of this lesson you shall be able to
- **name the types of drilling machines**
- **identify the parts of bench type, pillar type drilling machines**
- **compare the features of bench type, pillar type and radial drilling machines.**

The principal types of the drilling machines are

– the sensitive bench drilling machine
– pillar type drilling machine
– the column drilling machine
– the radial arm drilling machine (radial drilling machine)

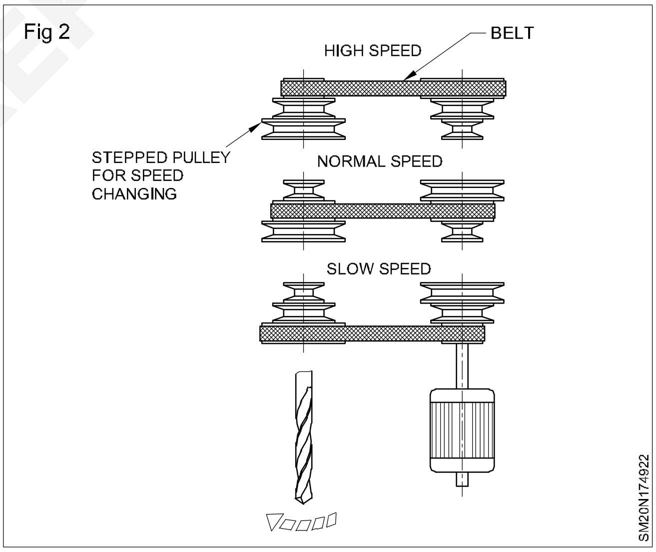
(You are not likely to use the column and radial types of drilling machines now. Therefore, only the sensitive and pillar type machines are explained here.)

Sensitive bench drilling machine (Fig 1) :



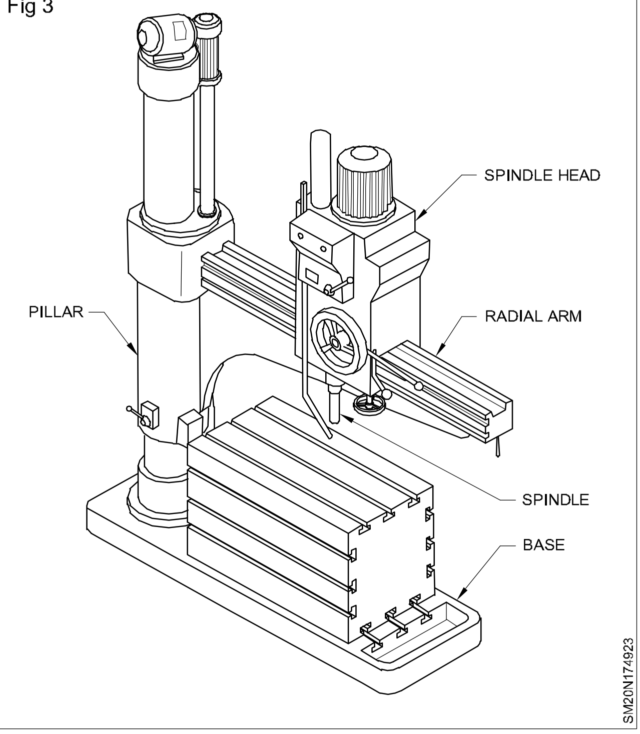
The simplest type of sensitive drilling machines is shown in the figure with its various parts marked. This is used for light duty work. This machine is capable of drilling holes up to 12.5 cm diameter. The drills are fitted in the chuck or directly in the tapered hole of the machine spindle. For normal drilling the work surface is kept horizontal. If the holes are to be drilled at any angle the table can be tilted.

Different spindle speeds are achieved by changing the belt position in the stepped pulley. (Fig 2)



Pillar type drilling machine : This is an enlarged version of the sensitive bench drilling machine. These drilling machines are mounted on the floor and driven by 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. (Fig 3)

Fig 3

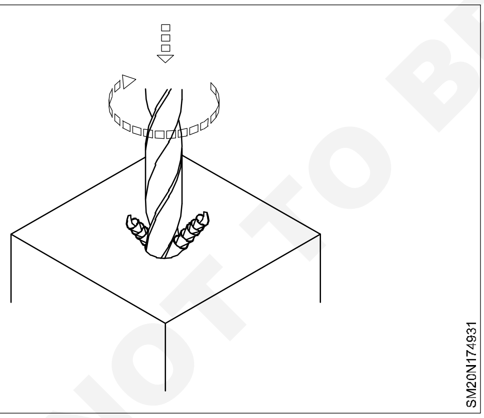


Drill (Parts and function)

Objectives: At the end of this lesson you shall be able to
- **state the function of drills**
- **identify the parts of a drill**
- **state the function of each part of the drill.**

Drilling is a process of making holes on workpieces. The tool used is drill. For drilling, the drill is rotated in clockwise direction with a downward pressure causing the tool to penetrate into the material. (Fig 1)

Fig 1



Parts of a drill

The various parts of a drill can be identified from the figure. (Fig 2)

Point: The cone shaped end which does the cutting is called the 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 the machine. (Fig 3) Shanks are of two types. Taper shank is used for larger diameter drills, and straight shank is used for smaller diameter drills.

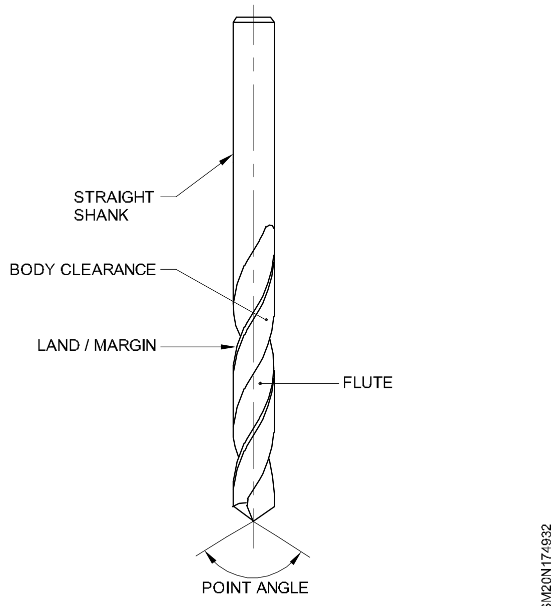
LIP : LIP is the cutting edge which penetrates into metal while drilling.

Tang: This is a part of the taper shank drill which fits into the slot of the drilling machine spindle.

Body: The portion between the point and the shank is the body of the 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 2



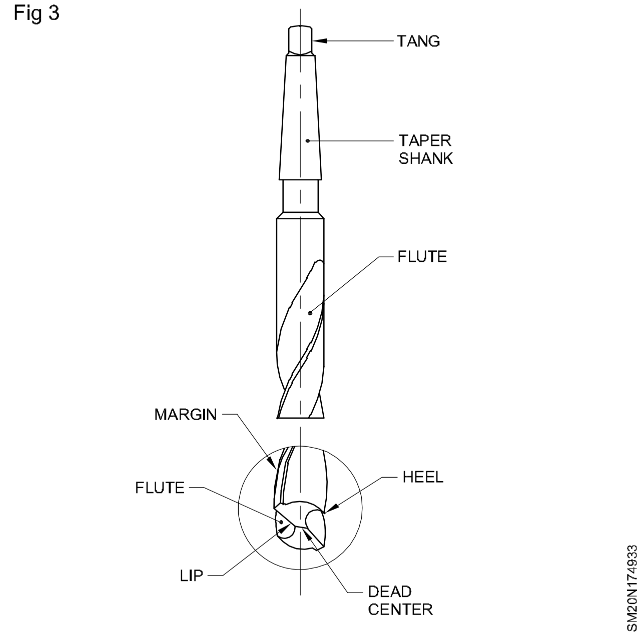


Fig 3

– to form the cutting edges
– to cut the chips and
– allow them 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 is measured across the land/margin.

Body clearance: Body clearance is the part of the body which is reduced in diameter to cut down the friction 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. (Fig 4)

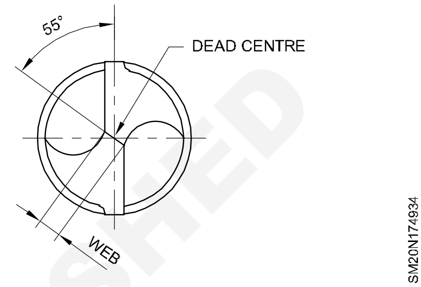


Fig 4

Drill angles

Objectives: At the end of this lesson you shall be able to
- **identify the various angles of a twist drill**
- **state the functions of each angle**
- **list the tool types for drill as per ISI**
- **distinguish the features of different types of drills**
- **designate drills as per BIS recommendations.**

Like all cutting tools the drills are provided with certain angles for efficiency in drilling.

Angles

There are different angles for different purposes. They are listed below.

Point angle, Helix angle, Rake angle, Clearance angle and Chisel edge angle.

Point angle/cutting angle : The point angle of a general purpose (standard) drill is 118^0. This is the angle between the cutting edges (lips). The angle varies according to the hardness of the material to be drilled. (Fig 1)

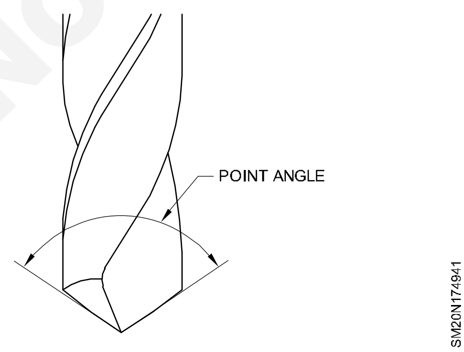


Fig 1

Helix angle : Twist drills are made with different helix angles. The helix angle determines the rake angle at the cutting edge of the twist drill. (Fig 2)

The helix angles vary according to the material being drilled. According to Indian Standard, three types of drills are used for drilling various materials.

Type N - for normal low carbon steel

Type H - for hard and tenacious materials

Type S - for soft and tough materials

The type of drill used for general purpose drilling work is type N.

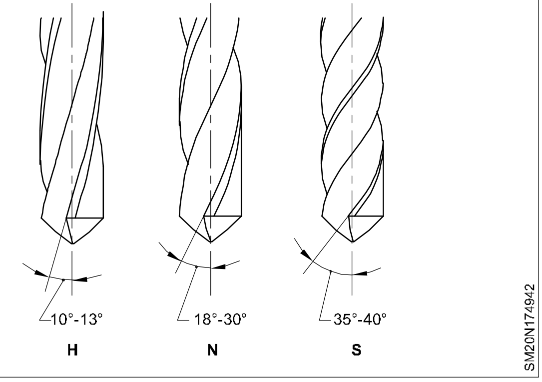
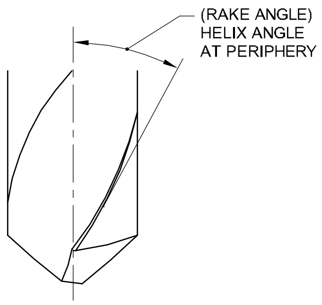


Fig 2

Rake angle is the angle of flute (Helix angle). (Fig 3)

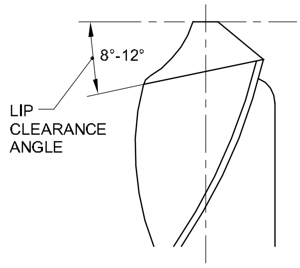
Fig 3



SM20N174943

Clearance angle : Clearance angle is to prevent the friction of the tool behind the cutting edge. This will help in the penetration of the cutting edges into the material. If the clearance angle is too much, the cutting edges will be weak, and if it is too small, the drill will not cut. (Fig 4)

Fig 4



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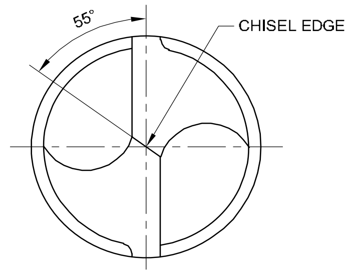
Chisel edge angle/web angle: This is the angle between the chisel edge and the cutting lip. (Fig 5)

Fig 5



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Designation of drills: Twist drills are designated by the

– diameter
– tool type
– material.

Example

A twist drill of 9.50 mm dia. of tool type 'H' for right hand cutting and made from HSS is designated as

Diameter of the drill

IS NO.

Twist drill 9.5-H-IS5101 - HS

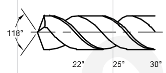
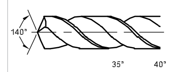
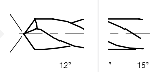
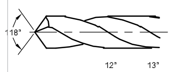
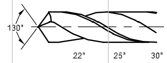
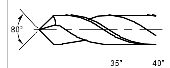
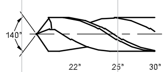
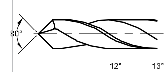
Tool Material

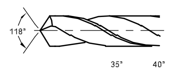
Tool type

If the tool type is not indicated in the designation, it should be taken as Type 'N' tool.

DRILLS FOR DIFFERENT MATERIALS

Recommended drills

Material to be drilled	Point angle	Helix angle d=3.2–5	5-10	10	Material to be drilled	Point angle	Helix angle d = 3.5 mm	5 mm
Steel and cast steel up to 70 kgf/mm^2 strength, Gray cast iron, Malleable cast iron, Brass, German silver, nickel					Copper (up to 30 mm drill diameter) Al-alloy, forming curly chips celluloid			
Brass, CuZn 40					Austenitic steels Magnesium alloys			
Steel and cast steel 70...120 kgf/mm^2					Moulded plastics (with thickness s>d)			
Stainless steel, Copper (drill diameter more than 30 mm), Al-alloy, forming short broken chips					Moulded plastics with thickness s<d laminated plastics (ebonite) Marble, slate, coal			

		Zinc alloys	

Drilling thin plates

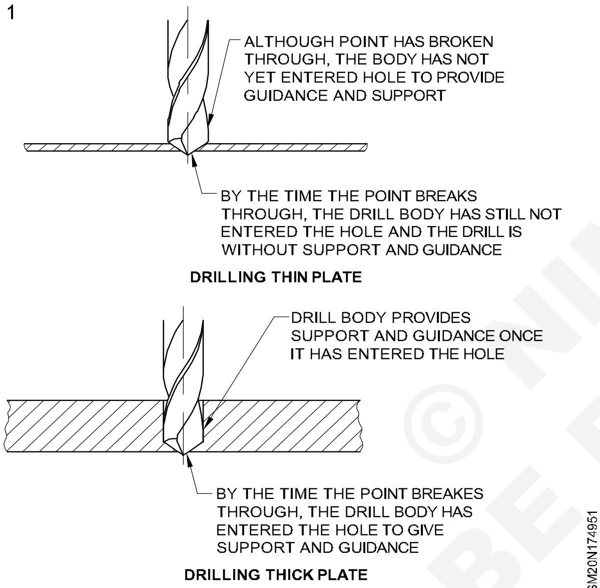
Objectives: At the end of this lesson you shall be able to
- **state the problems faced while drilling on thin sheets**
- **state the modification made on drill points for drilling thin sheets.**

Drilling holes on thin metals with the normal drill is difficult due to the following reasons.

The drill point will not have adequate material to support. (Fig 1a & b)

The drill point will break through the material and grabe before the periphery of the drill enters in the hole. (Fig 1b)

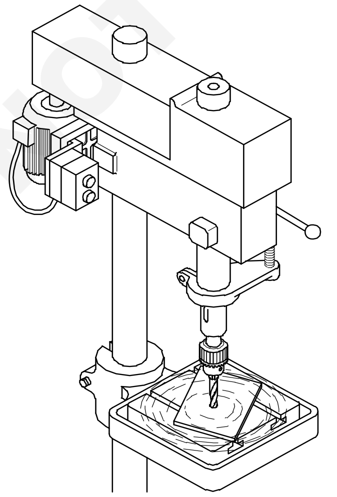
Fig 1



The holes drilled will be out of shape.

When the drill grabs, there is a tendency to spin round and this is very dangerous and unsafe. (Fig 2)

Fig 2

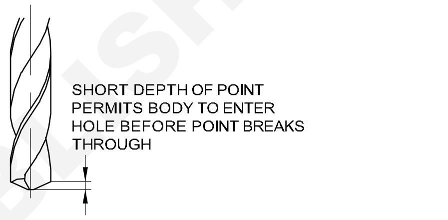


This can be overcome by re-sharpening the drill point as stated below.

Grinding the drill point with increased angle

This will reduce the length of the point and will permit the drill body to enter the metal before the point breaks through. (Fig 3)

Fig 3

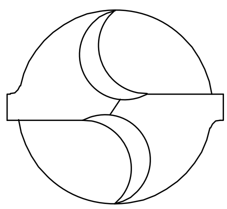


OBTUSE ANGLE DRILL POINT

Thinning the point of the drill to reduce the web thickness

This will improve the efficiency of the drill which has been ground with an increased cutting angle. (Fig 4)

Fig 4

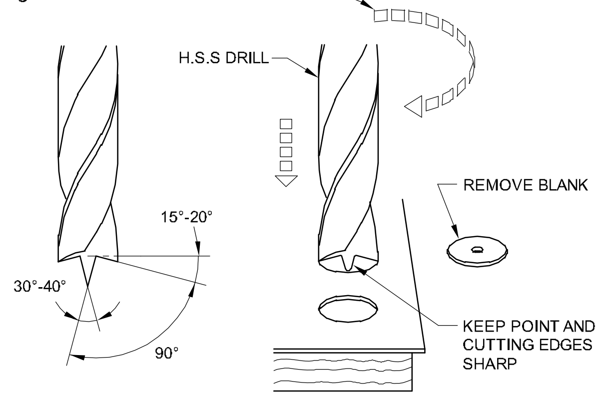


POINT THINNING TO REDUCE WEB AND INCREASE EFFICIENCY OF AN OBTUSE ANGLE DRILL

Grinding the end of a drill to form a 'W' shape

This method is not suitable for very small drills.(Fig 5)

Fig 5



DRILLING THIN METALL WITH A SHEETMETAL DRILL

This is sometimes called 'dead centre' drill. In this the centre point is slightly longer than the outer cutting edges. The hole cut will be clean and without any distortions. After cutting, a clean blank comes out.

For making bigger diameter holes on thin sheet metals trepanning types of tools are used.

Cutting speed and feed - RPM

Objectives : At the end of this lesson you shall be able to
- **define cutting speed.**
- **state the factors for determining the cutting speed**
- **differentiate between cutting speed and RPM**
- **determine RPM/spindle speed**
- **select RPM for drill sizes from tables.**

For a drill to give a satisfactory performance, it must operate at the correct cutting speed and feed.

Cutting speed is the speed at which the cutting edge passes over the material while cutting, and is expressed in metres per minute.

Cutting speed is also sometimes stated as surface speed or peripheral speed.

The selection of the recommended cutting speed for drilling depends on the materials to be drilled, and the tool material.

Tool manufacturers usually provide a table of cutting speeds required for different materials.

The recommended cutting speeds for different materials are given in the table. Based on the cutting speed recommended, the RPM, at which a drill has to be driven, is determined.

Materials being drilled with HSS drill	Cutting speed (m/min)
Aluminium	70 - 100
Brass	35 - 50
Bronze(phosphor)	20 - 35
Cast iron (grey)	25 - 40
Copper	35 - 45
Steel (medium	20 - 30
carbon/mild steel) Steel (alloy,high tensile)	5 - 8
Thermosetting plastic (low speed due to abrasive properties)	20 - 30

Calculating RPM

$$v = \frac{\pi \times d \times n}{1000} \text{ m / min.}$$

n - RPM

v - cutting speed in m/min.

d - diameter of the drill in mm

π = 3.14

Examples: Calculate the RPM for a high speed steel drill ϕ 24 to drill mild steel.

The cutting speed for MS is taken as 30 m/min. from the table.

$$n = \frac{1000 \times 30}{3.14 \times 24} = 398 \text{ RPM}$$

It is always preferable to set the spindle speed to the nearest available lower range. The selected spindle speed is300 RPM.

The RPM will differ according to the diameter of the drills. The cutting speed being the same, larger diameter drills will have lesser RPM and smaller diameter drills will have higher RPM.

The recommended cutting speeds are achieved only by actual experiments.

Feed in drilling

Objectives : At the end of this lesson you shall be able to
- **state what is meant by feed**
- **state the factors that contribute to an efficient feed.**

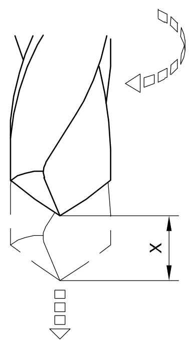
Feed is the distance (X) a drill advances into the work in one complete rotation. (Fig 1) Feed is expressed in hundredths of a millimeter.

Example - 0.040mm

The rate of feed is dependent upon a number of factors.

Finish required

Fig 1



Type of drill (drill material)

Material to be drilled

Factors like rigidity of the machine, holding of the workpiece and the drill, will also have to be considered while determining the feed rate. If these are not to the required standard, the feed rate will have to be decreased.

It is not possible to suggest a particular feed rate taking all the factors into account.

The table for the feed rate given here is based on the average feed values suggested by the different manufacturers of drills. (Table 1)

Table 1

Drill diameter (mm) H.S.S.	Rate of feed (mm/rev)
1.0 - 2.5	0.040 - 0.060
2.6 - 4.5	0.050 - 0.100
4.6 - 6.0	0.075 - 0.150
6.1 - 9.0	0.100 - 0.200
9.1 -12.0	0.150 - 0.250
12.1 - 15.0	0.200 - 0.300
15.1 - 18.0	0.230 - 0.330
18.1 - 21.0	0.260 - 0.360
21.1 - 25.0	0.280 - 0.380

Too coarse a feed may result in damage to the cutting edges or breakage of the drill. Too slow a rate of feed will not bring improvement in surface finish but may cause excessive wear of the tool point, and lead to chattering of the drill. For optimum results in the feed rate while drilling, it is necessary to ensure the drill cutting edges are sharp. Use the correct type of cutting fluid.

Cutting fluids (Coolants)

Objectives: At the end of this lesson you shall be able to
- **state the function of the cutting fluids**
- **compare the characteristics of soluble oil/synthetic oils and neat cutting oils**
- **state the method of mixing soluble oil**
- **state the applications of soluble oil, synthetic oil and neat cutting oil**
- **identify the common types of cutting fluids for different materials and applications.**

Cutting fluids (Coolants)

Cutting fluids play an important role in reducing the wear of cutting tools.

They help to carry away the heat generated during cutting operations flush away the chips from the cutting point maintain accurate dimensions produce good quality finish prevent corrosion operate machines on a high cutting speed and feed. Cutting fluids of different types are available, but only those commonly used are explained here.

Soluble oil

Soluble oil is the most popular variety of cutting fluid. Soluble oils of different types are available.

This is an emulsified oil, which, when mixed with water, is an excellent cutting fluid. Soluble oil is comparatively cheap, and can be used for a number of machining operations.

Soluble oil should be mixed correctly and the proportions of oil and water as recommended by the manufacturer should be strictly followed.

It may be noted that for preparing a stable emulsion, oil should always be added to the water and not vice versa. While mixing, it should be continuously stirred.

Indian Oil Corporation produces three types of soluble cutting oils,

SERVO CUT 'S', SERVO CUT XL and SERVO CUT CLEAR.

Servo cut 'S' oil when mixed with water, forms a milky emulsion. This oil has high cooling and lubricating properties. It is capable of minimizing tool-wear and improving the surface finish. This oil is recommended for a variety of cutting operations of ferrous and non-ferrous metals. It is used in a concentration of 5% for general machining operations, and for grinding, more dilute emulsions are prepared.

Servo cut XL is a superior quality soluble oil. This, when mixed with water, forms an opaque emulsion. This oil gives good performance in hard water.

Servo cut clear oil, when mixed with water and used, will give clear visibility during machining. This has excellent cooling and lubrication properties, and is capable of ensuring long tool life and improved surface finish.

Oil cutting fluids can cause metal cuttings to 'clog' in operations like fine grinding where fine particles of metal are removed. To overcome this, non-oily synthetic soluble cutting oils (chemical solutions) are used.

Difference between punch holes & drill holes

Objectives : At the end of this lesson you shall be able to
- **identify the different types of make holes**

Difference between punched hole and drilled hole.

Punched hole	Drilled hole
1. Punch is a hand tool to produce hole.	1. Drill bit as tool to produce hole.
2. Manually operated	2. Drills are operated in machine by power
3. Only thin sheets can be produced.	3. Thin and thick plates can be drilled
4. Solid and hollow punch are used	4. Various types like parallel and taper shank drills are used.
5. Hand lever punch also used.	5. Drills bits and used in various machines like lathe, milling, M/C centres etc.
6. Punch used in straight direction	6. Drilling operation performed in clock wise direction
7. Hand lever punch used to make holes near the edge of the thin sheets (20-24 SWG)	7. No limitation in plate thickness but depands on drill bit body length.
8. Tinner's hand punch used for punching holes upto 6mm dia.	8. Producing hole depand on drill cutting angle w.r.t material to be drilled.
9. Iron hand punch is heavy punch, which can be punched holes upto 12mm dia in thin sheets.	9. Radial drilling m/cs is used for bigger dia. holes.
10. Punched hole dia. accuraccy depands on punch size	10. Holes diameter depands on diameter of the drills and lip/web of drill bits.

Universal swaging machine

Objectives: At the end of this lesson you shall be able to
- **state what is the universal swaging machine**
- **state the different operations carried out on the universal swaging machine**
- **state the parts and function of the universal swaging machine**
- **state the care and maintenance of the universal swaging machine.**

Universal swaging machine is a very important machine in sheet metal working. It is used to perform various operations like turning, burring, beading, swaging, wiring, crimping, slitting, flanging etc.

These various operations are done by mounting relevant rollers suitable for particular operation. It is not necessary to have separate machine for each operation, hence it is called universal swaging machine.

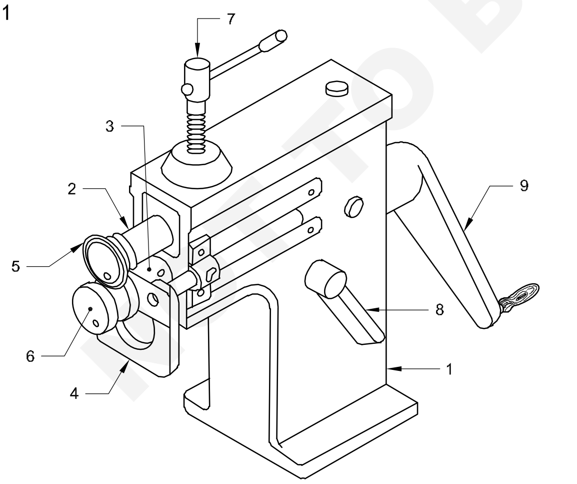
Parts of the universal swaging machine (Fig 1 & 2)

1 Body
2 Upper shaft with gear
3 Lower shaft with gear
4 Gauge plate with tightening screw
5 Set of rollers
6 Locking nut for rollers
7 Upper roller adjusting handle for tightening upper roller
8 Bottom roller adjusting handle
9 Operating handle

1 Body

Body is made of cast iron on which all other parts are mounted as shown in Fig 1.

Fig 1



UNIVERSAL SWAGING MACHINE (HAND OPERATED)

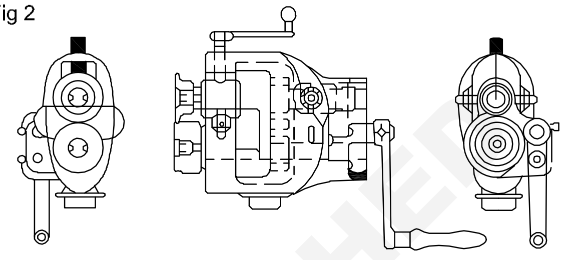
2 Upper shaft with gear

It is used to hold the upper roller on one end and a gear on the other end.

3 Lower shaft with gear

It is used to hold the bottom roller on one end and the

Fig 2



UNIVERSAL SWAGING MACHINE (HAND OPERATED)

gear on the another end. The top shaft gear and the bottom shaft gear are meshed.

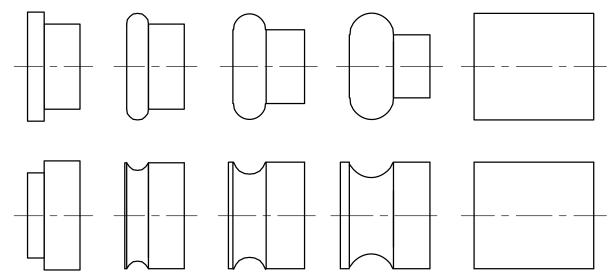
4 Gauge plate with tightening screw

It is used to set the width of the flange and to guide the disc or cylindrical body to get uniform flanging. (Turning up edge)

5 Set of rollers (Fig 3)

Rollers are available in sets of upper roller and bottom roller. For different operations, different set of rollers are used.

Fig 3



ASSORTMENT OF SETS OF ROLLERS

6 Locking nut for rollers

The rollers are fixed tightly using locking nut.

7 Upper roller adjusting handle

It is used to adjust the upper roller according to the pressure required to be applied while performing different operations.

8 Bottom roller adjusting handle

It is used to adjust the bottom roller in axial direction according to the requirements for different operations.

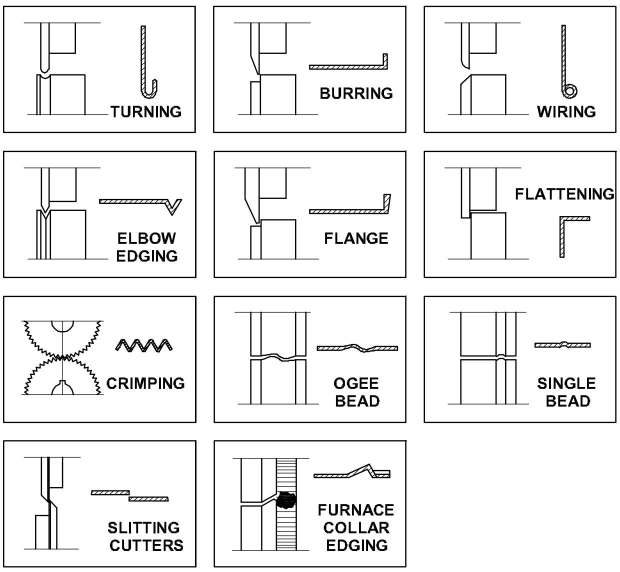
9 Operating handle

Handle is fixed on bottom shaft. By rotating handle, rollers are rotated.

Different operations carried out on the universal swaging machine

Various different operations are carried out on the universal swaging machine by changing the set of rollers. Fig 4 shows different operations that are carried out on the universal swaging machine. Those are

Fig 4

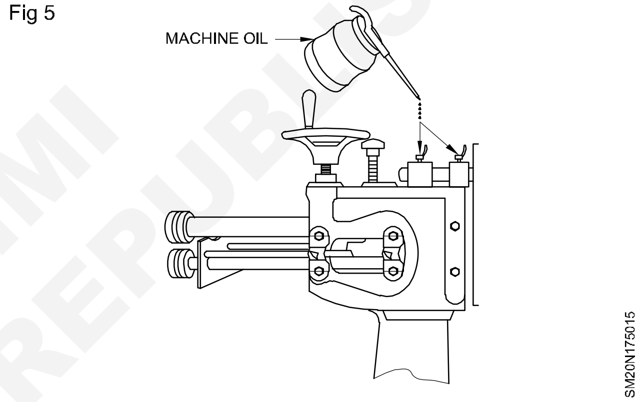


- Turning
- Burring
- Wiring
- Elbow edging
- Flanging
- Flattening
- Crimping
- Ogee beading
- Single beading
- Slitting
- Furnace collar edging

Safety, care and maintenance (Fig 5)

- Clean the rollers, gauge, and other parts using the rag.
- Lubricate all moving parts before starting the machine.
- Check the operating condition by rotating rollers with handle.
- Don't place your hand or finger near to the rollers, which may cause an accident.
- While using 'U' shaped metal guard to hold the workpiece, grip the metal guard properly, otherwise it may cause scratches or cuts on hands.

Fig 5



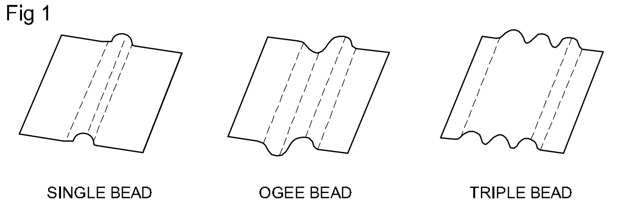
Beading machine

Objectives: At the end of this lesson you shall be able to
- **state what is beading**
- **explain important steps in carrying out beading operation on beading machine.**

In Sheet metal working, the operations like beading, swaging, crimping, corrugating, grooving etc can be performed on universal swaging machine by changing suitable rollers. Even though, there are specialised machines like crimping machine, beading machines are available.

Beading machines: Beads are formed on cylindrical sheet metal objects to serve as stiffeners, for reinforcement or ornamentation. The beading machine is equipped with special beading rolls which rotates on beading machine. The standard bead shapes are the single bead, ogee bead and triple bead as shown in Fig 1.

Fig 1



STANDARD TYPES OF BEADS.

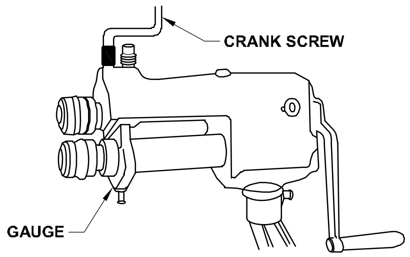
Hand operated bench mounted beading machine is shown in Fig 2. The power driven beading machine is shown in Fig 3. The two important steps in setting up and operating the beading machine.

1 First, set the gauge as already shown in Fig 2. The thumb screw on the bottom of the gauge must be tightened firmly so that it cannot slip when the bead is being formed.

2 The workpiece is inserted between the rolls up against the gauge and then the crankscrew on the top of the machine is tightened. Care should be taken not to set the crank screw too tight, because it may cause the rolls to cut through the bead.

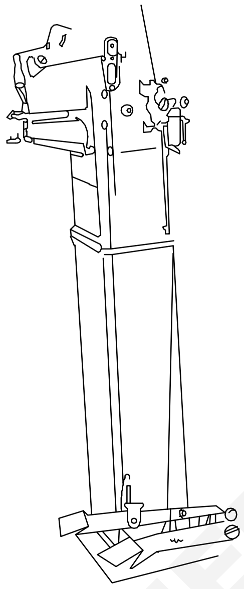
If a workpiece is to be both crimped and beaded it can be done at a time by using the combination machines.

Fig 2



HAND OPERATED BENCH MOUNTED BEADING MACHINE.

Fig 3



POWER DRIVEN

Fly press

Objectives: At the end of this lesson you shall be able to
- **describe the constructional features of a fly press**
- **state the working principle of a fly press**
- **list the types of fly presses generally used**
- **state the different operation that can be performed on a fly press, using different press tools.**

A fly press is also known as ball press. In the ball press a ball of metal is placed at one end of the fly aim. (Fig 1) The ram is worked in the frame by the operation of a screw rod, which is rotated by the operator by turning or swinging the operating handle or fly arm. Multistart Square threads are cut on the screw rod for better transmission of force and better strength. The bed is provided with 'T' slots to fix the die with the help of 'T' bolts. The ram slides in between two guides as in Fig 1. A locking screw is provided on the ram to fix the press tool. The press is made of cast iron and the frame in the form of 'C' hence it is called 'C' frame press.

Fly presses are specified according to the size of the screw rod. The pressure exerted is directly related to the screw rod diameter.

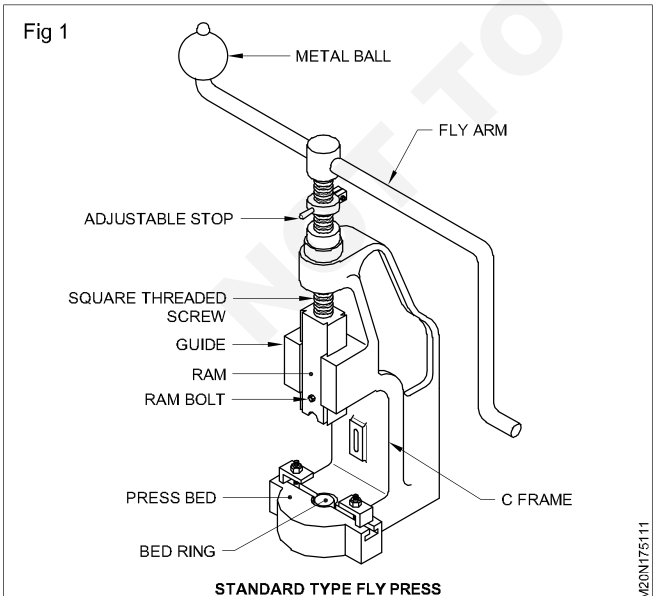
As a rough guide, the rating in tonnes of a fly press is twice the screw rod diameter. The force can be increased by fixing cast iron ball weights to the fly arms.

The fly press works on the principle of bolt and nut system. The rotary movement of the fly arm is converted into the reciprocating movement of the ram.

The commonly used fly presses in fabrication shops are

1 **Standard or 'C' frame press:** This is the most commonly used press in fabrication shoes. The main dimensions are the bed to guides, centre to back and the diameter of the screw rod. (Fig 1)

Fig 1

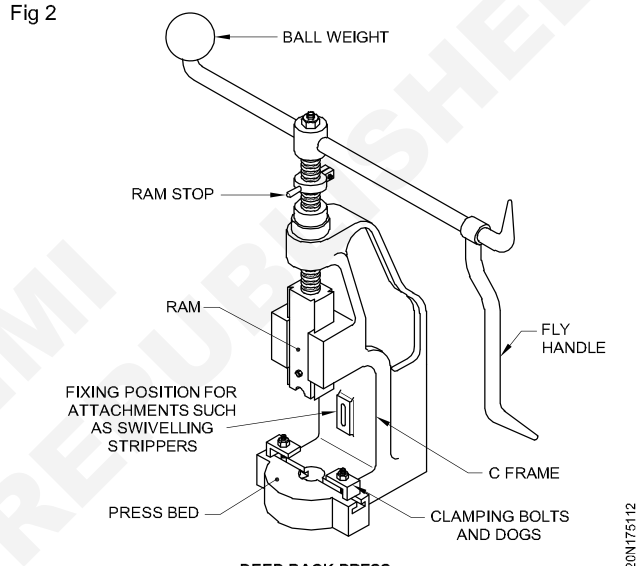


STANDARD TYPE FLY PRESS

2 **Tall type press:** These are available with the ranges of bed to guide dimensions. Maximum 360 mm. The movement of the screw rod will be more. (Stroke)

3 **Deep back press:** These presses have a range of centre to back dimensions which are greater than the standard presses, maximum about 310 mm. (Fig 2)

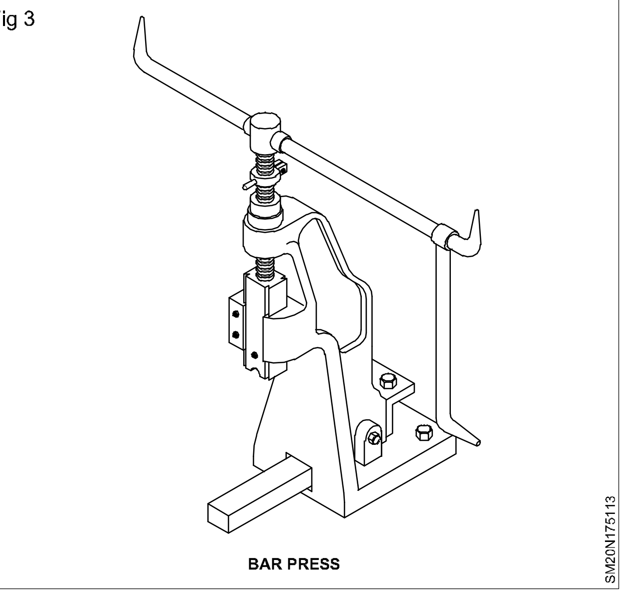
Fig 2



DEEP BACK PRESS

4 **Bar type press:** The solid bed is omitted and provision is made to fit a bar on which the work may be supported. Press operations on cylindrical components can be carried out on this press easily. (Fig 3)

Fig 3



BAR PRESS

Operations that can be performed on a fly press are blanking, piercing, punching, notching, forming, embossing, bending, flattening and embossing.

Safety, Care and Maintenance

Check that the ball of the fly arm is fixed firmly.

Always apply grease on the screw rod.

Apply oil to the guides.

Do not overtighten the ram screw.

Use correct size wrench to tighten the ram screw and the clamp bolts.

Concentrate on the job while working.

Do not operate the press without proper knowledge of it.

Always check the clamps and bolts before operating the press.

Keep your fingers away from the operating area of the tool.

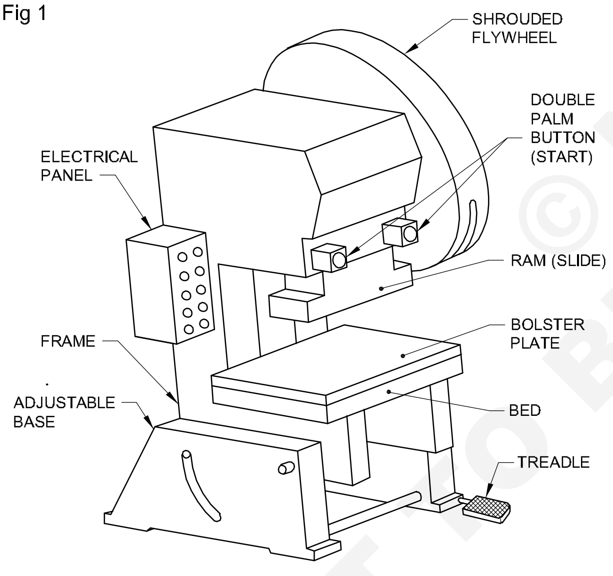
Observe and see that your co-workers are at a distance away from you when operating the fly arm.

Power press

Objectives: At the end of this lesson you shall be able to
- **state the constructional features of a power press**
- **identify the different types of power presses**
- **state and explain the different operations that can be performed on a power press**
- **state the safety precautions while working in a press shop.**

The constructional feature of a power press is almost similar to that of a fly press or hand press. (Fig 1) Except that the ram is driven by power. The power presses may be identified as Mechanical or Hydraulic, according to the type of working mechanism used to transmit power to the ram. In a mechanical press, the rotary motion got from an electric motor is converted into a reciprocating motion of the ram by using various mechanical devices. In a hydraulic press, the fluid under high pressure is pumped on to one side of the piston and then on to the other in a hydraulic cylinder to drive the reciprocating movement. The power presses are designated according to (1) The power source (2) Frame construction (3) Number of slides in action.

Fig 1



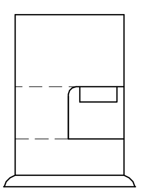
POWER PRESS

Types of presses

The different types of presses used in industries are

1 **Gap press (Fig 2):** This press has a gap like opening in the frame for feeding the sheet metal from one side of the press. The gap is shown by dotted lines.

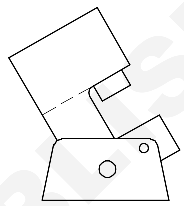
Fig 2



GAP PRESS

2 **Inclinable press (Fig 3):** This is the most common type of press used in industry. The advantage of using this press is its ability to be tilted back on its base, permitting the scrap or finished component to come out from the die by gravity without the help of any type of handling mechanism. This press is not as rigid as the gap press due to its construction.

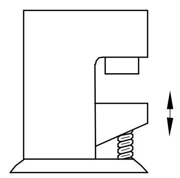
Fig 3



INCLINED PRESS

3 **Adjustable bed press (Fig 4):** This press has the mechanical arrangement for raising or lowering the bolster plate. This helps in setting of different sizes of work and press tools on the machine. This press is also not as rigid as the other presses due to the table mechanism arrangement.

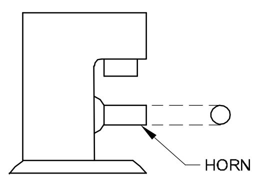
Fig 4



ADJUSTABLE BED PRESS

4 **Horn bar press (Fig 5):** The horn bar press has a cylindrical horn like projection from the machine frame. This is the bolster plate of the machine. The horns may be inter changed for different size of work. This press is used to carry out press operations on cylindrical components.

Fig 5

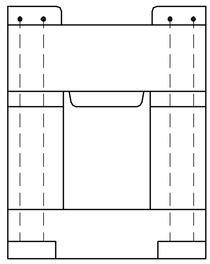


HORN PRESS

5 **Straight slide press (Fig 6):** The straight slide press has two vertical rigid frames, mounted on both sides of the base which are intended for absorbing severe load exerted by the slide or ram. This machine is most

suitable for heavy work. The sheet metal has to be fed into the machine only from the front side due to the presence of the side frames.

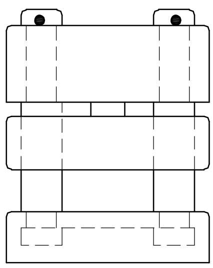
Fig 6



STRAIGHT SIDE PRESS

6 Pillar Press (Fig 7): The pillar press is operated by hydraulic power. It has four pillars mounted on the bolster plate or base. The pillars support are guide the ram. Forming and deep drawing operations can be done on this press.

Fig 7



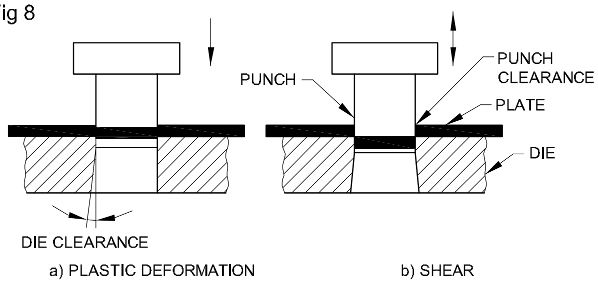
PILLAR PRESS

Press sizes: The size of a press is designated by its maximum load applied on a piece of a blank. It is expressed in tonnes. The mechanical presses are designed with capacities ranging from 5 to 4000 tonnes. Hydraulic presses may specially be designed with capacity ranging upto 50000 tonnes. The bed area which is a very important dimension must be stated alongwith the size of the press.

Power Press Operations: The press operations are classified based on the operations performed.

Shearing: Shearing is an operation of cutting sheet metal with the help of a punch and die on a power press. The sheet is placed on the die and when the punch descends on the metal, it causes a rupture and forces the metal to be severed and ram the sheet metal. As the clearance between the punch and die is very small it forces the metal to drop down from the die opening. (Fig 8)

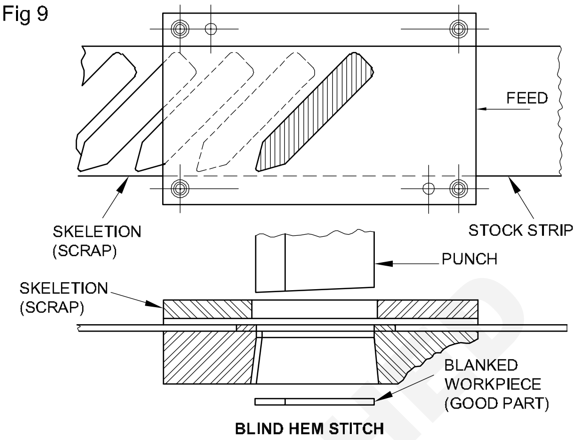
Fig 8



SHEARING OPERATION

a) **Blanking:** Blanking is an operation of producing a flat component from a strip of sheet metal. The metal cutout is the required component and the sheet with the cut on the die is the scrap. In blanking, the size of the blank is governed by the size of the die and the clearance is left on the punch. (Fig 9)

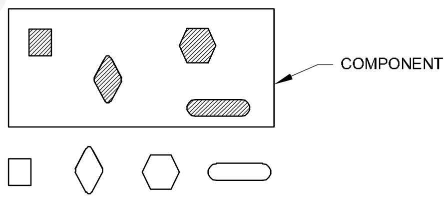
Fig 9



BLIND HEM STITCH

b) **Piercing:** Piercing is an operation of making a cutout on a component. The cutout can be of any shape. The material punched out which comes out of the die is the scrap and the metal with the cutout which is on the die is the component. The punch governs the size of the cutout and the clearance is provided on the die. (Fig 10)

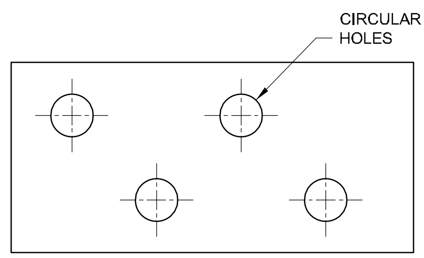
Fig 10



SCRAP (SLUG)

c) **Punching:** Punching is an operation of punching out circular holes. The difference between punching and piercing is that this cutout made by piercing can be of any shape. But in punching only circular holes are made. The size of the hole is governed by the size of the punch and the clearance is provided on the die. (Fig 11)

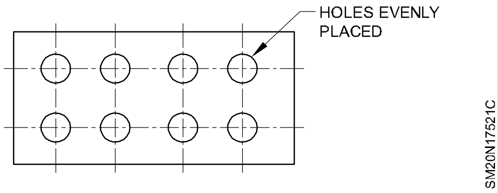
Fig 11



d) **Perforating:** Perforating is an operation of punching circular holes in a regular pattern or evenly spaced.

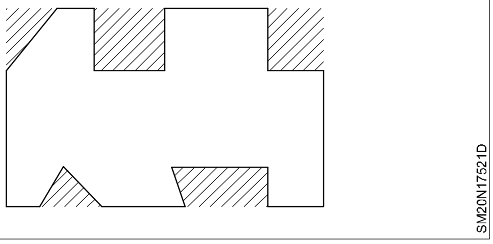
It is similar to that of punching except that in punching circular holes are made anywhere but in perforating the circular holes are evenly spaced. (Fig 12)

Fig 12



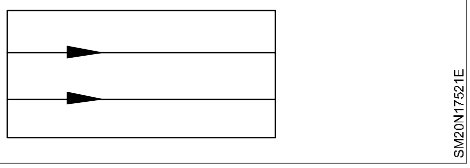
e) Notching: Notching is the operation of removing the metal to the required shape from the edge of the sheet, to facilitate subsequent forming operations using a notching tool. (Fig 13)

Fig 13



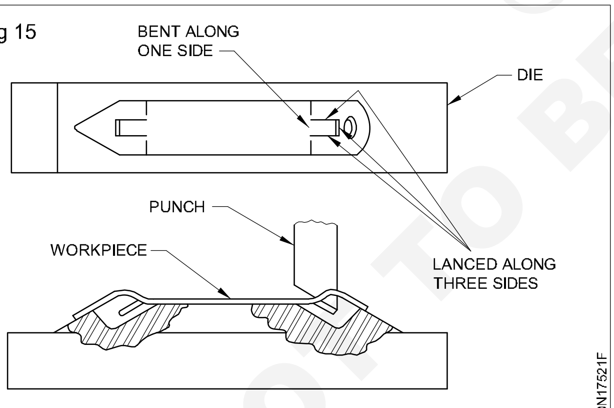
f) Slitting: Slitting is the operation of cutting sheet metal in a straight line along the length. (Fig 14)

Fig 14



g) Lancing: Lancing is the operation of cutting a sheet metal through part of its length and then bending the cut portion. This operation is mainly used as ventilators in duct work, electrical panels, vehicle bodies etc. (Fig 15)

Fig 15

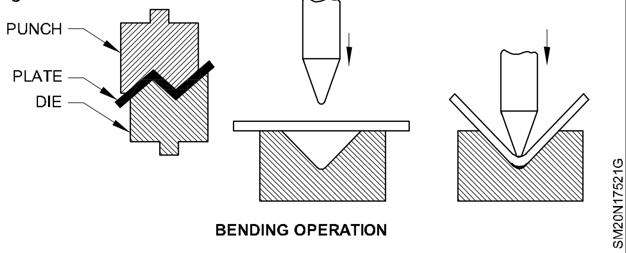


LANCING TOOL

Bending: Bending is an operation of deforming a flat sheet metal into a desired shape with the help of a punch and die. When the load is released, the metal tends to come back to its original position. This is called spring back. This can be overcome by bending the metal to a greater angle than required and when the load is removed the component will spring back to the desired angle. (Fig 16)

a) Angle bending: The angle bending is the operation of bending sheet metal to a sharp angle. The punch and die are designed to the required angle taking into consideration the spring back effect.

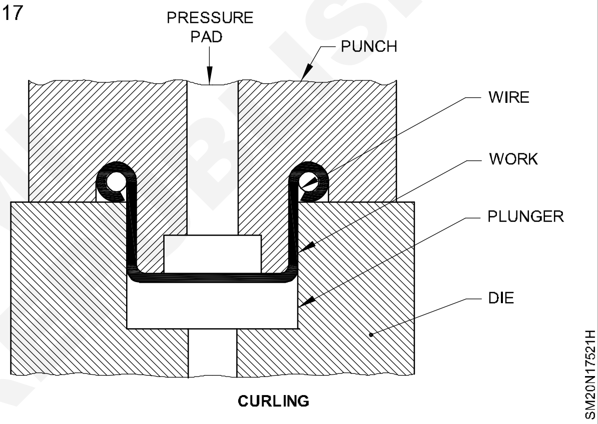
Fig 16



BENDING OPERATION

b) Curling: Curling is the operation of forming the edge of an article into a roll or a curl. This is an edge stiffening process. As the punch descends into the die , the metal rolls into a curl into the cavity of the punch. The rolling of the edges are made over a wire to strengthen the edge. The plunger or the knock out pad in the die block acts as a pressure pad and lifts the workpiece when the punch starts moving in the upward direction. The pressure pad which is fitted in the punch ejects the workpiece out of the punch at the end of the stroke. (Fig 17)

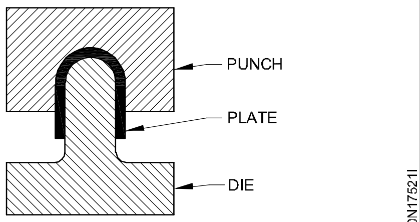
Fig 17



CURLING

c) Forming: Forming is an operation of deforming a sheet metal along a curved axis. The shape of the component is governed by the shape of the press tool. Knock out plates or pads are required in forming operations as the components are pressed against the die walls while forming. (Fig 18)

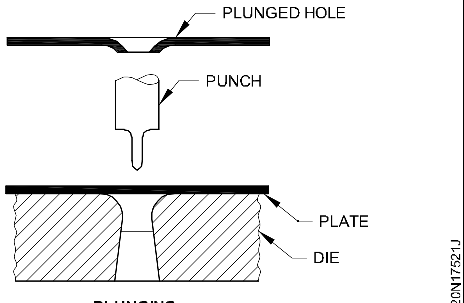
Fig 18



FORMING

d) Plunging: Plunging is the operation of deforming the sheet metal at the face of a previously punched hole to accommodate the heads of screws or a rod through the plunged hole. The plate is first pierced at the required position ad then the plunging punch is pressed into the hole. This causes the deformation of the metal in the die cavity. The shape of the plunged hole depends on the shape of the punch. On thin sheet metal this is done by dimpling operation where the metal will be punched and a dimpling tool will be kept at the extreme of the hole and using a hammer the forming will be completed to accommodate the heads of countersunk screws and countersunk rivets. (Fig 19)

Fig 19



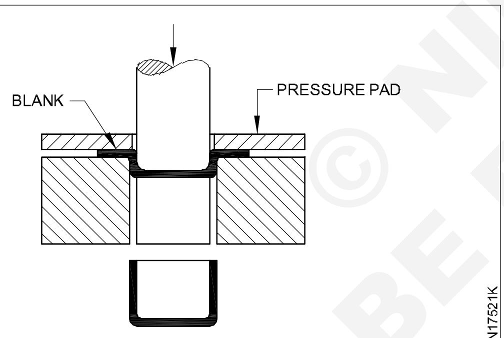
PLUNGING

Drawing: Drawing is the operation of producing cup shaped articles from flat sheet metal blanks. The blank is placed on the die and while the punch comes down, the pressure pad holds the blank firmly on the die. As the punch further comes down the metal blank is pushed into the die opening and the metal is made to flow down the die plastically to form the sides of the cup. The pressure pad avoids the formation of wrinkles developed while forming (Fig 20). The size of the blank required to draw out a cup can be calculated by the formula given below.

$$D = \sqrt{d^2+4dh}$$

Where D = The diameter of the blank

Fig 20



DRAWING OPERATION

d = The diameter of the cup

h = The height of the cup

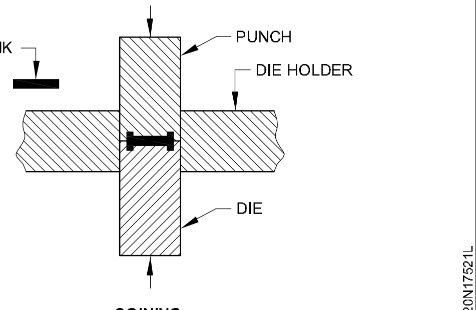
a) **Cupping:** Cupping is the operation of forming cup shaped articles by drawing operation.

Squeezing: Squeezing operation is the most severe of all cold press operations. More pressure is required to squeeze the metal into the cavity of the die and punch to get the required shape. Hydraulic presses are most suited for this operation.

a) **Coining:** Coining is the operation of producing coins, medals or other ornamental work. The metal having good plasticity and correct size is placed into the tool and pressure is applied on the tool from both ends. Compressive load the metal flows under severe and fills into the cavity of the punch and die. The component gets sharp impression on both sides according to the engravings on the punch and die. (Fig 21)

b) **Embossing:** Embossing is the operation of forming impressions of figures, letters or designs on sheet metal. The punch or the die or both of them may have

Fig 21

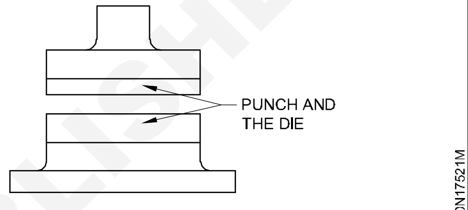


COINING

the design engraved on them which are formed on the sheet metal by squeezing and with the plastic flow of metal.

Flattening or Planishing: Flattening or Planishing is the operation of straightening the curved or bent sheet metal parts, on a press using a planishing tool. (Fig 22)

Fig 22



PLANISHING PUNCH AND DIE SET UP

Safety precautions to be followed when working in a power press shop

Maximum accidents occur in an industry in a press shop

1 Never operate any machine without the proper knowledge of the machine.

2 Always check and lubricate the sliding and rotating parts.

3 Never try to clean the machine when the machine is switched on.

4 Always check that the foot treadle is locked.

5 Do not form or cut metal beyond the capacity of the machine.

6 Always keep your fingers away from the working area of the punch and die.

7 Concentrate on the job while working.

8 Have a good understanding with the co-workers when working in a group on the machine.

9 Never try to operate any machine which are under break down.

10 If any break down occurs report the matter to the concerned incharge immediately.

11 Do not try to attend any repair works by yourself.

12 Never leave the work spot without switching off the machine.

13 If any break down occurs put a “breakdown” board.

14 Lock the foot treadle and switch off the machine after the completion of work.

15 Never operate any machine if you are not well (sick).

Press brake

Objectives: At the end of this lesson you shall be able to
- **state the principle of the operation of press brake**
- **state the types of press brakes**
- **explain the different operations carried out in press brake.**

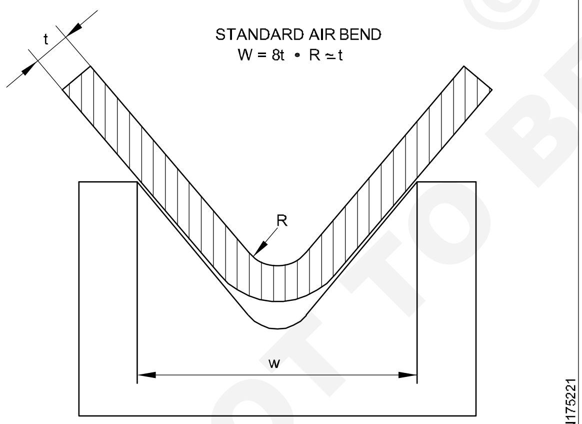
Principle of the operation of the press brake: Press brakes are designed to bend to a rated capacity depend on a die ratio of 8:1, which is accepted as ideal conditions. The figure 1 shows the measuring of die ratio. This is recommended for use with a standard Vee die for 90 degree air bends and gives an inside radius equal to the thickness of the metal.

Different thickness of plates formed over the same die will have the same inside radius. But force or load required to bend will differ.

If the die opening is less than 8 times the metal thickness, fracture bend may occur. However it is possible to produce good bends in light gauge sheet metal with a die opening of 6 times the metal thickness. But this may require greater pressure for high tensile plates above 9.5 mm thickness. It is recommended that the die opening be increased to 10 to 12 times the metal thickness. This considerably reduces the bending load required.

Types of Press Brakes: Press brakes are generally Mechanical or Electro Hydraulic. In fact a press brake is a wide ram press and therefore can be used for extremely wide range of pressing work, with suitable pressing tools. The press brake capacities are usually given in either or both, pressure exerted or maximum actual workdone based on W = 8T as Fig 1.

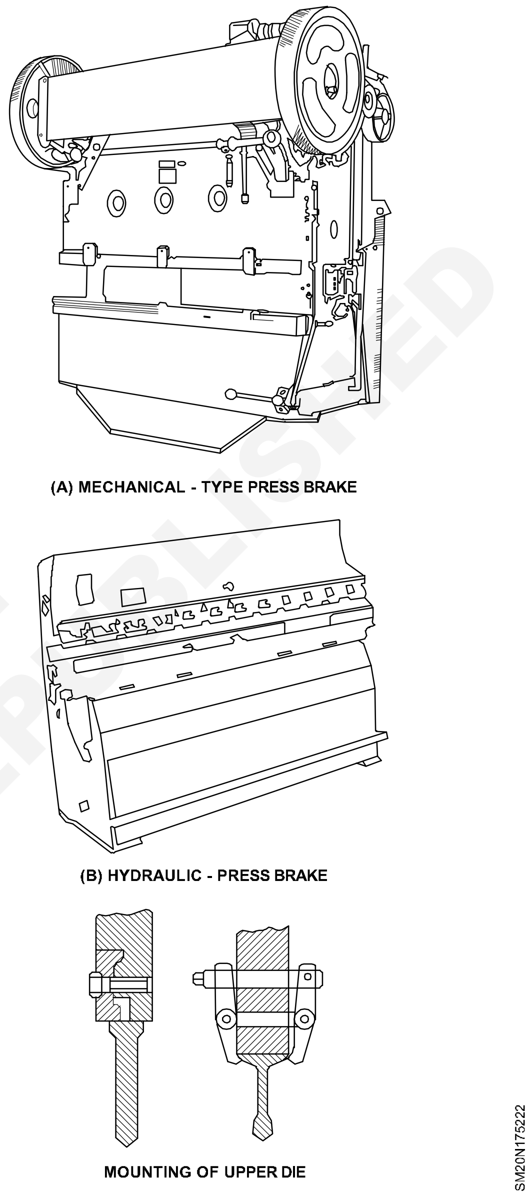
Fig 1



DIE RATIO

Fig 2a & 2b shows two types of press brake. Press brake may be up stroking or down stroking with a down stroking. Press the ram being the top tool down to the bottom fixed tool. The up stroking press brake is one in which the ram pushes the bottom tool up to the fixed top tool. Hydraulic press brakes are up stroking. Some smaller press brakes are available with a swing out bending beam. Machines with light duty are rated between 25 tonnes and 75 tonnes. Medium duty press brakes are between 75 tonnes and 150 tonnes and heavy duty machines between 150 tonnes and 500 tonnes. Some large machines have a table length of 5.5 mm.

Fig 2



(A) MECHANICAL - TYPE PRESS BRAKE

(B) HYDRAULIC - PRESS BRAKE

MOUNTING OF UPPER DIE

Figure 3 (a-h) shows the versatility of the press brake. The load on the ram of a 25 tonnes machine would be equivalent to a mass of 25 x 1000 = 2500 kgs. This load would exert a force on the workpiece of 25000 x 9.8/N. That is 2.5 mm of 245250 N. Similarly, a 152 tonne machine will exert a force on the workpiece of 15.2 mm.

Interchangeable four way dies (Fig 3a)

Fig 3a shows interchangeable female dies which are used for bending medium and heavy plate. This is provided with 85 degree opening on each of the four faces. Male punches for use with four way dies are made with 60°.

Acute angle dies (Fig 3b)

By using this die in conjunction with flattening dies, a variety of seams can be made on sheet metal. Acute angle dies may be set to bend 90° by adjusting the ram height.

The goose neck punch (Fig 3c)

When producing a number of bends on the same component clearance for previous bends has to be considered. This punch is designed for the above said purpose. These tools will enable a variety of sheet metal sections to be formed. The bending force for mild steel is given in table I.

Flattening (Planishing) tool (Fig 3d)

Flattening tools of various forms may be used in pairs for flattening a returned edge or hem on the edge of the sheet metal.

Radius bending (Fig 3e)

A radius bend is best formed in a pair of tools. The radius on the male punch is slightly less than that required to allow for spring back in the sheet metal. A large radius can be produced by adjusting ram height and progressively feeding the sheet metal by the tool.

Channel dies (Fig 3f)

These channel dies are made with pressure pads, to enable the sheet metal to be held against the face of the male die during forming operation. As a rule, channel dies are only successful upto 2.64 mm thickness sheet metal only.

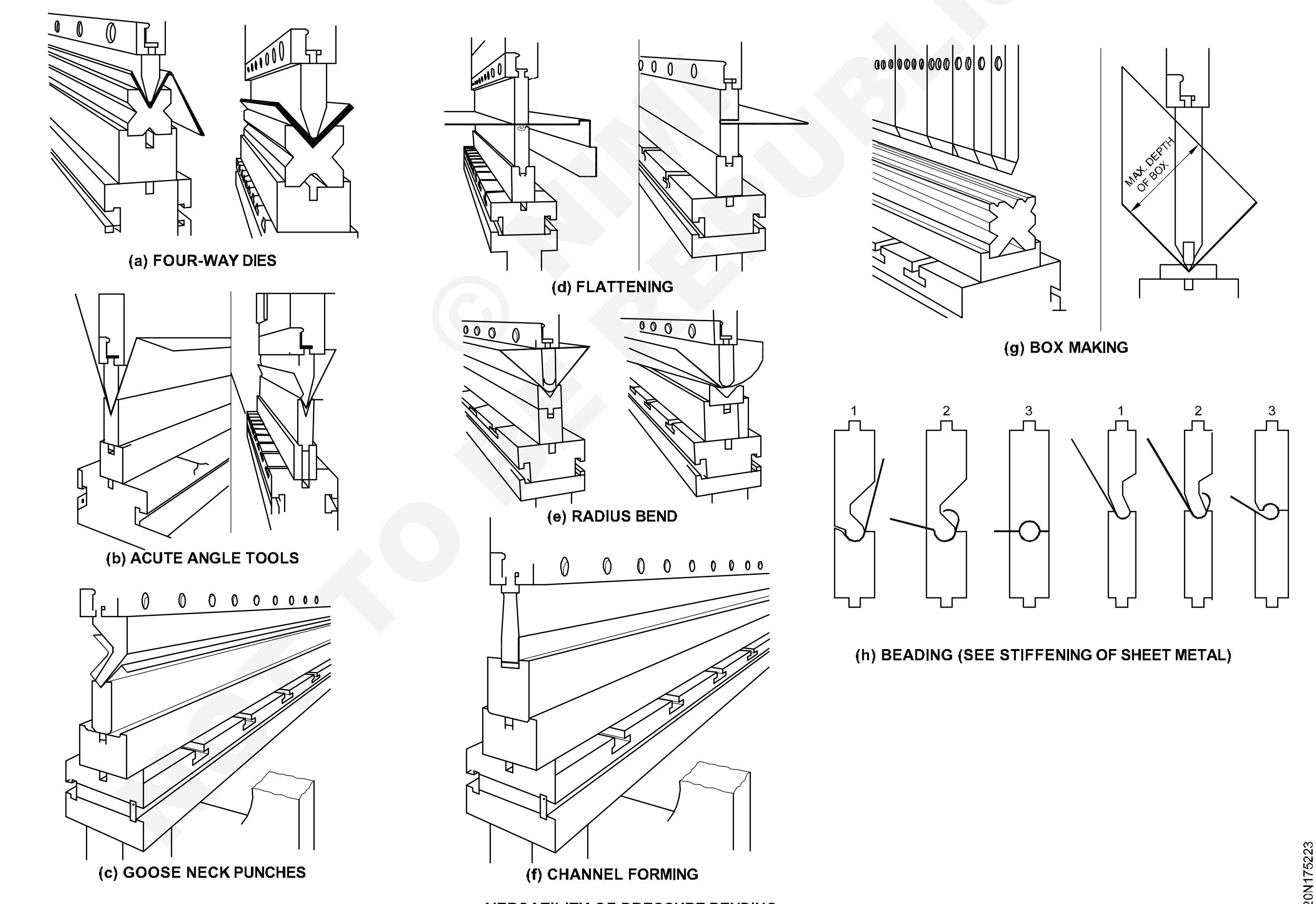
Box making (Fig 3g)

Male punches for box making must be deep to the possible extent. Generally standard machines are fitted with box dies, which will form a sheet metal box of 170 deep. For deeper boxes to produce, the machine must be provided with greater die space and longer male dies. For every extra 25 mm of die space the depth of the box is increased by 17 mm.

Beading

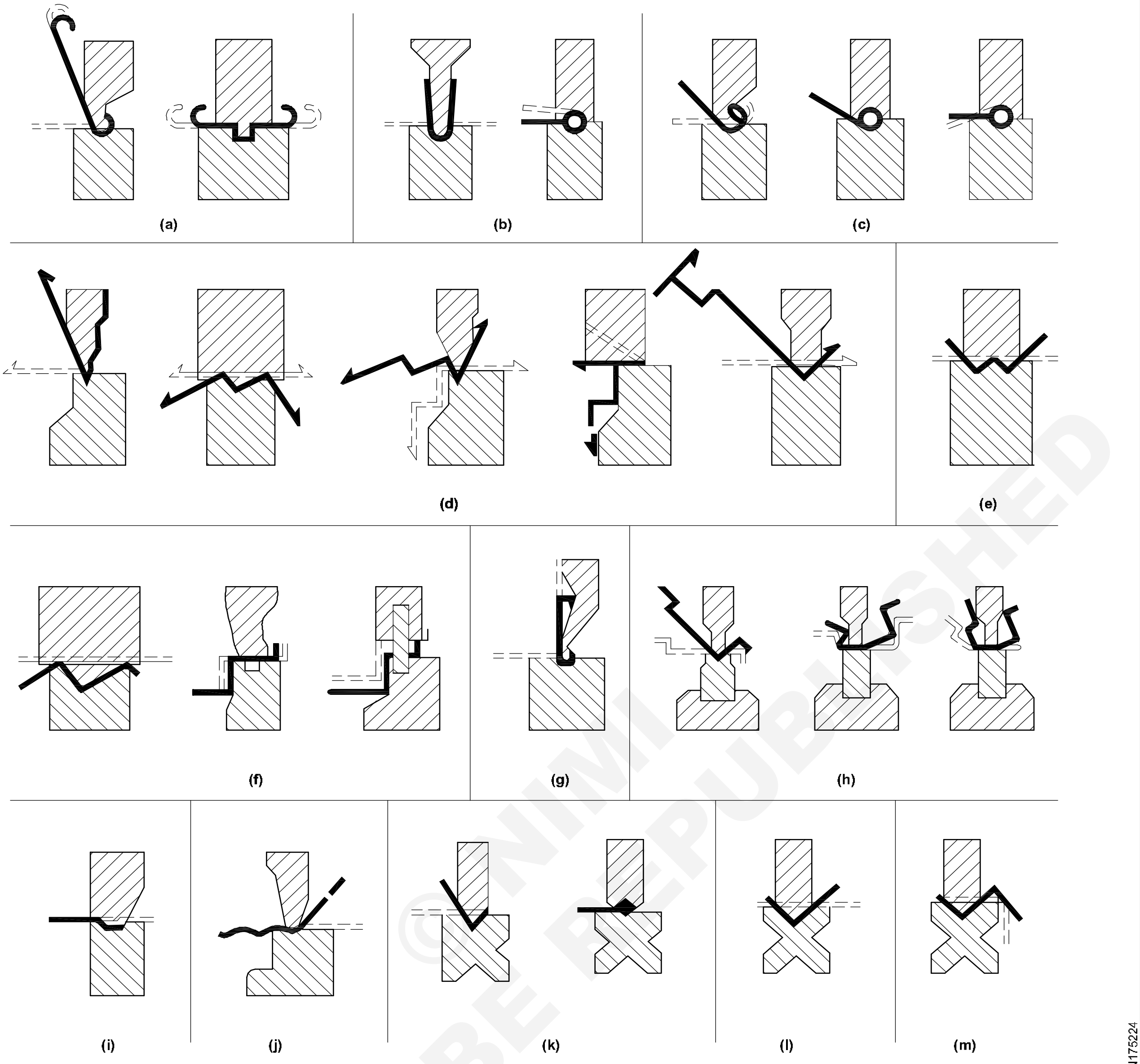
To form a bead on the edge of the sheet metal. three operations are necessary as shown in Fig 3h. Examples of press brake operations bends are illustrated in Fig 4.

Fig 3



VERSATILITY OF PRESSURE BENDING

Fig 4



EXAMPLES OF BEND BY PRESS BRAKE

Method To Calculate Processes And Adjustment

Objectives: At the end of this lesson you shall be able to
- **to improve stress management .**

Pressure Adjustment :

Pressure adjustment control flow measurement process involves measurement and control efficiency to increase successful operation of the machines and systems, so control valves play a vital role in this process. Deliver savings and increase process availability, reduce process variability and reduce maintenance costs. Correctly fitted control valves will last longer compared to valves of comparable size, so the actual size of the valve control valve should be carefully considered. Control valves are often sized based on future maximum design process art and a safety factor that leads to the purchase and maintenance of a larger than normal valve specification. This results in poor control performance in addition to overexploited performance and poor learning performance when a control system is measured.

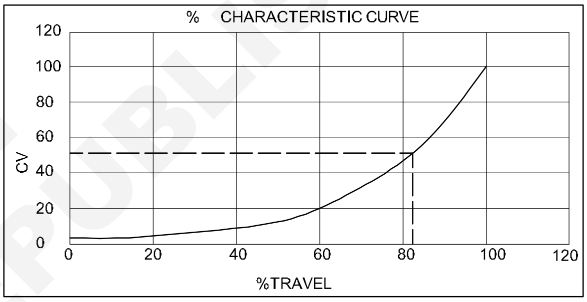
A common approach is to calculate the flow rate, which can be described as the flow capacity and the trim azmidu orum CV per minute of cans, F(15.5c), which will pass through a valve with a pressure drop relative to T>pa. just the simplest words with a C14 USPBM/PNTU.

A fully open control valve with PSI passes fluid with pressure rise and specification seven valve characteristics (AM CEE as indicated) tend to determine the valve volume or volume of the process fluid. Most valve trainers have CV in their product catalog for various functions to allow for the required flow rate while providing constant control. The data provides an example of the percentile flow.

Fig 1

%TRAVEL	0	10	20	30	40	50	60	70	80	90	100
Cv	2	2.96	4.37	6.47	9.56	14.14	20.91	30.92	45.73	67.62	100

EQUAL PERCENTAGE CHARACTERISTIC CURVE COORDINATES



EQUAL PERCENTAGE CHARACTERISTIC CURVE

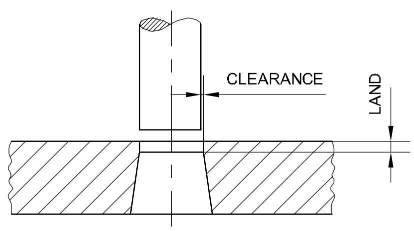
SM20N175311

Cutting Clearance

Objectives: To be able to by the end of this lesson.
- State what is the interval for the act of cutting
- changes in workpiece /parts due to the following operations high
  - clearance of lamp cut
  - Excessive clearance of cut
  - Inadequate spacing of cut
  - Centrifugal displacement between punch and Die
  - viscosity at the cutting sides of punch and die
  - Calculating cut spacing for production material cutting
- Size and punch an die size
- Explain calculation of interval for calculating the sizes of upanch and tie.

Inside the panchkaru during the action of the panch called and disconnects the workpiece so the size of the punch is less than the size of the die.
Fig. when the gap on the punch side slides between its (the dead space on the side of the corresponding die) the gap is called the shear gap.

Fig 1

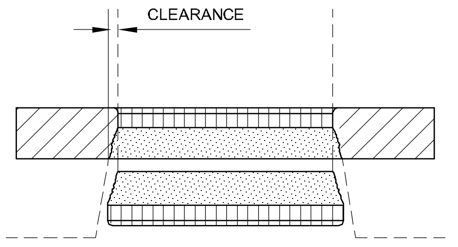


SM20N175321

Action of the instrument days and the quality of the work material will change due to inappropriate intermediates one of the spacing tools for the box panjim die also comes under while visually inspecting the work piece produced in the pressure process which indicates the gauge for the side. Flaws can be found
High size interval of cutting (optimum clearance)
Suant cutting clearance misalignment
Excessive cutting clearance
High clearance of the cut (Optimum clearances) Box with a high clearance when the small radius of us will be formed.
A field is the result of flexural (deforestation). (First stage of shearing) A burmished shear band is formed in

one – third of its size in the raw material and the remaining sheared area reaches the centroid stage.

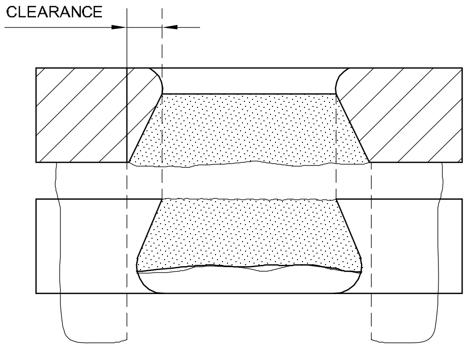
Fig 2



OPTIMUM CUTTING CLEARANCE

Excessive cutting clearance excessive clearance between punch and die forming in the first stage, the raw material is pressed into shape fom the cutting stage to form a large radius at the edges. This is cut of
O) A fetus with a large amount of cysts. The material to be cut by the rocks is dragged

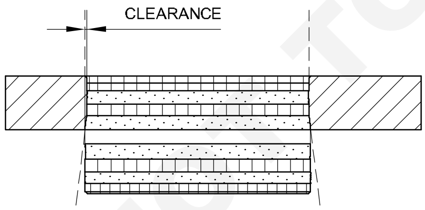
Fig 3



EXCESSIVE CUTTING CLEARANCE

Insufficient cutting clearance:
If the cutting clearance is small, the thickness of the cutting edge will be high. If the gap is too small, two more cutting edges will be formed. If the angle between the punch and the cross is small, the material will be marked by the pressure on the edge of the edge (figure 4). During the first stage of fracture, incipient interstitial fractures at the edges may develop from stress testes.

Fig 4

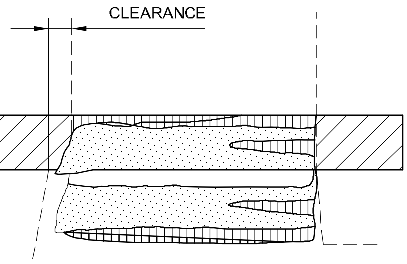


INSUFFICIENT CUTTING CLEARANCE

Moalignment between punch and die : from the nature of the cut part, the punch and die show whether they are in perfect alignment, while they are far apart on one side and with less space on the other side, so that the nature of the cut part of the work piece is revealed on both sides of the blank (Fig. 51)
Biru side : (po side) of the fractured part. The shriveled half will show lumps. There should be no cracks in the process. The shear gap is the dykes. The overburden punching between if the cutting edge is sharp, the soft side blanky (a waste is always on the punch

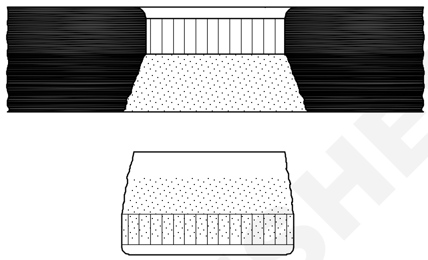
The colored part of the stock is plong (Effective nature is negative

Fig 5



MISALIGNMENT OF PUNCH AND DIE

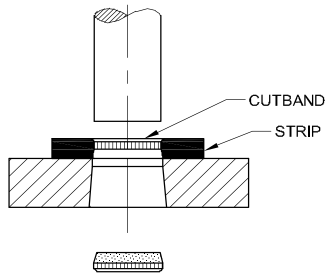
Fig 6



BURR SIDE

DOC Relationship of piece part size to punch and the die size: the size of the exposed workpiece is th same as that of the cut bar.
Blanking : Blanking (a) is done by the blanking cutting edge of the die so the open area in the die determines the amount of blanking (a) waste (Figure 7)
Palnch = plank
Size –total size interval
Size of plank's die = planky size
(C G & M) Metal sheet worker contact concept 2.2.53

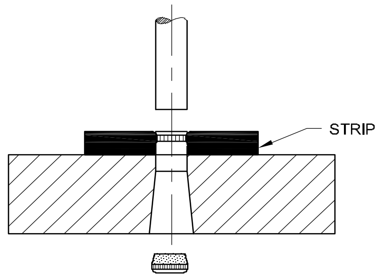
Fig 7



BLANKING

Pliercing : Punching is the act of cutting into the material so the size of the punch determines the size of the hole created.

Fig 8

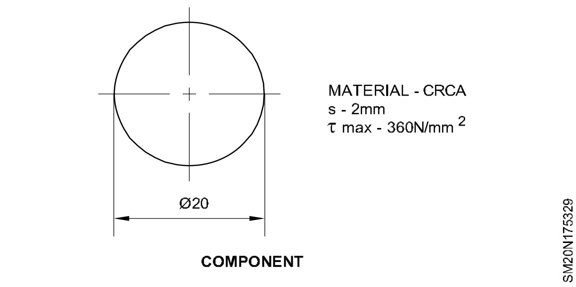


Basunji's measure in piyal
Duma is calculated between

$$= C \times S \times \sqrt{\frac{\tau\ MAX}{10}}$$

Where c is constant N = 0005 for precision part manufacturing
001 A typical section of section 5x3. Moment of the sheet mm S = Sheet Thickness - mm
Mm shear strength of material rumimly
Examples of recipes are

Fig 9



It is the middle of the cut $= C \times S \times \sqrt{\frac{\tau\ MAX}{10}}$

$$= 0.01 \times 2 \times \sqrt{\frac{360}{10}}$$

$$= 0.01 \times 2 \times \sqrt{36}$$

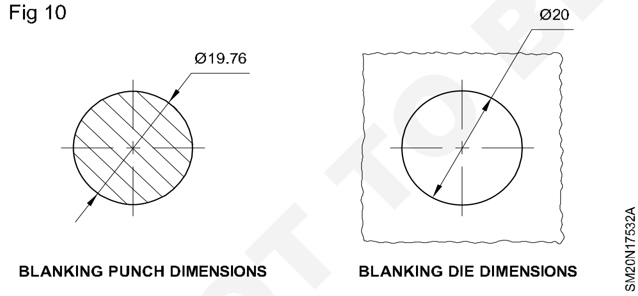
= 0.01x2x6

= 0.12mm/side

The spacing of the cut was determined

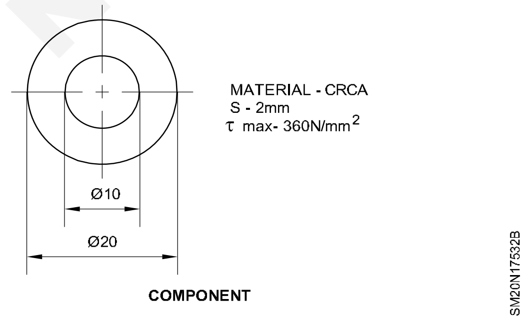
= 0.12mm /side

Fig 10



Example 2 Fig

Fig 11



Spacing of cut

$$= C \times S \times \sqrt{\frac{\tau\ MAX}{10}}$$

Intersection of the cut $= C \times S \times \sqrt{\frac{\tau\ MAX}{10}}$

$$= 0.01 \times 2 \times \sqrt{\frac{360}{10}}$$

$$= 0.01 \times 2 \times \sqrt{36}$$

= 0.01x2x6

= 0.12mm / side

Fig 12

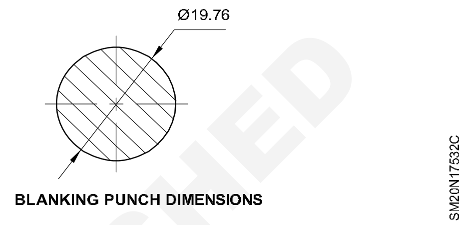


Fig 13

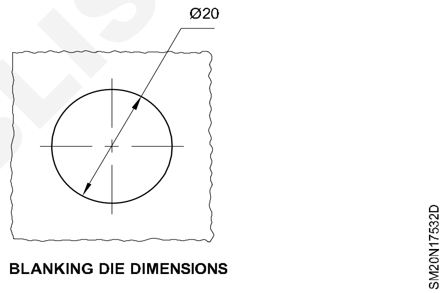


Fig 14

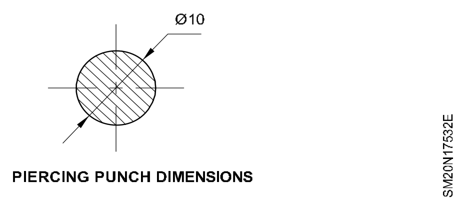


Fig 15

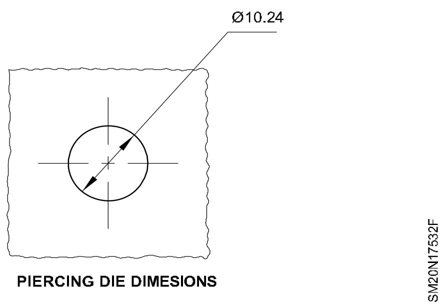


Fig. Determining the dimensions of the pilerumbanch and die
Example 3

Interval $= C \times S \times \sqrt{\frac{\tau\ MAX}{10}}$

$$= 0.01 \times 1 \times \sqrt{\frac{160}{10}}$$

= 0.04mm/TdLm

Dimension of planking bunch

Fig 16

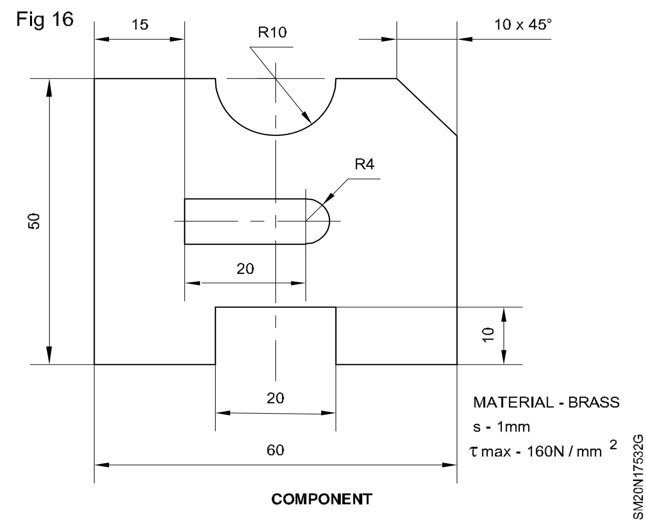
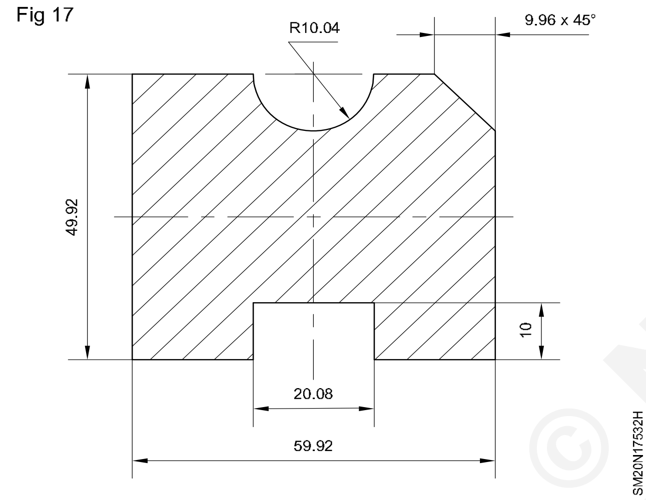
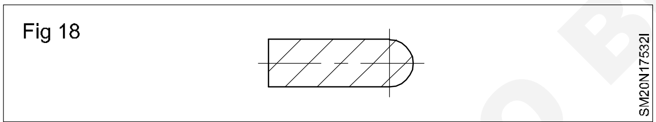


Fig 17



Pear's punch is the size of the hole in the pan.)

Fig 18



Part of the size	Interval +/-	Bunch sizes
50	*-0.08*	*49.94*
20	*+0.08*	*20.08*
60	*-0.08*	*59.92*
10	*-*	*10*
*10*x*45*	*-0.04*	*9.96*x*45°*
R*10*	*+0.04*	R*10.04*

Penang is the size of penang Di size of the part made Fig : 41

Fig 19

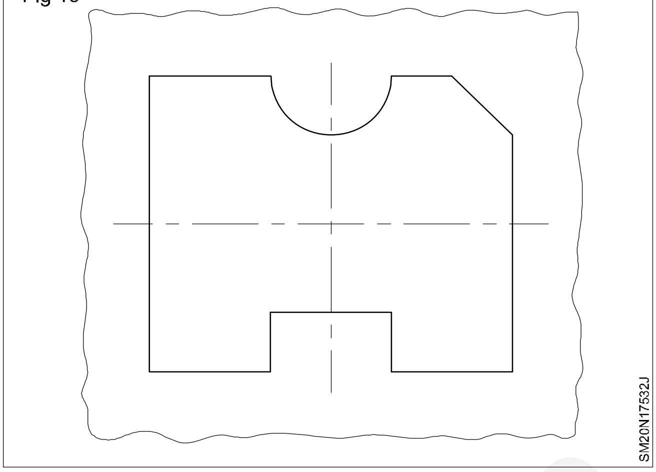
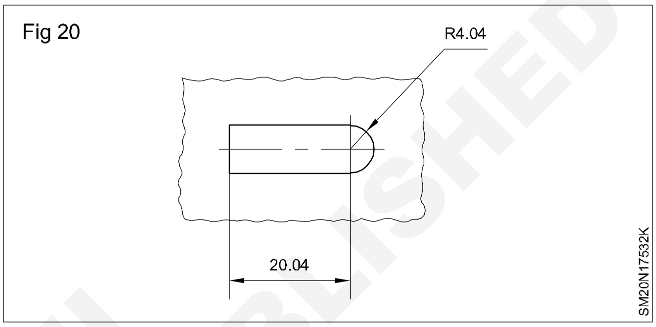


Fig 20

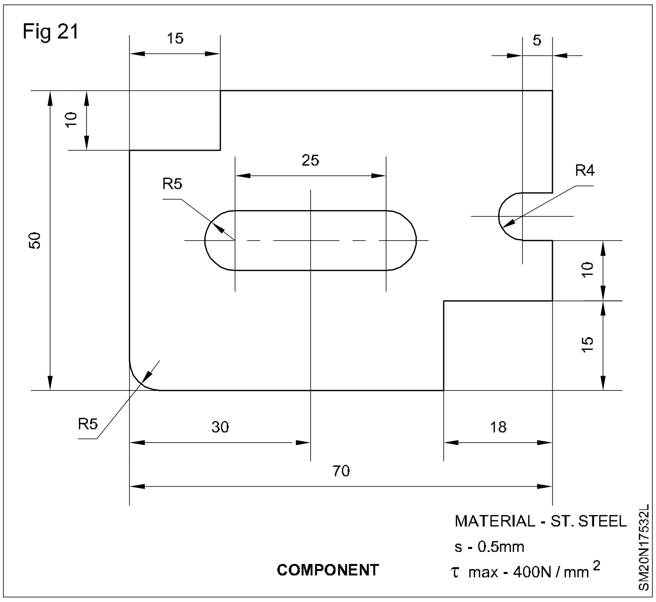


Part of the size	Interval +/-	Bunch sizes
20	-0.04	20.04
R 4	+0.04	R 4.04

Example 4

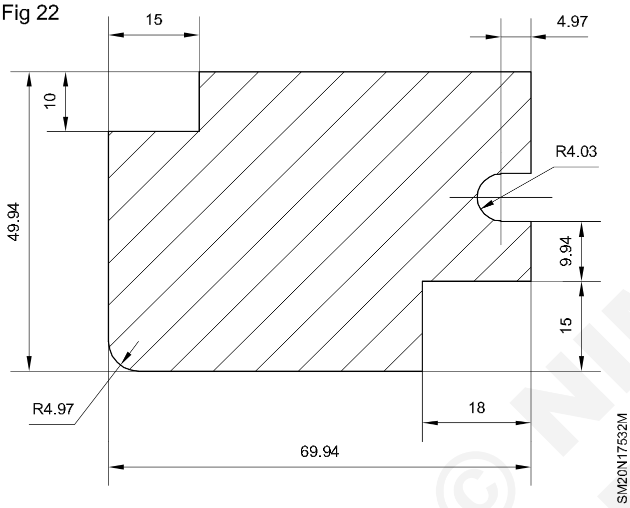
Fig. Determining the dimensions of the punch and die for the following curves

Fig 21



Part of the size	Interval +/-	Bunch sizes
50	-0.06	49.94
R5	-0.03	R4.97
70	-0.03	69.94
15	-	15
10	-	10
15	-	15
10	-0.06	9.94
R4	+0.03	R 4.03
5	-0.03	4.97
18	-	18

Fig 22



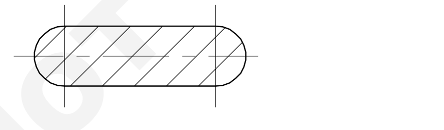
Interval $= C \times S \times \sqrt{\frac{\tau\ MAX}{10}}$

$= 0.01 \times 0.5 \times \sqrt{\frac{400}{10}}$

= 0.03mm/ பக்கம்

Piercing punch size is the size of the practical hole (image)

Fig 23



The blanking die size is the size of the part yadam is the same

Piercing die sizes (Fig.57)

Part of the size	Interval +/-	Bunch sizes
R 5	+0.03	Rs.0.3
25	-	25

Fig 24

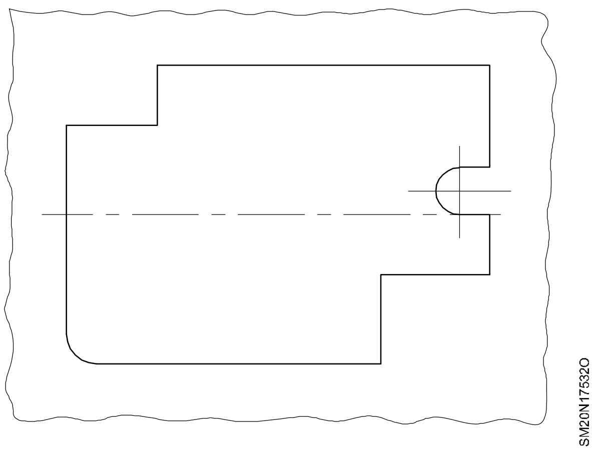
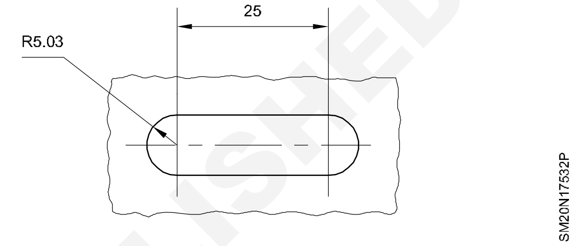


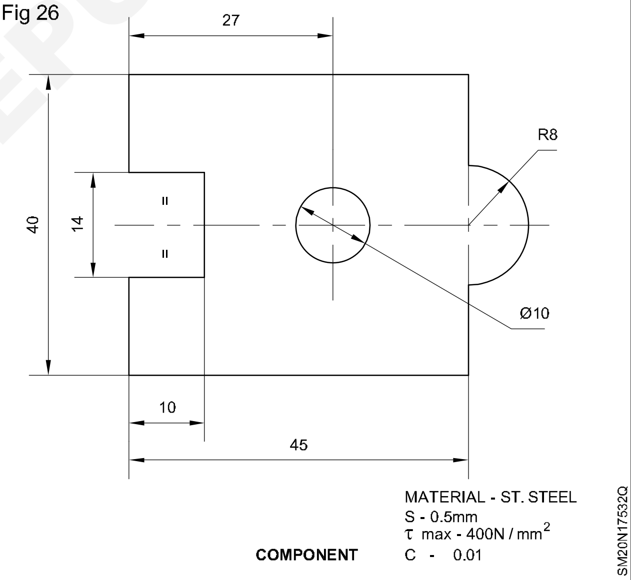
Fig 25



Example S

Determination of punch and weight dimensions for the following components (Fig.)

Fig 26



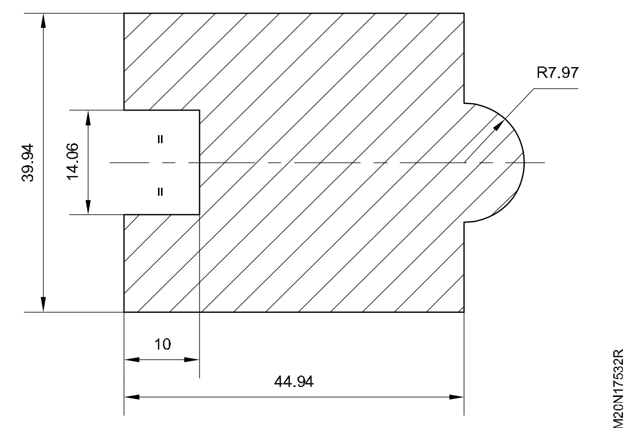
Interval $= C \times S \times \sqrt{\frac{\tau\ MAX}{10}}$

$= 0.01 \times 0.5 \times \sqrt{\frac{400}{10}}$

= 0.03mm/பக்கம்

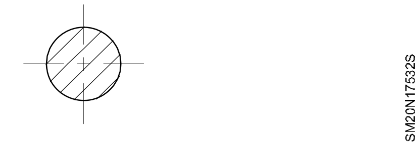
Part of the size	Interval +/-	Bunch sizes
45-0.06	44.94	
40-0.06	39.94	
14+0.06	14.06	
10-	10	
RS-0.03	R7.97	

Fig 27



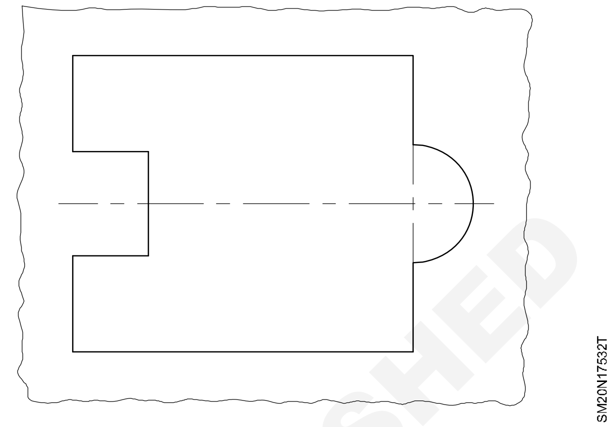
There should also be a firebill size for the turning size . (Fig)

Fig 28



The size of the pierced part is the size of pini panch

Fig 29

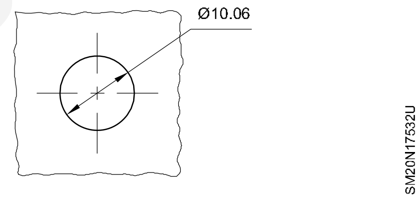


Piercing die sizes fig brazing die size = part size + spacing

= 10+0.06

= 10.06

Fig 30



Introduction to " C " and " H " frame presses

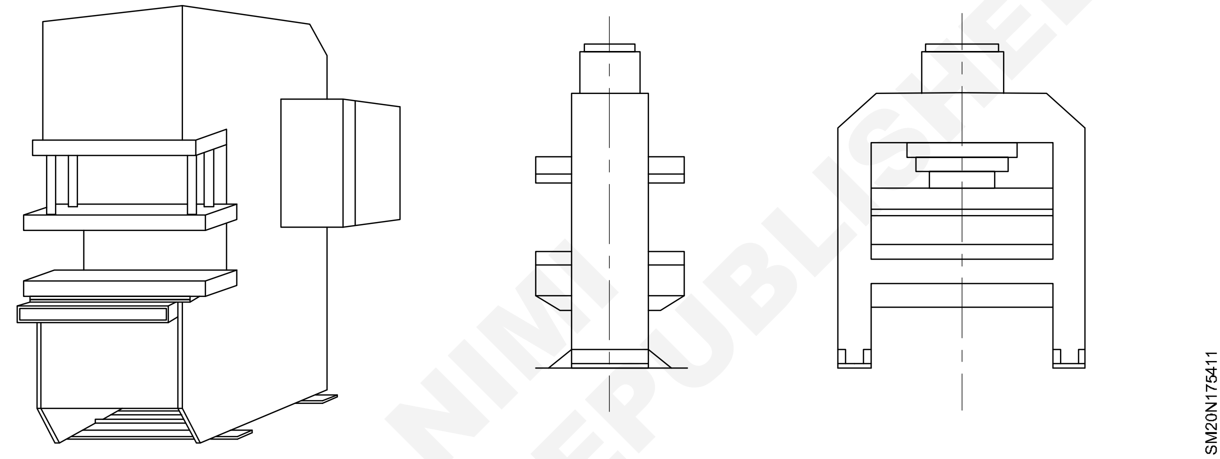
Objectives: At the end of this lesson you shall be able to
- **"C" and "H" shaped pressure die**

These pressure molds are manufactured with three convenient facilities to facilitate lifting and removal of the work pieces made in the dirty manner with wadins.

There is a chance for the mold to become clear and this type of die is pressed vertically on the mold so that the central pressure on the material is away from the center line

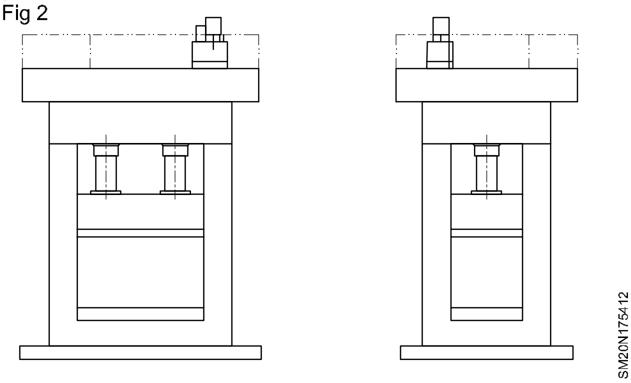
2 numbered pressure axis or R – rod pressure axis set up designed for compact performance and low cast printing to be integrated into the HDTV system; the sidewalls of low efficiency press molds are either rolled channel or corrugated men and the next high performances press molds are made of heavy steel plates.

Fig 1



Example include designs and variable light internal plates.

Fig 2



Stainless steel

Objectives: At the end of this lesson you shall be able to
- **state the uses of stainless steel**
- **state the properties of stainless steel**
- **explain the classes of stainless steel and its composition.**

Stainless steel is a class of chromium containing steel, used for corrosion resistance and for service at elevated temperatures.

Along with iron stainless steel contains 0.2 to 0.6% of carbon, 12 to 18% chromium 8% nickel 2% molybdenum.

Mechanical properties of stainless steel:

Stainless steel improves yield strength, elongation, and impact can be toughness. It hardened through heat treatment.

Cast alloy stainless steel are used in high pressure service at temperatures upto 540°C.

It is resistance to corrosion at elevated temperatures.

Stability resistance to warping, cracking or thermal fatigue.

It is magnetic proof and is not affected by acid.

Creep strength resistance to plastic flow.

The uses of stainless steel (cast) are metal treatment furnaces, gas turbines, aircraft engines, oil refinery furnaces, cement mill equipment turbo chargers for

– High tensile strength

– Large spread between yield strength (YS) and ultimate tensile strength (UTS)

– High ductility and toughness

– Low thermal conductivity.

Stainless steel can be divided into five categories:

1 Ferritic stainless steels. These have a body centered cubic structure and are magnetic. This is an iron based alloy containing 16 to 18% chromium.

2 Martensitic stainless steel have a body centered cubic structure and are magnetic containing 12% chromium and 0.1% carbon.

3 Austenitic stainless steel have a face centered cubic structure and are non-magnetic. It contains 18% chromium and 8% nickel.

4 Duplex stainless steel contains a mixture of ferrite austerity and is magnetic.

5 Precipitation hardenable stainless steel.

Non Ferrous Metals Properties and Uses

Objectives: At the end of this lesson you shall be able to
- **various non-ferrous metal and alloys calling name**
- **state the properties of gunmetal, mumtz metal, white metal,phosphorus , silver**

1 Tin:

Silver white in colour, malleable and ductile metal.

Specific gravity 7.8 and melting point 230° C.

Uses : It is used as protective covering for iron and steel sheets and pulleys.

It is used in ship building work. In ice rooms internal linings to protect from atmospheric effects and also for preparing alloys.

2 Lead :

Soft bluish grey metal with a specific gravity of 11.36 and a melting point of 326° C, malleable and ductile.

Uses:

It is used for water pipes and sanitary fittings and to prepare soft solders and coating material for chemical contianers.

3 Zinc:

Bluish white grey in colour. It is a crystalling metal. Brittle at ordinary temperature but malleable and ductile between 100° C to 150° C. Good conductor of heat and electricity. Specific gravity 7.0 and melting point 420°C.

Uses:

Used for galvanizing on iron sheets. making dry cells cover and for making zinc points, forms a number of alloys like brass silver spelter, silver.

4 Silver:

A white metal symbol (AB) specific gravity is 10.7 and the melting point is 964°C. sterling silver is applied only to the specific silver copper alloy.

Uses:

It is used to prepare spelters for silver solder. It is also used for making ornaments and jewelleries.

5 Mumtz metal:

Mumtz metal consists of 60% copper and 40% zinc.Mumtz metal primarily is hot working alloy is used where cold working is not required. This metal possess good mechanical properties properties, combining strength with ductility, corrosion resistance is very good. This brass is having pleasing colour. This yellow brass is invented by George F.Mumtz in 1832.

6 Gun metal:

Copper 88%, tin 10%, zinc 2%. It is tough, strong and hard , high corrosion resistance. Bearing and wearing qualities are high. Zinc promotes fluidity and so it is suitable for castings.

Uses:

It is used for making mirror accessories, bearings, glands, steam pipes, fittings and gears.

7 White metal :

White metal is an alloy of lead antimony tin employed for machine bearings, packings and linings to the low melting point alloys. It is used for toys, ornaments and fusible metals and to the type metal. White metal consists of 85%, copper 5%, antimony 10%.

8 Phosphorous bronze:

Tin 10% to 14% phosphorous 0.3 to 1% remaining copper. It is having good tensile strength. Very high corrosion resistance and excellent bearing quality.

Uses:

It is used for bearing, gears, worm wheels,slide valves, springs etc.

Introduction To Tubes And Pipes Bending

Objectives: At the end of this lesson you shall be able to
- **state the uses of tubes and pipes in sheetmetal work.**

INTRODUCTION

Metal tubes are used in different types of machines and installations. Tubes in hydraulic system rarely runs in a straight line. Tubes are curved, twisted for making structural frames and are bent by computerised numerical control (CNC) pipe bending machines.

Conduit pipes ranging from 16 mm to 65 mm diameter are used for electrical installations.

Pipes and tubes are made of metals and plastics and are used for transport, water, oil, gas and for domestic and industrial purposes. G.I.Pipe (galvanised iron) is commonly used for many purposes.

British standard pipe threads BSP, ISO, DIN. Standard threads are cut on pipes for joining purposes. Pipes are first cut to length with a hacksaw or pipe cutter and then a pipe reamer is used to remove the burr on the inside diameter of the pipe.

Generally the tube size is specified by the outer diameter, whereas the pipe size is specified by the internal diameter.

Pipe and Tubing: The sheet metal worker uses both black pipe and galvanized pipe as legs and stiffeners. In general the pipe work is done by plumber or pipe fitter.

Sheet metal worker may sometimes have to connect few small fittings to connect the equipment to the installed pipe.

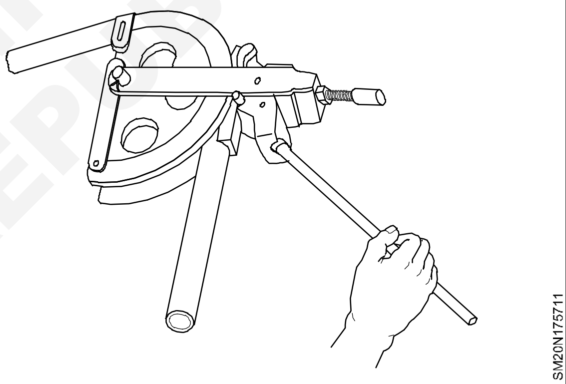
Pipes can be obtained in various sizes. The pipes commonly used in the sheet metal trade are from 3/8 inch to 1 1/4 inch in diameter.

Split pipe: For a smooth, very stiff edge, the sheet metal worker uses split pipe. Split pipes are available in galvanized black and stainless steel

Bending of pipes

While bending pipes of large diameters with thin wall thickness fill up sand and block both ends. In the case of small diameter pipes or tubes, pour lead into them before bending. After bending, heat and remove the lead. Bending fixtures can be used for cold bending of small diameter pipes. Special bending fixtures (Fig 1) are also available for bending.

Fig 1



Pipe bending machines

Objectives: At the end of this lesson you shall be able to
- **identify the three most common pipe benders**
- **differentiate their constructional features**
- **name the parts of bending machines**
- **state the uses of bending machines.**

There are some situations in plumbing jobs, where it is preferable to bend a pipe rather than use a pipe fitting.

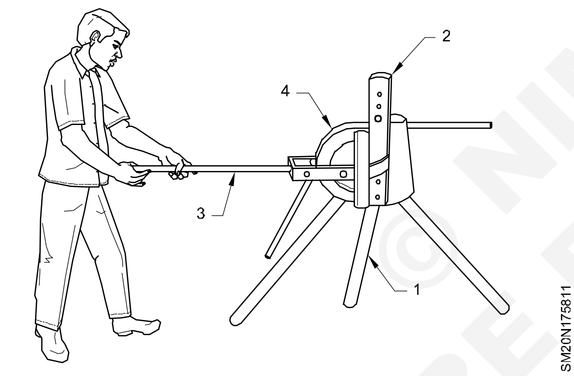
The most common pipe benders are listed here.

Portable hand operated pipe bender (Fig 1)

The portable hand-operated pipe bender consists of the following parts

1 Tripod stand
2 Pipe stop lever
3 Handle or lever
4 Inside former.

Fig 1

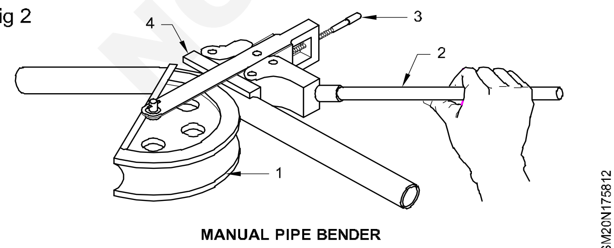


Bench type hand operated pipe bender (Fig 2)

This consists of the following parts. It is used for bending galvanized iron and steel pipes.

1 Inner former
2 Lever or handle
3 Adjusting screw with lock nut
4 Pipe guide.

Fig 2



MANUAL PIPE BENDER

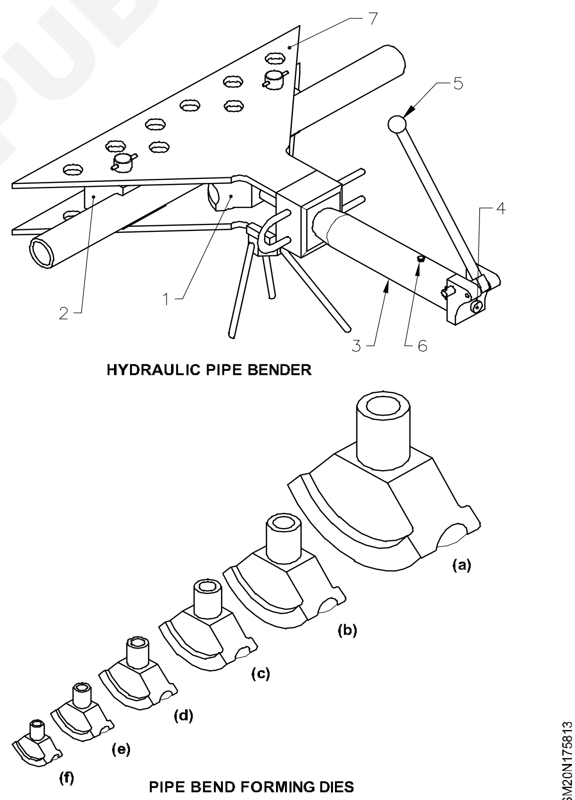
Hydraulic bending machine (Fig 3)

This machine can be used for bending G.I and M.S.pipes without sand filling to any direction.

It consists of the following the parts.

1 Inner former
2 Back former
3 Hydraulic ram
4 Pressure release valve
5 Operating lever
6 Bleed screw
7 Base plate.

Fig 3



PIPE BEND FORMING DIES

Inner formers are interchangeable and are able to bend pipes up to 75 mm diameters. (Figs 3a, b, c, d, e & f)

Three roll forming machine

Objectives : At the end of this lesson you shall be able to
- **state the constructional features of three roll forming machine**
- **state the types of three roll forming machine**
- **state the uses of three roll forming machine**
- **differentiate between plain and slip roll forming machines.**

These machines are generally known as forming or rolling machines.

These machines are used to form sheet metal or wires to various curvatures and diameters. All articles in the shape of cylinders and others which are formed to a radius greater than 25 mm can be quickly formed on these machines.

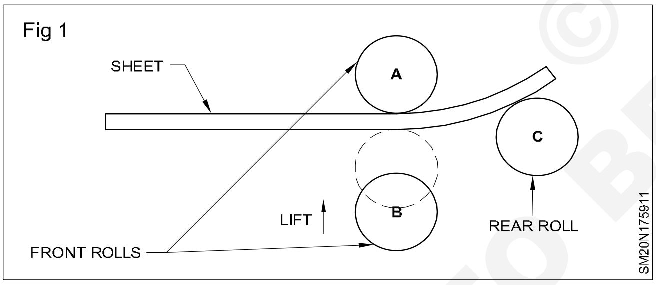
The most commonly used machines in sheet metal shop are of three types. They are

Plain forming machine, the slip roll forming machine and Pyramid type roll forming.

Plain forming machine: These machines have three rollers, through which the flat sheets of metal are fed to be formed with cylindrical shapes. The two front rollers grip the metal and force it against the rear rollers which bend it upwards resulting in curving the sheet and forming the cylinder.

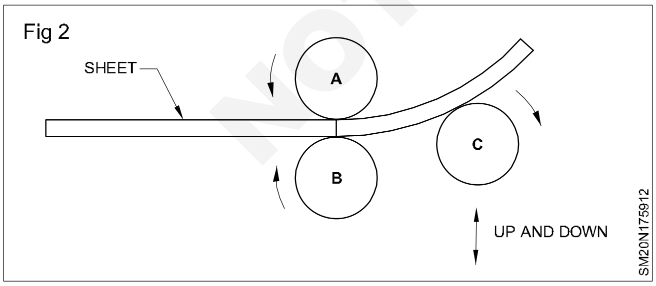
The lower roll can be adjusted to suit different thickness of metals. (Fig 1a)

Fig 1



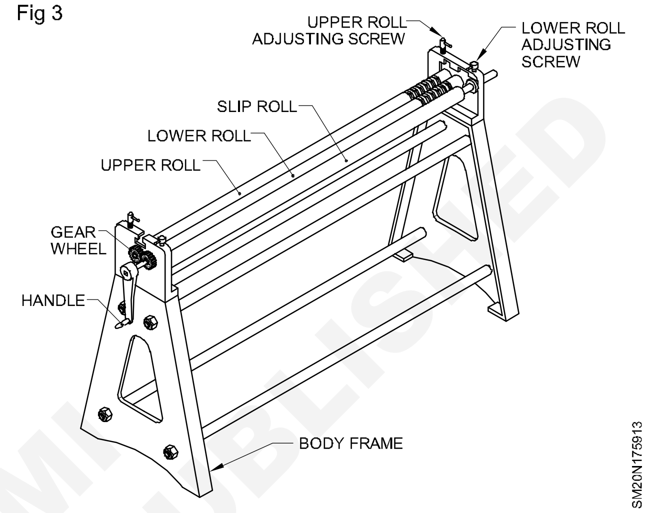
The rear roller can be raised or lowered to form cylinders of different diameters. The rear roller does the actual forming process. (Fig 1b)

Fig 2



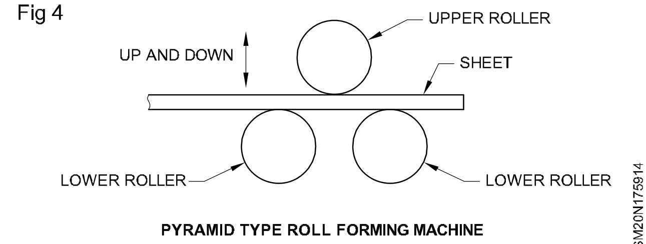
Slip roll forming machine (Fig 2): The operating principle of the machine is similar to that of a plain forming machine, except that the upper roller on the slip roll machine can be released and swing away to facilitate removing the formed piece of metal. Grooves are provided on the front and rear rollers for forming wires and wire edges.

Fig 3



Pyramid Type roll forming (Fig.3): Heavy gauge sheets and plates are formed in pyramid type roll forming machine. The rollers are placed like a pyramid as shown in Fig.3. Upper roller is adjusted up and down to make the bend radius. These machines are generally driven by Electric motors.

Fig 4



PYRAMID TYPE ROLL FORMING MACHINE

Forming cylinders with wired edges (Fig.4): When forming cylindrical articles with wired edges, the wire should extend past the edge of the metal at one end. This is the end that should be inserted between the rollers. The wire at the other end should be slightly shorter than the metal, forming a hollow space for inserting wire from the other end.

Insert a small piece of wire into this space to avoid smashing of the metal. Form the metal to the desired curvature until the ends meet. Remove the short piece of wire and insert the extended wire into the space from where the wire can be removed. Continue to roll until the seam has passed through the rolls. Remove the part by releasing the top roller adjustments.

Safety, care and maintenance: While operating the machine, keep the fingers away from the rollers.

After the completion of work, clean with grease and oil the gear wheels and screws.

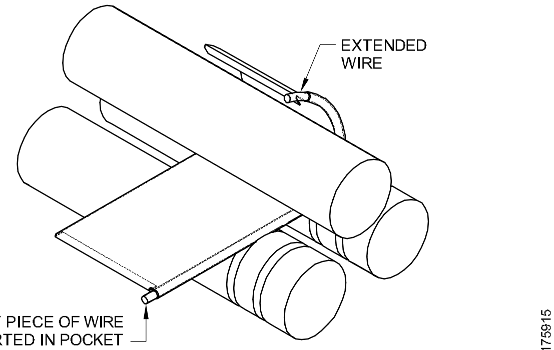
The rollers should be free from scratches and dents. If not, the same impressions will be formed on the workpiece also.

Form wires, in the grooves provided only at the ends and not in the centre of the rollers.

While forming, the rear roller should be adjusted gradually for increasing or decreasing the radius.

Avoid oil or grease on the rollers. Wipe off the oil and grease before starting to form the part, if not the part will slip and rolling will not take place.

Fig 5



FORMING A CYLINDER WITH WIRED EDGE.

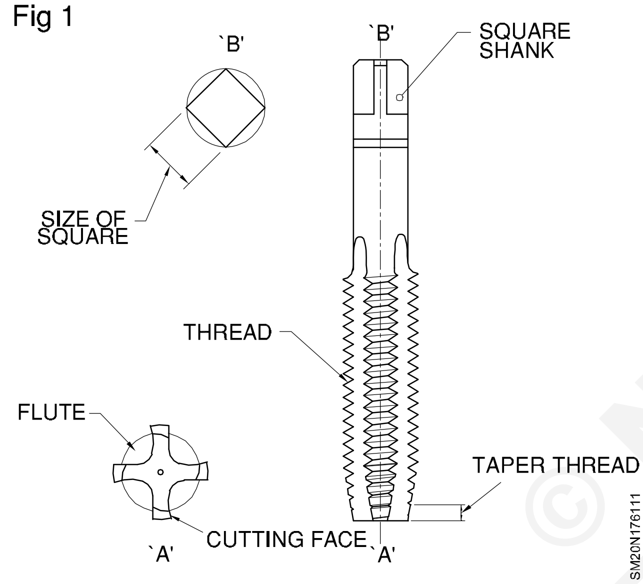
Hand taps and wrenches

Objectives: At the end of this lesson you shall be able to
- **state the uses of hand taps**
- **state the features of hand taps**
- **state the functional use of different taps in a set**
- **the different types of tap wrenches and its uses.**

Uses of hand taps : Hand taps are used for internal threading of components.

Features (Fig 1) **:** They are made from high carbon steel or high speed steel, hardened and ground.

Fig 1



Threads are cut on the surface, and are accurately finished.

To form the cutting edges, flutes are cut across the threads.

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 threads.

The size of the tap 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 and plug.

Types of taps in a set (Fig 2)

Hand taps for a particular thread are available as a set consisting of three pieces.

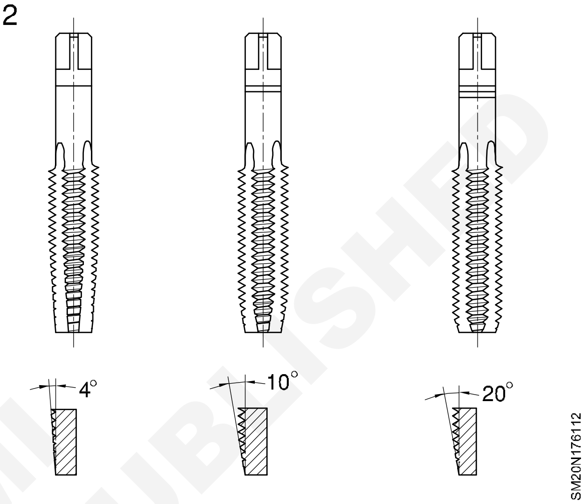
These are

– First tap or taper tap

– Second tap or intermediate tap

– Plug or bottoming tap.

Fig 2



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 thread by the taper tap in through holes which are not deep.

The second tap or intermediate tap is used to size the threads.

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 such as 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) **:** This is the most commonly used type of tap wrench. It is available in various sizes. 175,250,350 mm long. 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) **:** 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, most suitable for smaller size taps.

Fig 3

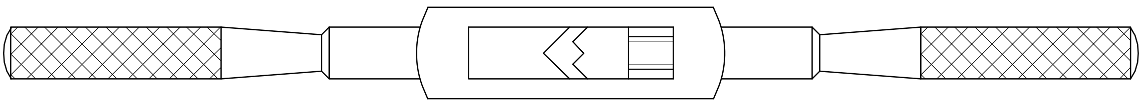

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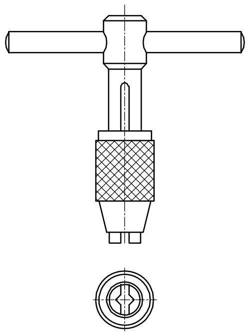
Fig 4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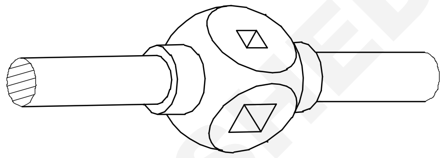
This wrench is not available for holding large diameter taps. (Fig 4)

Solid type tap wrench : 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, prevent damage to the taps. (Fig 5)

Fig 5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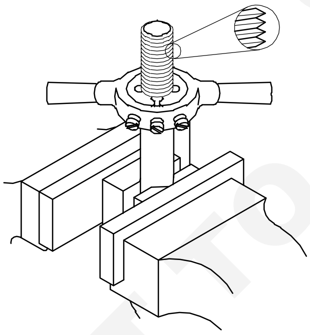
Die and die stock

Objectives: At the end of this lesson you shall be able to
- **state the uses of dies**
- **identify the different types of dies**
- **name the different types of die stock for each type of die**
- **state the use of die nets**

Use of dies : Threading dies are used to cut external thread on cylindrical workpieces. (Fig 1)

Fig 1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TYPES OF DIES

The following are the different types of dies

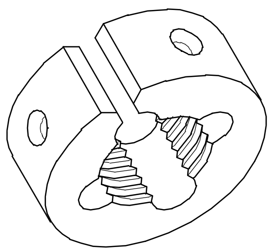
– Circular split die (Button die)

– Half die

– Adjustable screw plate die

Circular split die/button die (Fig 2) **:** It has a slot cut to permit slight variation in size.

Fig 2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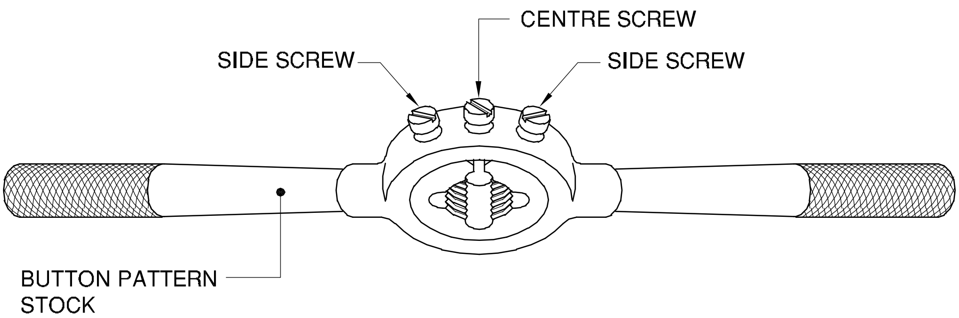
When held in the die stock, variation in size can be made by using the adjustable screws. (Fig 3) This permits increasing or decreasing of the depth cut. When the side

Fig 3



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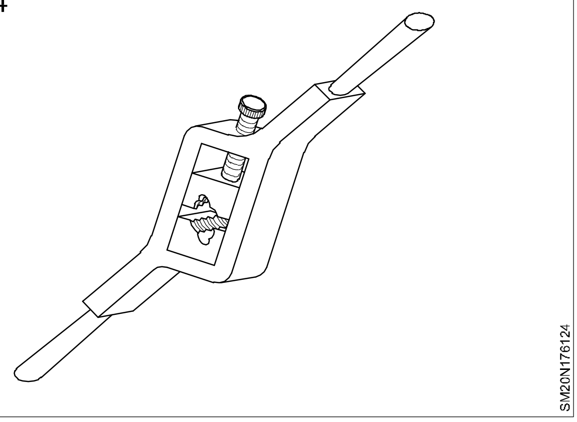
screws are tightened the die will close slightly. For adjusting the depth of the cut, the centre screw is advanced and locked in the groove. This type of die stock is called button pattern stock.

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 die stock, the die pieces can be brought closer together or can be moved apart. They need a special die holder.

Fig 4



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.

When the guide plate is tightened after placing the die pieces in the collar, the die pieces are correctly located and rigidly held. (Fig 6)

The die pieces can be adjusted, using the adjusting screws on the collar. This type of die stock is called quick cut stock.

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.

The die pieces should have the same material serial number.

Die nuts (Solid die) **:** The die nut is used for chasing or reconditioning the damaged threads.

Die nuts are not to be used for cutting new threads.

Die nuts are available for different standards and sizes of threads.

The die nut is turned with a spanner. (Fig 7)

Fig 5

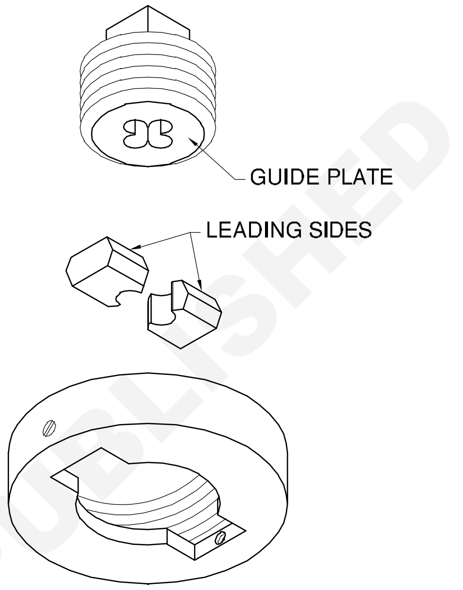


Fig 7

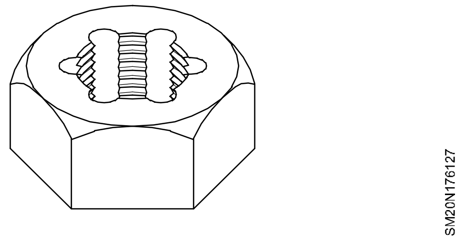
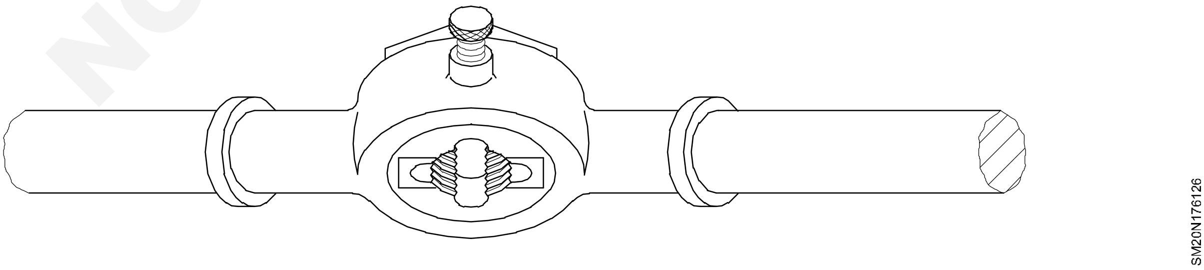


Fig 6

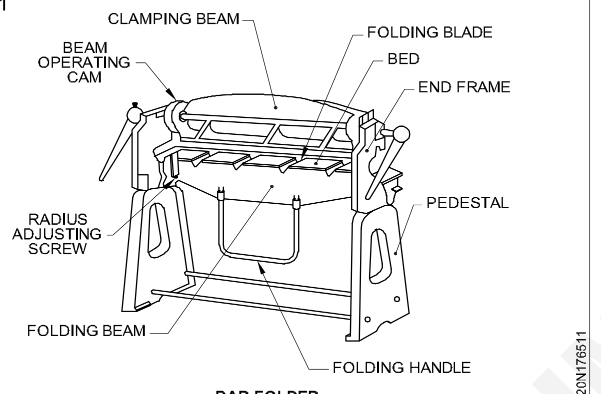


Bar folder/Bench folder

Objectives: At the end of this lesson you shall be able to
- **state the mechanism of folding and clamping of a bar folder**
- **state the specifications and features of a bar folder**
- **state the use and application of a bar folder**
- **state the defects in bending on a bar folder, their causes**

Bar folder (Fig 1): Bar folder is a hand operated machine, used for folding sheet metal at different angles. When it is mounted on a pedestal, it is called bar folder and when it is mounted on bench, it is called bench folder.

Fig 1



BAR FOLDER

Folding is completed in four steps i.e.

1 Setting the workpiece
2 Clamping
3 Folding
4 Removal of workpiece

It comprises of a clamping mechanism, a folding mechanism and a bed.

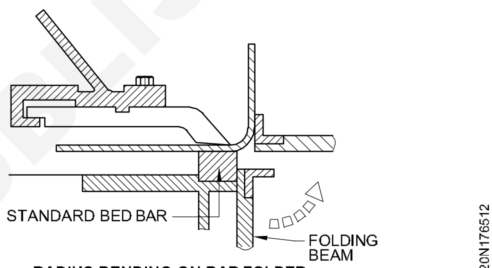
In the clamping mechanism, clamping beam is attached to the end frames. Clamping beam moves up and down, by rotating the beam operating cam, with the help of the beam operating lever. Clamping blade is fixed at the bottom of the clamping beam. Workpiece is clamped inbetween the clamping blade and the bed by turning the beam operating lever.

In the folding mechanism, folding beam is pivoted at the end frames, below the bed. Folding blade is fixed on the folding beam at its upper end and the folding handle is attached to the bottom. Workpiece is clamped inbetween the clamping blade and the bed. Workpiece is folded by moving the folding beam radially upward towards the operators side, with the help of the folding handle.

Bed is fixed on the end frames, Standard bed bar is fixed on the bed, on which the workpiece is placed in position. Radius adjusting screw (Fig 2) is provided at the end frame. With radius adjusting screw, the folding beam is moved forward. While turning the folding handle, the folding beam is moved forward and simultaneously radially upward, to fold the workpiece to the required radius. (Fig 2)

Specifications of the bar folder: Bar folder is specified by the maximum length of the bed and the thickness of the workpiece that can be bent. Thickness of the workpiece, that can be bent is determined by the lift of the clamping lever. The smallest width of the bend is usually 8 to 10 times of the metal thickness. The minimum inside corner radius of the bend is 1.5 times of the metal thickness. The variety of the bends and the combination of the bends can be made on the bar folder using mandrels, special stepped bar, radius fingers etc.

Fig 2



RADIUS BENDING ON BAR FOLDER

Fig 3 shows, folding step bends using special stepped bar.

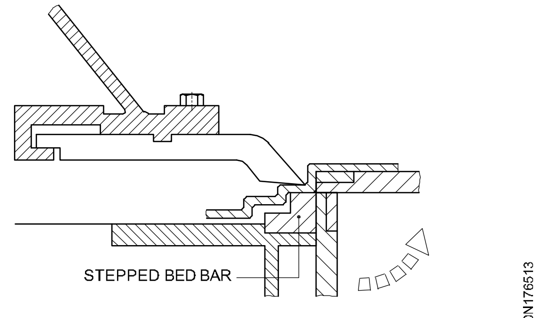
Fig 4 shows, bending at radius using radius in finger.

Fig 5 shows, bending at radius, using mandrel.

Fig 6 shows, variety of bends and combination of bends that can be made on a bar folder.

Defects and Remedies: While working on a bar folder, some defects in bending may occur. Following is the chart showing the nature of defects, probable causes and remedies.

Fig 3



MAKING SMALL REVERSE BENDS

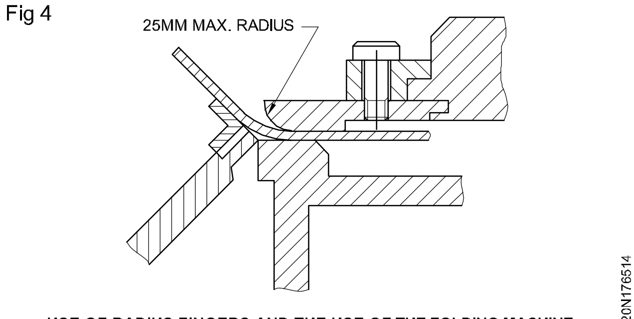


Fig 4 USE OF RADIUS FINGERS AND THE USE OF THE FOLDING MACHINE

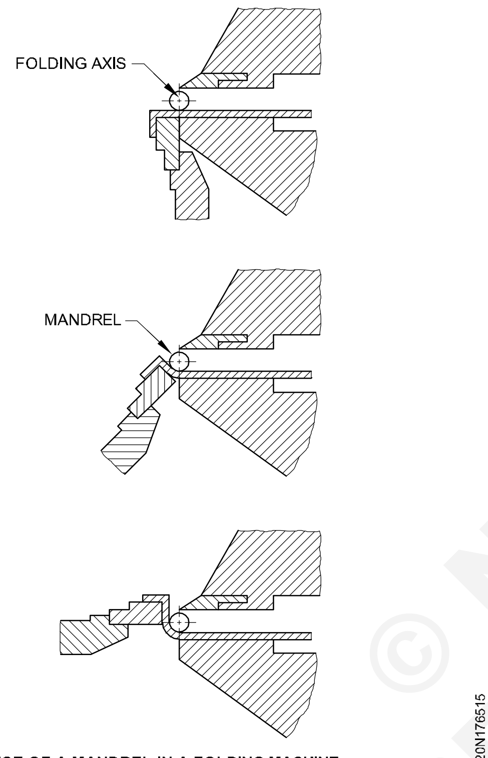


Fig 5 USE OF A MANDREL IN A FOLDING MACHINE

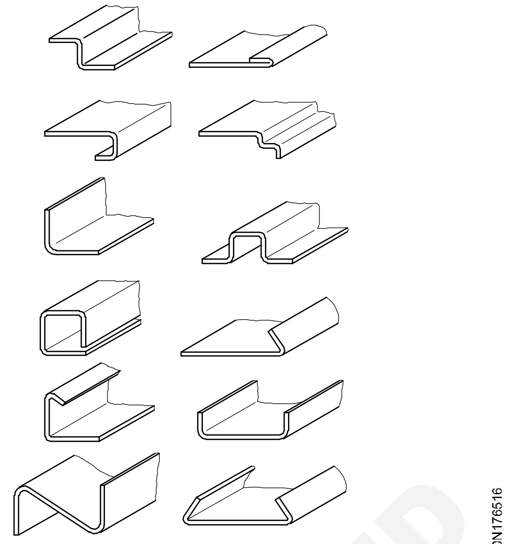


Fig 6 EXAMPLES OF WORK PRODUCED ON A FOLDING MACHINE

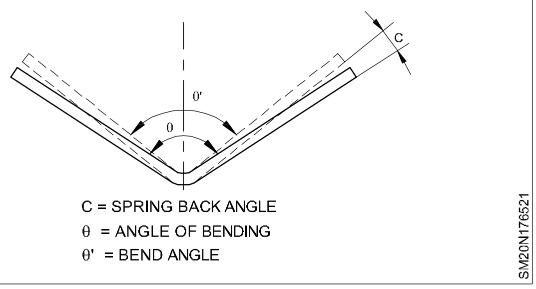
Spring back of a sheet metal after bending

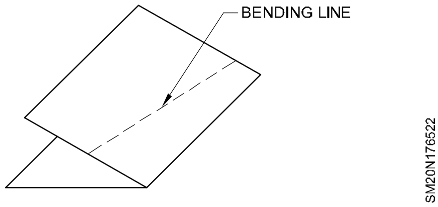
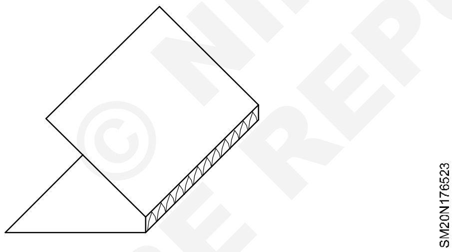
Objective : At the end of this lesson you shall be able to

- **state what is the spring back of a sheet metal after bending.**

Spring back: When a sheet is bent, if the bending force is removed, because of the elasticity of the material, the required deformation is not achieved. The result is the actual angle of the bend is less than the angle of folding. The phenomenon is called "spring back". (Fig 1) Spring back varies, depending on the material, the thickness of the material and the bending pressure. In the case of bending work, it is difficult to make an accurate bending angle because of the spring back. That is why, folding/ bending is done, at slightly larger angle, experimentally, by trial and error method, in order to get the correct bend angle.

Fig 1



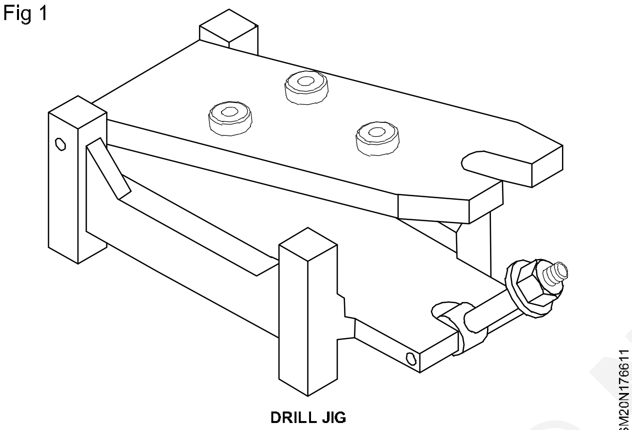
Sl.No.	Nature of the Defect	Probable	Remedy
1	Bend sides, not as per dimensions (Fig 7) Fig 2 	Marked bending line is not properly set.	Set the marked bending line, forward by half the material thickness from the front edge of the clamping bed.
2	Bending is not occuring on the bending line/at an angle to bending line/shifted from the bending line even though the workpiece is properly set.	Workpiece is not clamped perfectly.	Clamp the workpiece by moving the clamping beam downward by turning the clamping lever till the workpiece is clamped on the bed perfectly.
3	Cracks are observed on the bending line.(Fig 8) Fig 3 	Rapid folding operation or hard workpiece material.	Fold the workpiece by moving the beam operating lever gradually upward.

Jigs and fixtures

Objectives : At the end of this lesson you shall be able to
- **state the advantages of using jigs and fixtures**
- **distinguish between the functions of jigs and fixtures**
- **name the operations which can be performed on drill jigs**
- **name the different operations for which fixtures are used.**

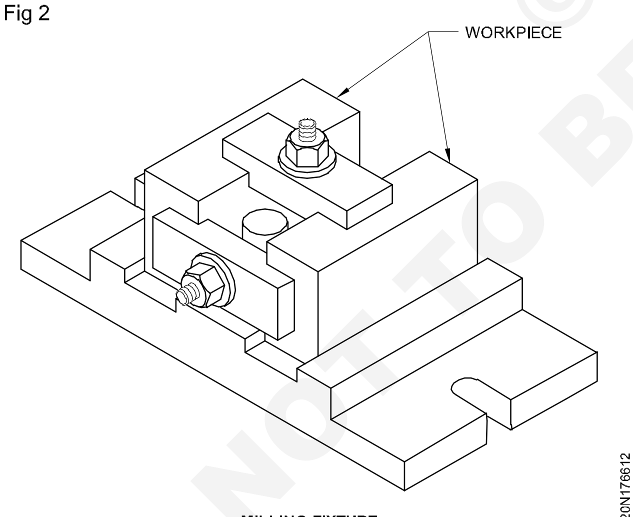
A great deal of importance is placed today on improving productivity in manufacturing processes. Application of jigs and fixtures has contributed a lot towards this direction. Jigs and fixtures (Figs 1 and 2) are devices used in manufactur-ing or assembling. They also facilitate in carrying out special operations accurately.

Fig 1



DRILL JIG

Fig 2



MILLING FIXTURE

Advantages of using jigs and fixtures

- Faster rate of production.
- Easy to perform the operations even by unskilled workers.
- Layout and marking on individual parts eliminated.

Jigs

A jig is a special device which holds, supports, locates and also guides the cutting tool during operation. Jigs are designed to accommodate one or more components at a time. Jigs are available for drilling or boring. Drilling jigs are used to drill, ream, tap and to perform other allied operations. (Fig 3) Boring jigs are used to bore holes which are either too large to drill or of odd size. (Fig 4)

Fig 3

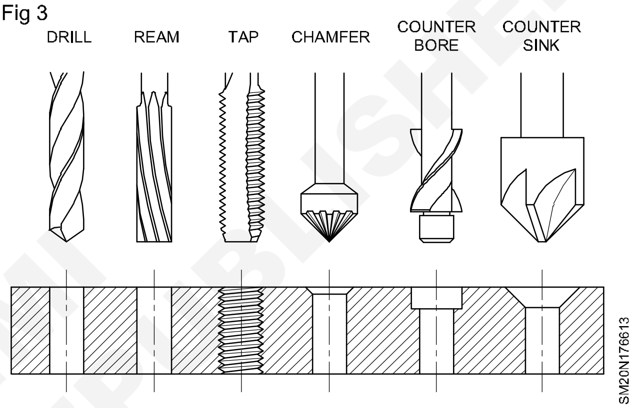
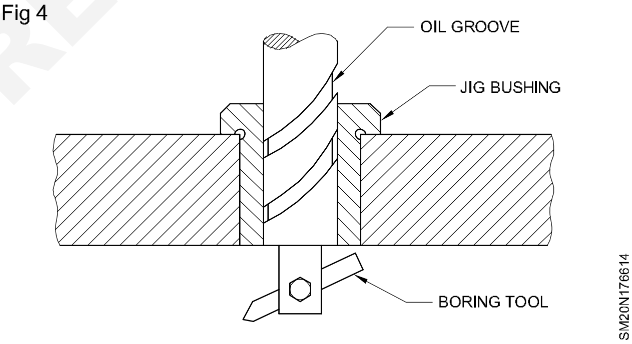


Fig 4



Fixtures

A fixture is a production tool that locates and holds the workpiece. It does not guide the cutting tools, but the tools can be positioned before cutting with the help of setting blocks and feeler gauges etc. (Fig 5)

Fixtures of different types are made for:

- milling
- turning
- grinding
- welding
- assembly
- bending etc. (Fig 6)

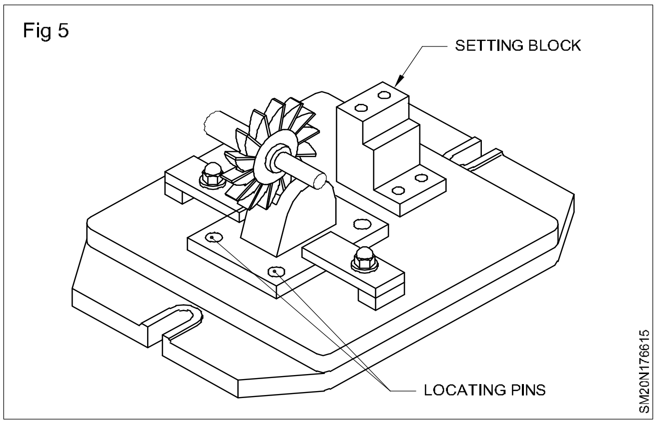


Fig 5
SETTING BLOCK
LOCATING PINS
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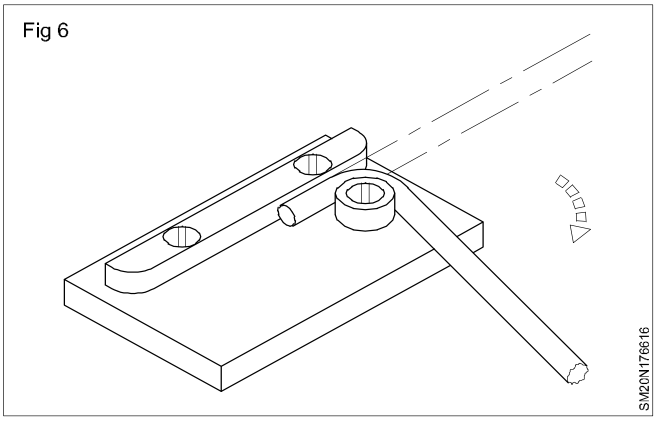
Fig 6
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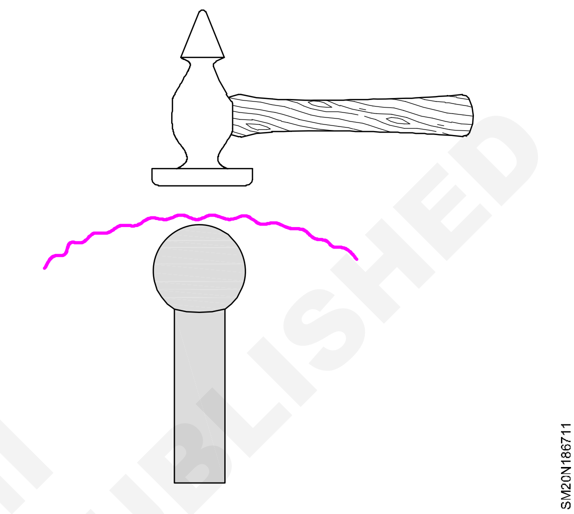
Planishing

Objectives: At the end of this lesson you shall be able to
- **learn about planishing**

Planishing

Planishing is a metalworking techique that involves finishing the surface by finely shaping and smoothing sheet metal. This is done by hammering with a planishing panel hammer or slapper file against a shaped surface called a planishing stake that is held in a vice or a mounting hole in a blacksmith's beak anvil, or against hand-held, shaped,metal tools that are known as Dollies or Anvils. The shape of the stake or dolly has to match the desired work piece contour, and so they come in a variety of complex shapes. After approximately forming a metal object, by stretching with techniques such as sinking and raising, and then shaping and smoothing an object, metal workers use planishing for surface finishing. Planishing is a hand-driven process used in auto body repair and sheet metal craft work such as medieval armour production.Common tools used for planishing include panel beating hammers, slappers, and neck hammers. Heavy rawhide or hardwood hammers are often used.

Fig 1



Description of Polishing Machine

Objectives: At the end of this lesson you shall be able to
- **state the different methods of polishing**
- **state the different compounds used for polishing and buffing**
- **state the method used for giving a satin finish on the metal surface**
- **state the different types of abrasive forms used for polishing according to the coarseness of grains.**

Polishing is a process of making a clean and scratch free surface.

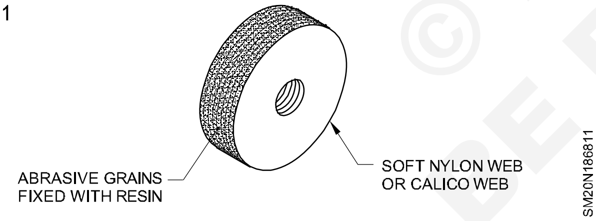
Polishing is done by holding the surface of a workpiece against an abrasive coated wheel or belt and moving the workpiece back and forth till the scratches and defects on the surface of the metal is removed.

The three main methods of polishing a metal by machine are by using

1 Compound and cloth wheels
2 Abrasive covered wheels
3 Abrasive coated belts, discs, sheets and drums.

Flexible abrasive sheets made of soft nylon web, filled with abrasive grains and resin are also used. These sheets are made with either silicon carbide or aluminium oxide. They come in different grades depending upon their coarseness like Coarse, Medium, Fine and very fine. (Fig 1)

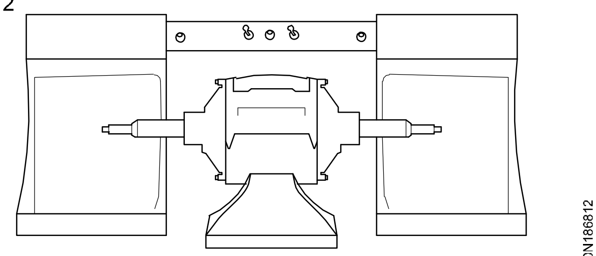
Fig 1



Crocus cloth is a very fine abrasive cloth made from red iron oxide coating. It is used to produce a very fine finish in final buffing operation.

Polishing with compounds and cloth wheels: Attach a clean, soft cloth wheel to the head of the polishing machine (Fig 2). Then select a stick of greaseless polishing compound. This is an abrasive mixed with glue in stick form. Switch on the machine and hold the abrasive stick against the turning wheel until the face is coated. This coating will dry quickly.

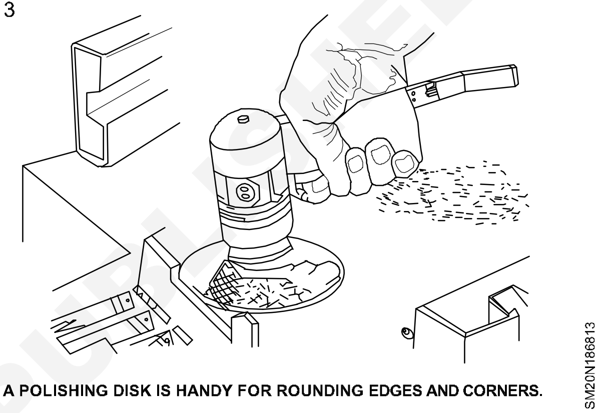
Fig 2



POLISHING MACHINE

Then, holding the workpiece firmly in your hands, move it back and forth across the wheel until the scratches have been removed. Keep the workpiece below the centre line of the wheel for safety. (Fig 3)

Fig 3



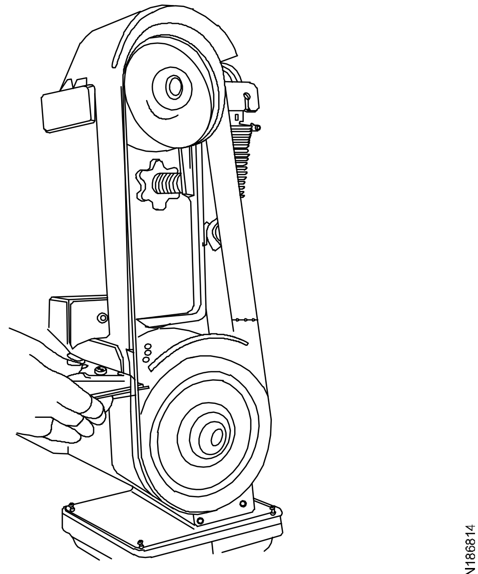
A POLISHING DISK IS HANDY FOR ROUNDING EDGES AND CORNERS.

Polishing with abrasive covered wheels: Polishing is often done with a wheel covered with an adhesive and abrasive grains. Wheels are commonly made from rope, felt canvas or leather.

Hard wheels are made with abrasive grains glued to make the face for polishing.

Polishing with coated abrasives: Coated abrasives are available in belt, disc, sheets and drum forms.

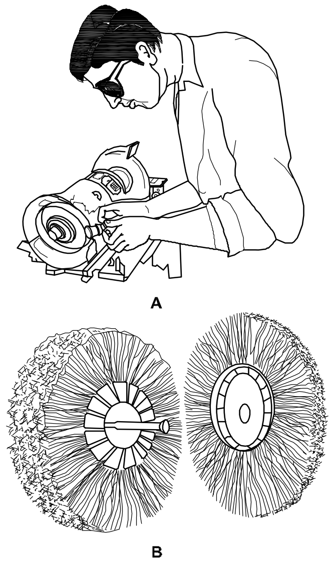
Fig 4



AN ABRASIVE BELT CAN BE USED FOR POLISHING METAL.

Flexible abrasive belts operate around two or three pulleys (Fig 4). These belts are covered with an Aluminium oxide abrasive use on steel and silicon carbide, to use on non-ferrous metals. To do the polishing hold the work on the underside of the sheet or against the belt in the areas between the pulleys. Apply even pressure as you work the piece back and forth. Polishing discs, sheets and drums are also used on polishing machine. (Fig 5) Always wear safety goggles when machine polishing a metal.

Fig 5



Buffing: All small scratches and imperfections must be removed by polishing. A power buffer is good for producing a high shine or luster. A buffing wheel can also be fastened to a lathe or drill press. These wheels are made of cotton, flannel, or felt. The outer surfaces of the wheels are coated with an abrasive compound for buffing. Use a different wheel for each kind of compound.

The four most commonly used natural abrasives are pumice, tripoli, rouge and whiting.

Pumice and tripoli are used for first polishing rouge or whiting are for butter to a highly polished or shiny surface. There are also many artificial abrasives such as aluminium oxide and powders mixed with a bonding agent. They are available in stick or cake form.

Materials for Buffing metal

Pumice: It is powdered lava white in colour used for scrubbing, cleaning and polishing.

Tripoli: It is a decomposed limestone, yellowish brown in colour used for polishing brass, copper, aluminium gold and silver.

Rouge: It is a red iron oxide, red in colour used to furnish or produce a high colour or luster.

Whiting: It is calcium carbonate (pulverized chalk) white in colour used for final polishing.

Polishing is a process of making the surface of a metal clean and free from scratches.

Buffing is a process of giving a shining or a mirror finish to the article to give it an attractive appearance.

Satin finish: The surface of the metal can be given a satin finish by finishing the surface against a wire wheel. (Fig 1)

– Attach the wire wheel to a pedestal grinder or a buffing machine.
– Switch on the machine
– Feed the surface to be finished against the wire wheel just below the centre line.
– Finish the surface as required.
– This will give an attractive softly scratched surface.

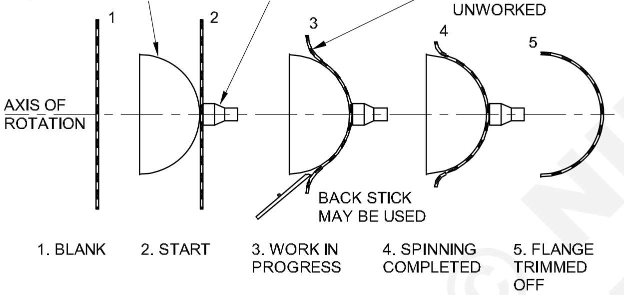
Always wear safety glasses. Fine bits of wire from the wheel can fly off and injure your eyes.

Operating principles of Spinning Lathe and Description

Objectives: At the end of this lesson you shall be able to
- **explain the term metal spinning**
- **state the parts and functions of the spinning lathe**
- **state the types of spinning tools and their uses**
- **state the safety precautions to be followed while working on the spinning lathe**
- **state the care and maintenance of the spinning lathe and spinning tools.**

Metal spinning: Metal spinning is a process whereby sheet metal discs are pressed or rolled to specific shapes by forcing the metal to flow over a suitable mandrel or chuck of the required form, usually by hand tools whilst chuck and metal are rotating together. The shape of the sheet metal changes due to the "PLASTIC FLOW" of metal under pressure manually applied through the "LEVERAGE" of spinning tools. The successive stages in manual spinning showing the spreading or drawing action on a spinning lathe are shown in Fig 1.

Fig 1



SPINNING PROCESS

Parts and function of spinning lathe

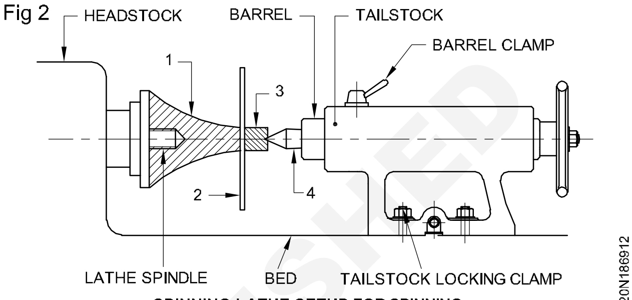
Headstock and spindle: Head stock and spindle must be sturdily built to withstand heavy forces which are applied during the spinning operation. The "HEAD STOCK" differs from that of machinist lathe, where the sheet metal disc (2) from which the article is to be shaped is not held in a chuck, but is held by friction between a "FORMER" (1) sometimes referred to as "MANDREL" or "CHUCK" and generally made of hard wood (such as mahogany or lignum vitae or steel or cast iron) and a follower (3) (Fig 1)

Former and follower: The former (1) is solidly fixed to a head stock spindle and turns with it. The follower (3) is a block of metal or hard wood introduced between the job and the nose of the tailstock barrel, as shown in (Fig 2). Various diameters of follower block are used and each is provided with a centre location.

Live centre: A special live centre (4) is employed capable of rotating freely without friction under the great amount of end thrust which is unavoidable in metal spinning.

Tailstock: The tailstock must have a provision for rapid advance and withdrawal of the barrel in order to allow the spun metal to be annealed. A quick action locking lever, when slackened, disengages the screw and allows the tailstock barrel to slide with ease, enabling it to be rapidly advanced or withdrawn.

Fig 2



SPINNING LATHE SETUP FOR SPINNING

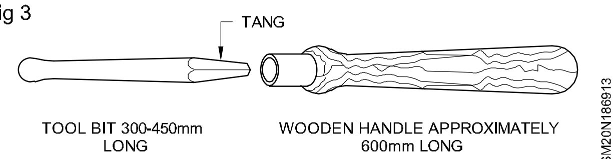
In Fig 2 pressure is applied by means of a tailstock hand wheel. Sufficient pressure must be applied in order to hold the former (1) the work (2) and the follower block (3) so tightly that they will revolve as one. The special live centre is shown at 4.

Types of spinning tools and their uses: The spinning lathe tools are generally named as hand forming tools also. All the tools mainly consist of two parts. They are (1) tool bit (2) wooden handle.

Tool bit is approximately 300-450 mm in length and usually forged to shape from high speed steel round bar and hardened.

It has a tang which fits into a handle. The wooden handle is approximately 600 mm in length. The bit, when securely fitted (Fig 3) projects from the handle for a distance of 200 mm. The average overall length of the hand forming tool is between 750 and 850 mm.

Fig 3



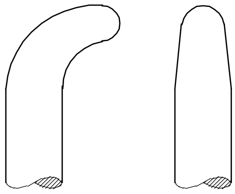
Types of the spinning lathe tools

1 Combination ball and point tool
2 Ball tool
3 Hook tool
4 Fish and tail planishing tool
5 Pointed or round nose tool
6 Cut off or trimming tool
7 Bending tool
8 All purpose flat or forming tool.

Use of the spinning lathe tools

1 **Combination ball and point tool (Fig 4):** This tool is most useful as it can produce different shapes by rotating it in different directions.

Fig 4



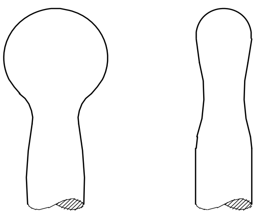
COMBINED BALL AND POINT

2 **Ball tool (Fig 5):** It is used for first step in spinning for hard metals such as brass and steel and also used to bring the metal near to the chuck. It is used for finishing curves.

3 **Hook tool (Fig 6):** It is used to give shape for inside formation.

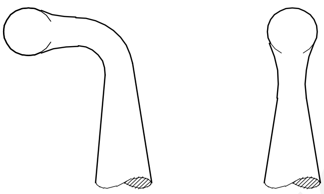
4 **Fish tail planishing tool (Fig 7):** It is commonly used for finishing work and very useful for sharpening any radii in the contour.

Fig 5



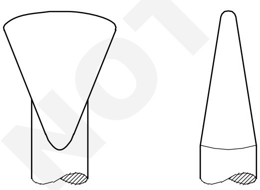
BALL TOOL

Fig 6



HOOK TOOL

Fig 7



FISH-TAIL PLANISHING TOOL

5 **Pointed or Round nose tool (Fig 8):** Used for hooking the disc to the chuck at the start of the spinning. It is also used for shaping small curves.

6 **Cut off or trimming tool (Fig 9):** Used for trimming the extra metal from the edge of the spun object.

7 **Bending tool (Fig 10):** Used for turning the edge of a spun project for beaded lip.

Fig 8

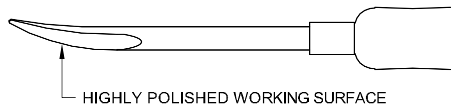
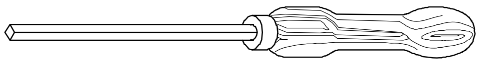
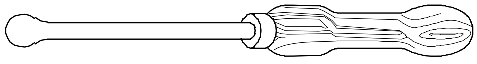


Fig 9



CUT OFF OR TRIMMING TOOL

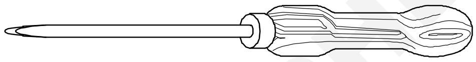
Fig 10



BENDING TOOL

8 **All purpose flat or forming tool (Fig 11):** One part of the tip is flat for smoothing purpose. The other side is round and it is used for all spinning purpose.

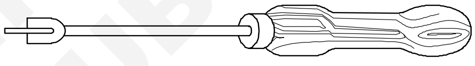
Fig 11



ALL PURPOSE FLAT OR FORMING TOOL

9 **Beading tool (Fig 12):** It is used for turning the edge of a spun project for beaded lip.

Fig 12



BEADING TOOL

Specification of the spinning lathe: Length of bed in mm. Height of centre over bed in mm. Power required in H.P. Net weight in kgs.

Care and maintenance

1 The spinning lathe should be cleaned before and after the work.

2 Lubricant is a must when spinning is under progress.

It is necessary, that the friction between the nose of the forming tool and the work be reduced to a minimum in order to prevent excessive heat being developed, scratching or cutting of the metal surface and possible damage to the tool.

To protect the tool and work piece from damage, it is absolutely necessary to lubricate the tool and the part using the correct lubricant.

It must be sufficiently adhesive to cling to the metal disc when it is revolving at high speeds.

In hand spinning, tallow and industrial soap or a mixture of both, are generally used as lubricants.

Safety precautions

1 Only authorised persons should operate the machine.
2 Do not use the machine if it is out of order.
3 Never clean or oil a machine while it is in motion.
4 Always stop the machine to make any adjustment.
5 Keep waste or clothes away from the revolving parts.
6 Never stand directly behind the revolving disc.
7 Too much lubricant should not be used at the time of spinning.
8 Should wear leather apron.

Spin forming dies

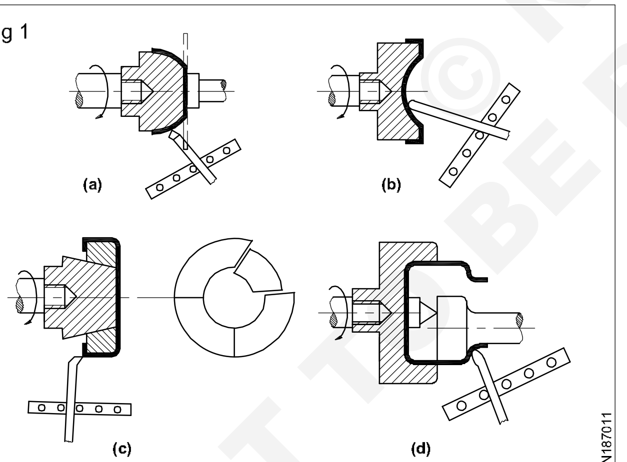
Objectives: At the end of this lesson you shall be able to
- **explain the different types of spinning dies**
- **state the use of segmental dies**
- **state the materials from which dies are made of.**

Spinning: Spinning is an operation of producing a seamless article on a spinning lathe with the help of various spinning tools. The quality of the product depends on the skill of the operator. Quality products can be produced by regular, sincere and systematic practice.

Spinning is a very economical means of producing a component, where the quantity of work is less and the cost of the press tool for producing that component will be more. In such cases, spinning process is recommended. The cost to make a spinning die will be very cheap when compared to press tools. The articles can be made fast hence saving time. After the completion of a particular job the die can be modified to suit the next job.

Spinning dies: Spinning dies are also called as chucks or formers. Spinning dies are generally made from cast iron or mild steel. These dies can also be made from oak, cherry or other hard wood. The metals used for spin forming are aluminium, copper and its alloys, silver, stainless steel and annealed mild metals.

Fig 1



SPIN FORMING DIES

There are various types of dies shown in Fig 1

a) **Outside drawing die:** It is mostly used for general spin forming. The shape of the die depends upon the contour of the component.

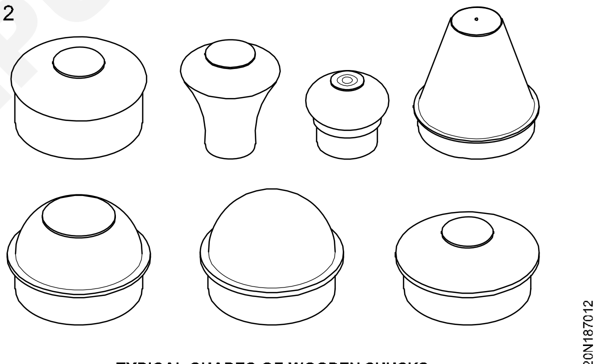
b) **Inside drawing die:** It is used for forming the indentation at the bottom of a vessel after initial drawing.

c) **Segmental die:** It is divided into several parts by means of a mechanism in which the die can be separated into several parts which can be removed easily from a finished component where the mouth is smaller than the die piece. It is also called a split die.

d) **Core die:** It is used for forming the neck of a vessal after initial drawing.

A few wooden formers are also shown in Fig 2. The spinning tools are also called as lateens.

Fig 2



TYPICAL SHAPES OF WOODEN CHUCKS

Metal joining methods

Objectives: At the end of this lesson you shall be able to
- **state the different methods used to change the shape of metals**
- **name and illustrate the different metal joining methods**
- **state the limitation/disadvantages of joining methods other than welding**
- **state the advantages of welding.**

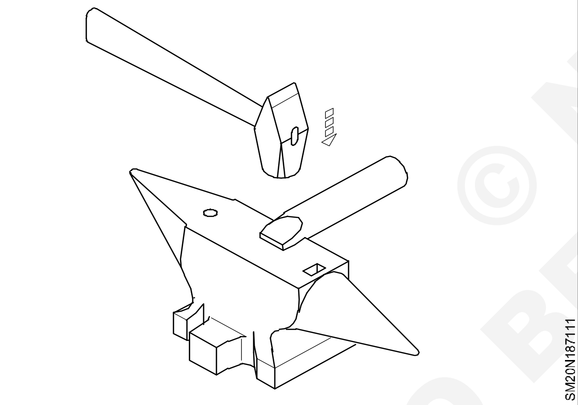
Welding is a metal joining method. The art of joining metals is about 3000 years old. The origin of welding is probably to be traced to the shaping of metals. In industry every worker is working for changing the shape of metals by different methods and machines.

Shaping of metals: To change the shape of the metals the following methods are generally used.

- Forging
- Moulding/casting
- Cutting
- Joining

Forging: This is a method used for changing the shape of metals, by heating the metal in a forge and then hammering it on an anvil, e.g. forming chisel, punch etc. by black-smiths. (Fig 1)

Fig 1



Moulding: This is a method in which the shape of the metal is changed by melting the metal into liquid form and then pouring the same into moulds. The poured metal takes the shape as per the mould after cooling e.g. bench vice, machine beds, frying pans, aluminium pressure cooker etc.

Cutting: This is a method in which the shape of metal is changed by cutting the extra material from a metal piece as per our requirement e.g. fitting, turning, machining, shearing, gas cutting etc.

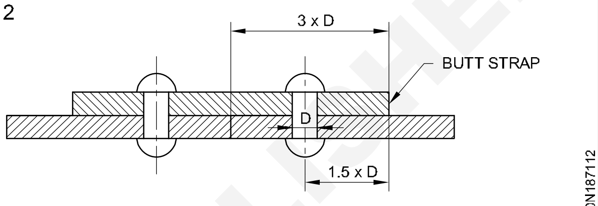
Joining: In this method the shape of the metal is changed by joining two or more pieces of metals as per our requirement e.g. making a chair, welding table, bridge, bus body, tin container, oilcan etc. The following methods are commonly used for joining the metals.

Metal joining methods

- Riveting
- Bolting
- Seaming
- Soldering (or) hooking
- Brazing
- Welding

Riveting: Riveting is a method of joining (temporarily) by drilling a common hole in overlapped pieces and then fastening them by putting a rivet and hammering. (Fig 2) Can be opened by cutting the rivet head.

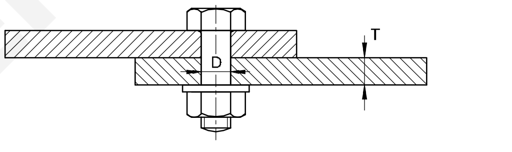
Fig 2



SINGLE COVER BUTT JOINT

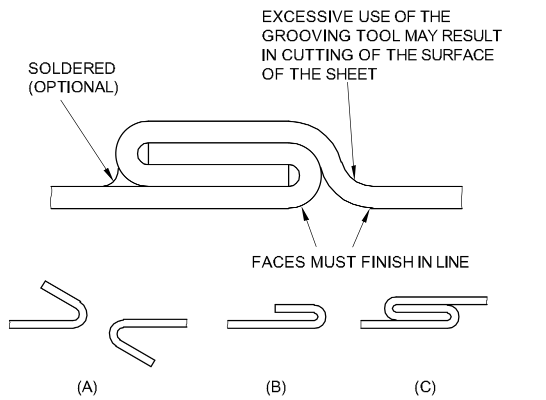
Assembling with bolt: Similar to riveting. The rivet is replaced by bolt and nut fastening. It can be easily opened by unscrewing the nut. (Fig 3)

Fig 3



Seaming: In this joint the edges of thin sheets to be joined are folded, hooked together and then pressed to form a joint. The joint can be opened by unfolding the hooks. (Fig 4)

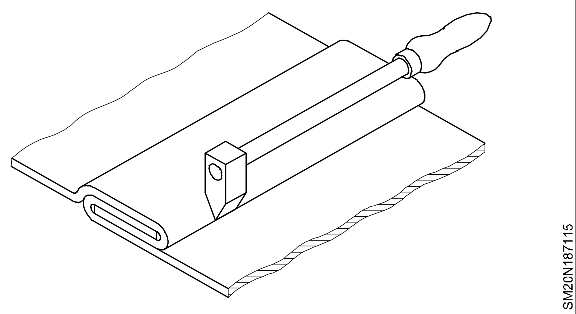
Fig 4



SINGLE GROOVED SEAM

Soldering: This joint is made on thin metals using solder as a joining medium. The melting point of solder is less than the metals to be joined. The joint can be opened by heating up to the solder melting temperature (below 400°C).

Fig 5



Brazing: The joint is similar to soldering but has more strength. The joining medium used is brass, which has a higher melting temperature than solder. The joint can also be opened by heating up to the melting point of brass (850-950°C).

Welding: A metal joining method in which the joining edges are heated and fused together with or without filler metal to form a permanent (homogeneous) bond is known as welding. Different methods of welding are given at the end of this lesson.

Limitation/disadvantages of joining methods other than welding

In riveting and bolting, number of holes are to be drilled and the strength of the plate gets reduced due to drilling of holes. So to maintain the required strength of the joint, it is necessary to use a higher thickness plate. This increases the cost of material. Drilling of holes, use of rivets, bolts, nuts, washers etc. will also increase the cost of making these type of joints. The projection of rivet head, bolt heads, nuts etc obstructs further assemblies and affects uniform flow of liquids or gases or air inside a pipe. In case of seaming using sheetmetal joints, plates with higher thickness cannot be formed as a joint. So sheetmetal joints are suitable for joining thin sheets only. The soldering and brazing is not suitable for joints which are subjected to temperatures above 300^0C and 800^0C respectively. The joint will get separated at the above temperature. Also the strength at the joint will be very less compared to the strength of the base metal.

Comparison between welding and other metal joining methods

Welding method: Welding is a metal joining method in which the joining edges are heated and fused together to form a permanent (homogeneous) bond/joint. Riveting, assembling with bolt, seaming, soldering and brazing all result in temporary joints. Welding is the only method to join metals permanently.

The temporary joints can be separated if:

– the head of the rivet is cut
– nut of the bolt is unscrewed
– hook of the seam is opened
– more heat is given than that required for soldering and brazing.

Welded joints cannot be separated like soldering and brazing because it is made homogeneous by heating and fusing the joining edges together.

Advantages of welding

Welding is superior to other metal joining methods because it:

– is a permanent pressure tight joint
– occupies less space
– gives more economy of material
– has less weight
– withstands high temperature and pressure equal to joined material
– can be done quickly
– gives no colour change to joints.

It is the strongest joint and any type of metal of any thickness can be joined.

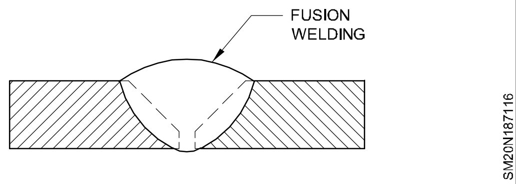
Different methods of welding

Welding is a method of joining metals permanently. It is an ancient method, about 1500 years old. The method used in ancient days was forge or blacksmith welding. One of the methods of classifying welded joints is the method used to effect the joint between metal pieces. Accordingly the methods are:

– **fusion method** without pressure / with pressure
– non-fusion method.

Fusion welding without pressure (Fig 1): A method of welding in which similar and dissimilar metals are joined together by melting and fusing their joining edges with or without the addition of filler metal but without the application of any kind of pressure is known as fusion welding.

Fig 6



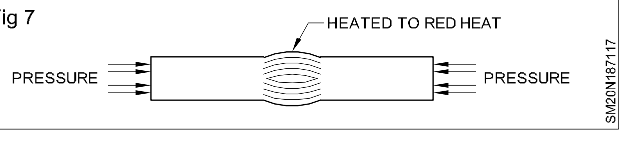
The joint made is permanent. The common heating sources are:

1) arc welding 2) gas welding. 3) chemical reaction (thermit welding)

Pressure welding (Fig 2) - This is a method of welding in which similar metals are joined together by heating them to plastic or partially molten state and then joined by pressing or hammering without the use of filler metal. This is fusion method of joining with pressure. The joint is made permanent. Heat source may be blacksmith forge (forge welding) or electric resistance (resistance welding) or friction.

Non-fusion welding - This is a method of welding in which similar or dissimilar metals are joined together without melting the edges of the base metal by using a low melting point filler rod but without the application of pressure.

Fig 7

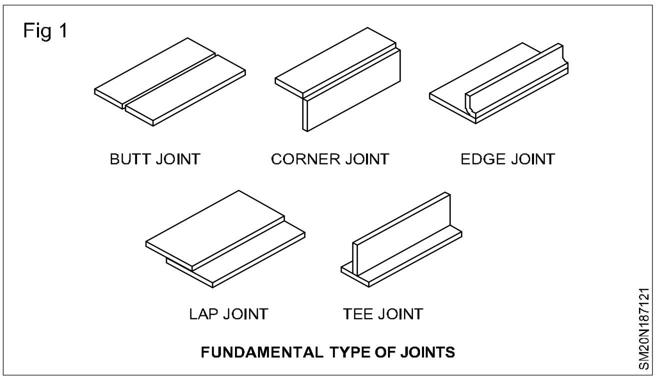


Basic welding joints and nomenclature of butt and fillet weld

Objectives: At the end of this lesson you shall be able to
- **illustrate and name the basic welding joints.**
- **explain the nomenclature of butt and fillet welds.**

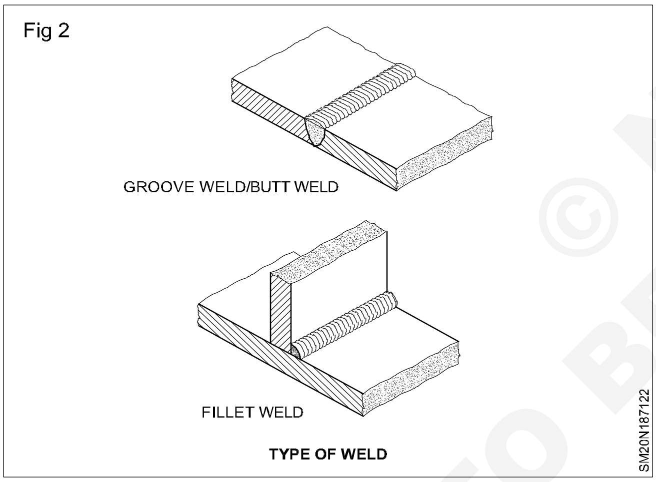
Basic welding joints (Fig.1)

The various basic welding joints are shown in Fig.1. The above types mean the shape of the joint, that is, how the joining edges of the parts are placed together.



Types of weld: There are two types of weld.(Fig.2)

- Groove weld/butt weld
- Fillet weld



Nomenclature of butt and fillet weld (Figs 3 and 4)

Root gap: It is the distance between the parts to be joined. (Fig 3)

Heat affected zone: Metallurgical properties have been changed by the welding heat adjecent to weld.

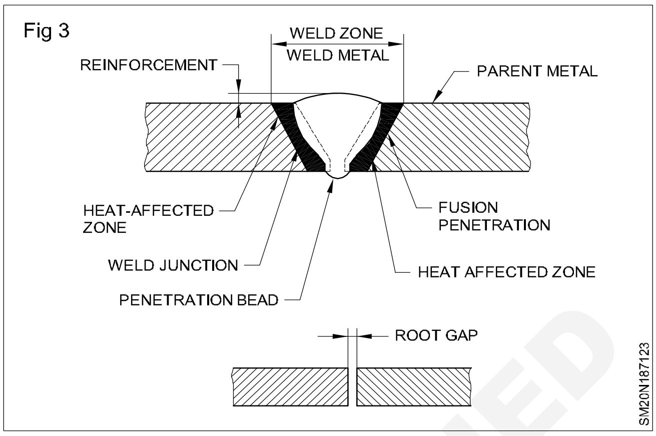
Leg length: The distance between the junction of the metals and the point where the weld metal touches the base metal ‘ toe’. (Fig 5)

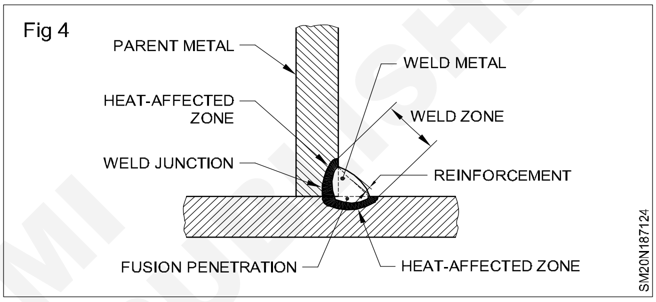
Parent metal: The material or the part to be welded.

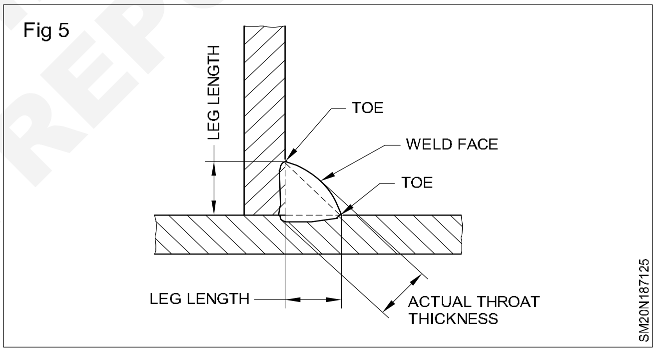
Fusion Penetration: The depth of fusion zone in the parent metal.(Fig.3 and 4)

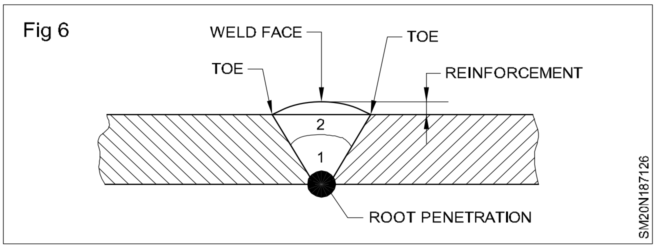
Reinforcement: Metal deposited on the surface of the parent metal or the excess metal over the line joining the two toes. (Fig 6)

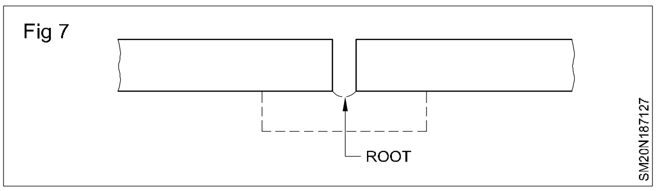
Root: The parts to be joined that are nearest together. (Fig 7)











Root face: The surface formed by squaring off the root edge of the fusion face to avoid a sharp edge at the root. (Fig 8)

Root run: The first run deposited in the root of a joint. (Fig 9)

Root penetration: It is the projection of the root run at the bottom of the joint (Fig.6 and 9)

Run: The metal deposited during one pass.Fig.9.

The second run is marked as 2 which is deposited over the root run. The third run is marked as 3 which is deposited over the second run.

Fig 8

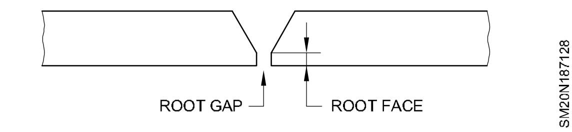
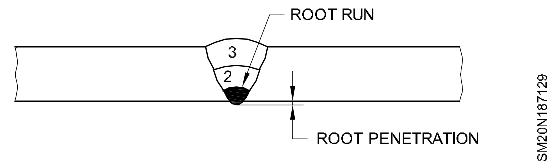
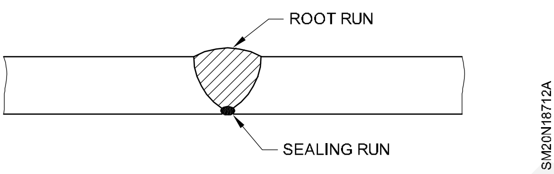


Fig 9



Sealing run: A small weld deposited on the root side of a butt or corner joint (after completion of the weld joint). (Fig 10)

Fig 10



Backing run: A small weld deposited on the root side of the butt or corner joint (before welding the joint).Fig.6

Throat thickness: The distance between the junction of the metals and the midpoint on the line joining the two toes.(Fig.5)

Toe of weld: The point where the weld face joins the parent metal.(Fig.5 & 6)

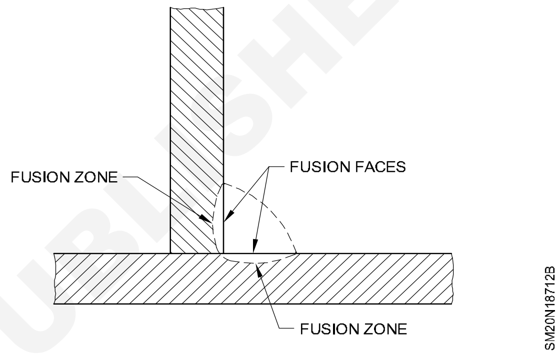
Weld face: The surface of a weld seen from the side from which the weld was made.(Fig.5 & 6)

Weld junction: The boundary between the fusion zone and the heat affected zone.(Fig.3 & 4)

Fusion face: The portion of a surface which is to be fused on making the weld.(Fig 11)

Fusion zone: The depth to which the parent metal has been fused. (Fig 11)

Fig 11



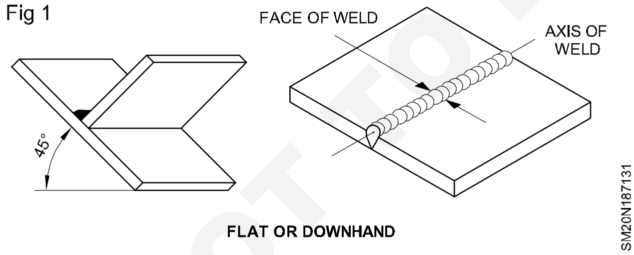
Basic welding positions

Objective : At the end of this lesson you shall be able to
- **name and illustrate the basic welding positions**

Basic welding positions

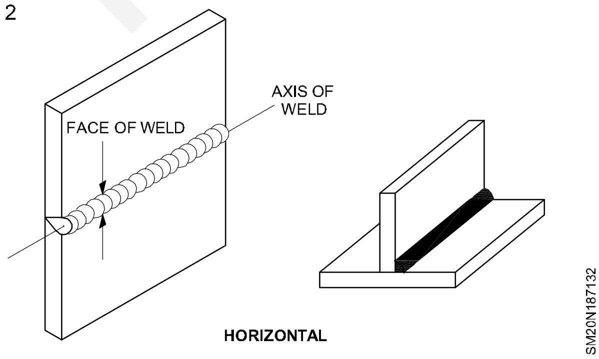
– Flat or downhand position (Fig 1)

Fig 1



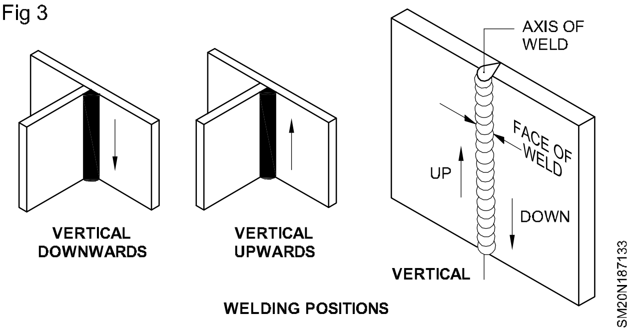
– Horizontal position (Fig 2)

Fig 2



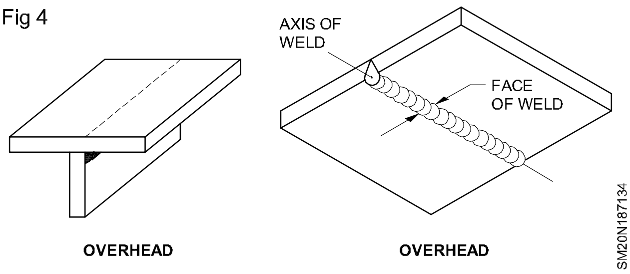
– Vertical position (Vertical up and down) (Fig 3)

Fig 3



– Overhead position (Fig 4)

Fig 4



All welding action takes place in the molten pool, formed in the welding joint/welding line.

The position of the welding joint line and the weld face in respect of ground axis indicates the welding position.

All joints may be welded in all positions.

High Pressure Oxy-acetylene welding equipment and accessories

Objectives: At the end of this lesson you shall be able to
- **distinguish between the features of oxygen and acetylene gas cylinders**
- **compare the features of oxygen and acetylene gas regulators**
- **distinguish between the hose-connectors used in oxygen and acetylene regulators**
- **describe the function of hose-protectors**
- **state the functions of blowpipes and nozzles.**

Oxy-acetylene welding is a method of joining metals by heating them to the melting point using a mixture of oxygen and acetylene gases. (Fig 1)

Oxygen gas cylinders: The oxygen gas required for gas welding is stored in bottle-shaped cylinders. These cylinders are painted in black colour. (Fig 2) Oxygen cylinders can store gas to a capacity of 7 m^3 with the pressure ranging between 120 to 150 kg/cm^2. Oxygen gas cylinder valves are right hand threaded.

Dissolved acetylene cylinders: The acetylene gas used in gas welding is stored in steel bottles (cylinders) painted in maroon colour. The normal storing capacity of storing acetylene in dissolved state is 6m^2 with the pressure ranging between 15-16 kg/cm^2.

Fig 1

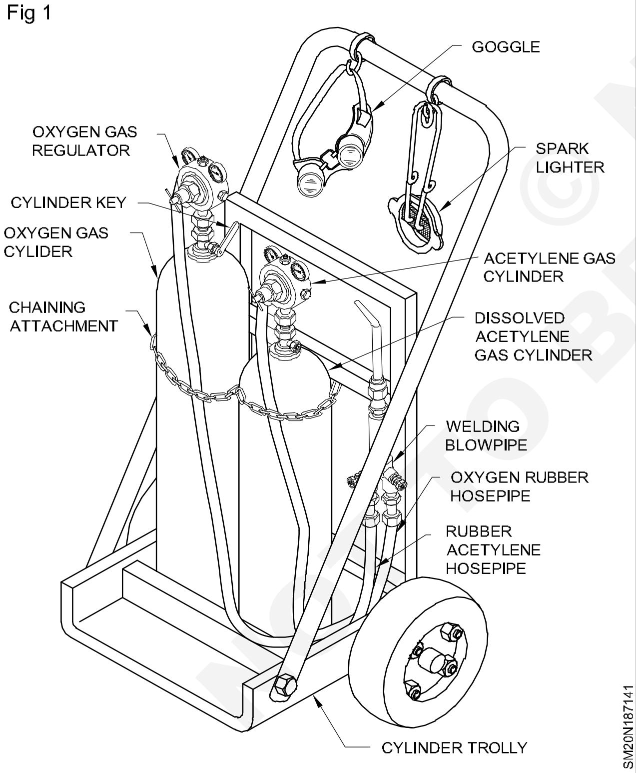
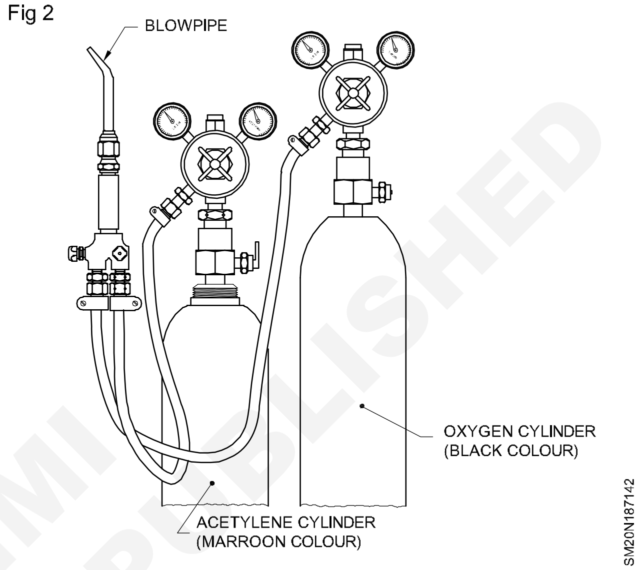
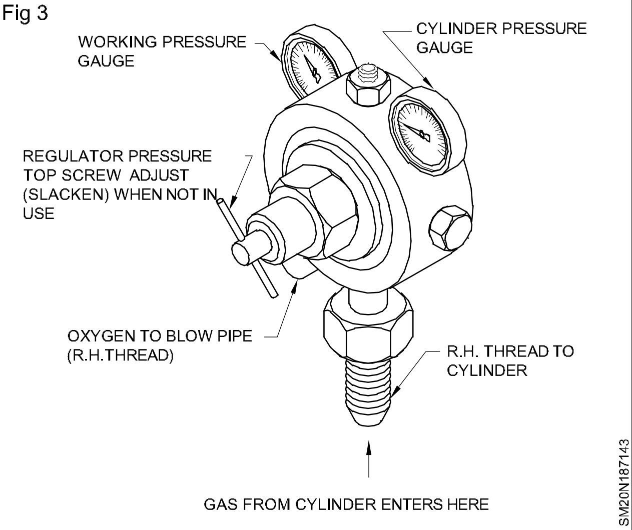


Fig 2



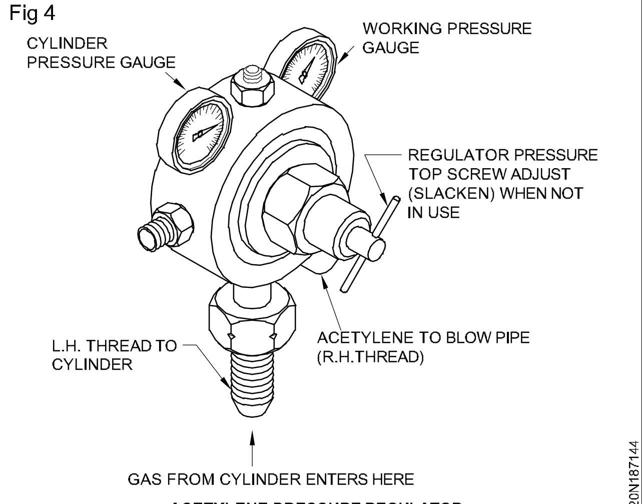
Oxygen pressure regulator: This is used to reduce the oxygen cylinder gas pressure according to the required working pressure and to control the flow of oxygen at a constant rate to the blowpipe. The threaded connections are right hand threaded. (Fig 3)

Fig 3



Acetylene regulator: As with the case of oxygen regulator this also is used go reduce the cylinder gas pressure to the required working pressure and to control the flow of acetylene gas at a constant rate to the blowpipe. The threaded connections are left handed. For quickly identifying the acetylene regulator, a groove is cut at the corners of the nut. (Fig 4)

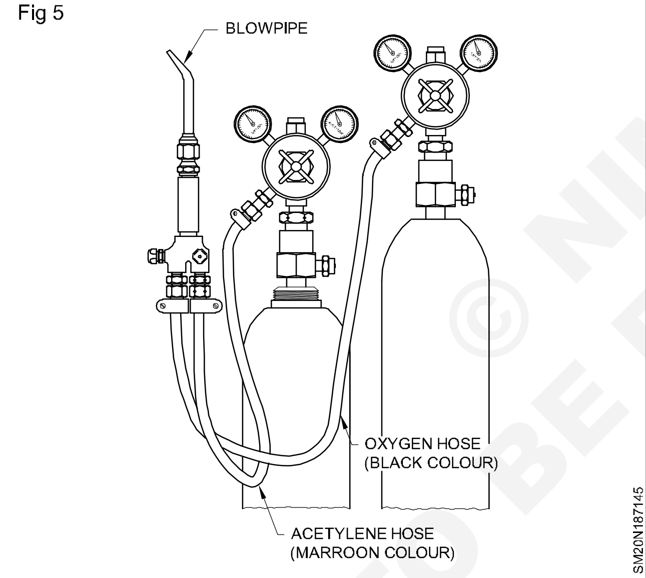
Fig 4



ACETYLENE PRESSURE REGULATOR

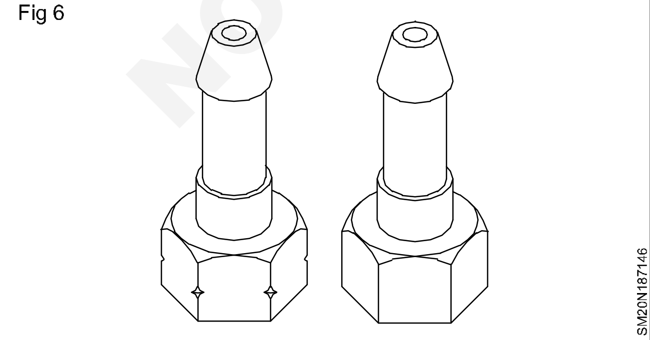
Rubber hose-pipes and connections: These are used to carry gas from the regulator to the blowpipe. These are made of strong canvas rubber having good flexibility. Hose-pipes which carry oxygen are black in colour and the acetylene hoses are of maroon colour. (Fig 5)

Fig 5



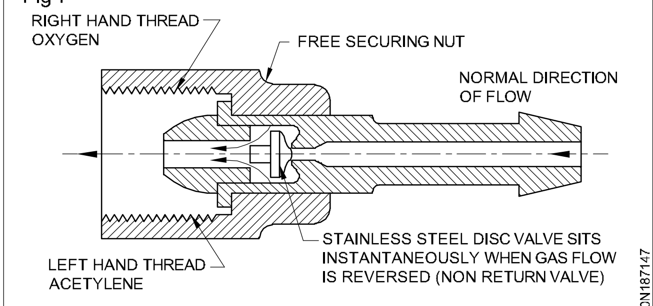
Rubber hoses are connected to regulators with the help of unions. These unions are right hand threaded for oxygen and left hand threaded for acetylene. Acetylene hose unions have la groove cut on the corners. (Fig 6)

Fig 6



At the blowpipe end of the rubber hoses hose-protectors are fitted. The hose protectors are in the shape of a connecting union and have a non-return disc fitted inside to protect from flashback and backfire during welding. (Fig 7)

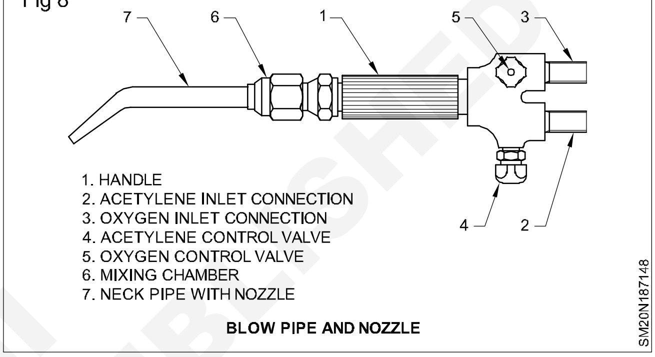
Fig 7



HOSE PROTECTOR

Blowpipe and nozzle: Blowpipes are used to control and mix the oxygen and acetylene gases to the required proportion. (Fig 8)

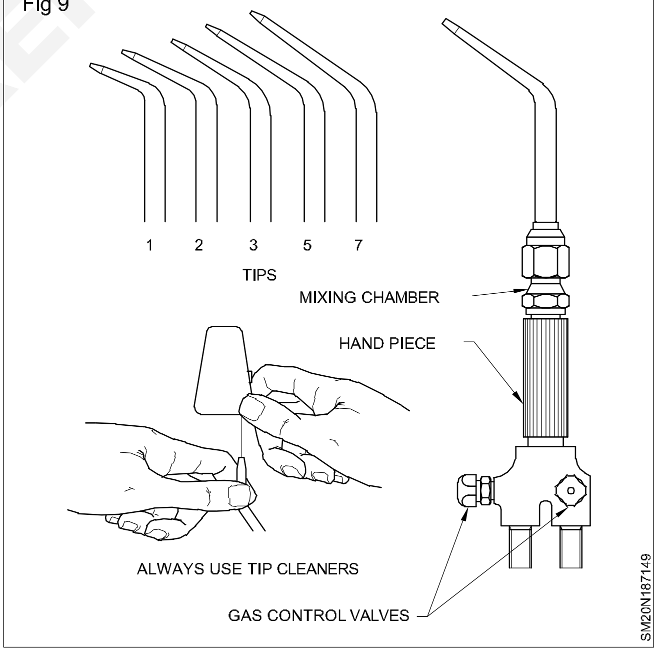
Fig 8



BLOW PIPE AND NOZZLE

A set of interchangeable nozzles of different sizes is available to produce smaller or bigger flames (Fig 9).

Fig 9



The size of the nozzle varies according to the thickness of the plates to be welded. (Table 1)

TABLE 1

Plate thickness mm	Number	Nozzle size Litres/hr
0.8	1	29
1.2	2	57
1.6	3	86
2.4	5	140
3.0	7	200
4.0	10	280
5.0	13	370

Plate thickness mm	Number	Nozzle size Litres/hr
6.0	18	520
8.0	25	710
10.0	35	1000
12.0	45	1300
19.0	55	1600
25.0	70	2000
25.0	90	2500

Gases used in welding and gas flame combinations

Objectives: At the end of this lesson you shall be able to
- **name the different types of gases used in welding**
- **compare the different types of gas flame combinations**
- **state the uses of the different gas flame combinations.**

In the gas welding process, the welding heat is obtained from the combustion of fuel gases in the presence of a supporter of combustion (oxygen).

Comparison of different gas flame combinations and their uses

Sl. No.	Fuel gas	Supporter of combu-stion	Name of the gas flame combina-tion	Temperature	Application/Uses
1	Acetylene	Oxygen	Oxy-acetylene flame	3100 to 3300^{0}C (Highest tempe-rature)	To weld all ferrous and non-ferrous metals and their alloys; gas cutting & gouging of steel; brazing bronze welding; metal spraying and hard facing.
2	Hydrogen	Oxygen	Oxy-hydrogen flame rature)	2400 to 2700^{0}C (Medium tempe-cutting of steel.	Only used for brazing, silver soldering and underwater gas
3	Coal gas	Oxygen	Oxy-coal gas flame	1800 to 2200^{0}C (Low temperature)	Used for silver soldering and underwater gas cutting of steel.
4	Liquid petroleum gas (LPG)	Oxygen	Oxy-liquid pet-roleum gas fla-me	2700 to 2800^{0}C (Medium temper-ature)	Used for gas cutting steel & heating purposes. (Has moisture and carbon effect in the flame.)
5	Acetylene	Air	Air-acetylene flame	1825 to 1875^{0}C (Low temperature)	Used only for soldering, brazing, heating purposes and lead burning.

(Oxy-acetylene gas flame combination is used in most gas welding processes because of the high temperature and heat intensity.)

Principles of ARC Welding

Objectives: At the end of this lesson you shall be able to
- **state the types and classify electric welding processes**
- **state the principle of electric arc welding**

Electric welding: This is a process of welding in which the heat energy is obtained from electricity.

When electric current passes through a, medium material it generates heat.

The amount of heat generated depends upon:

- the amount of current passing through the medium
- the changes taking place in the medium
- the resistance of the medium.

By adjusting current and resistance, sufficient heat can be produced to melt the metals.

Principle of shielded Metal Arc Welding

An electric arc is maintained between the end of a coated metal electrode and work piece.

The flux covering melts during welding and forms gas and slag to shield the arc molten weld pool. The flux also provides a method of a adding scavengers, deoxidizers and alloying elements to the weld metal

Various Name Stick Electrode welding,
Electric Arc welding,
Shielded Metal Arc welding (SMAW)
Manual Metal Arc welding (MMAW)
Popularly known as Arc welding

IIt is a manual & ancient welding process, 100 years old

Main parts in SMAW

- Welding Machine
- Electrode Holder
- Ground Clamp(Earth)
- Welding Cables

Types of power source

1 AC welding Transformer
2 DC motor Generator
3 Rectifier set
4 Inverter

SMAW advantages / Disadvantages

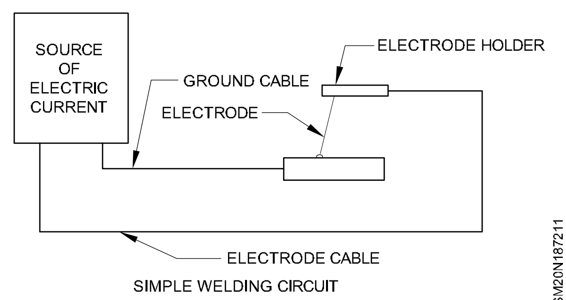
Advantages:

1 Field or shop use; less sensitive to wind and dirt
2 Wide range of consumables
3 All positional; flexible
4 Very portable; can reach limited access areas
5 Simple, inexpensive equipment

Disadvantages:

1 High skill factor
2 Slag inclusions
3 Low deposition rate and operating factor
4 High level of fume
5 Hydrogen control
6 Can't weld low melting point (e.g.pb,sn,zn) or reactive metals (e.g.ti)

Fig 1



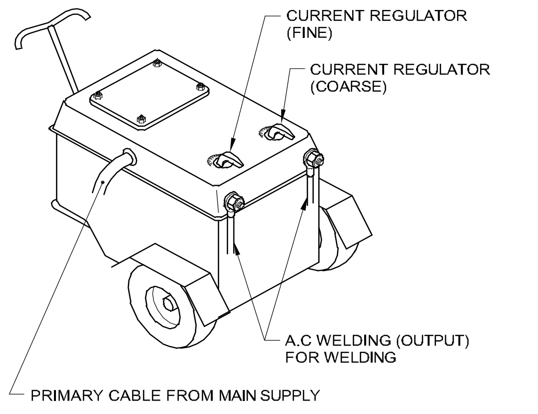
SIMPLE WELDING CIRCUIT

Types of Welding Machine

Objectives: At the end of this lesson you shall be able to
- **identify the features of an AC welding transformer, DC welding generator and welding rectifier**
- **explain the working principle of the above welding machines**
- **compare the advantages and disadvantages of an AC and a DC welding machine**
- **explain the care and maintenance of welding machines.**

AC welding transformer: This is a type of AC welding machine which converts AC main supply into AC welding supply. (Fig 1)

Fig 1



AC WELDING TRANSFORMER

> **AC main supply has high voltage-low ampere. AC welding supply has high ampere-low voltage.**

It is a step down transformer, which:

- reduces the main supply voltage (220 or 440 volts) to welding supply open circuit voltage (OCV), between 40 and 100 volts
- increases the main supply low current to the required high output welding current in hundreds of amperes.

An AC welding transformer cannot be operated without AC main supply.

Constructional features: It consists of an iron core made out of a special alloy thin iron sheet stampings. Two coils of wire are wound over the iron core without any interconnection between them.

One coil, called primary winding, consists of a thin conductor and has more turns which receive energy from the mains. The second coil, called secondary winding consists of a thick conductor and less turns which supply energy for welding.

A current regulator is attached to the secondary output supply to adjust the amperes for welding suitable to the various sizes of electrodes.

Two welding cables are attached with the output terminals.

One is for the electrode and the other is for earth or job.

The transformer may be air-cooled or oil-cooled.

Working principle: The AC main supply (220-440 volts) is connected to the primary winding which produces a magnetic lines of force in the iron core.

The magnetic lines of force affects the secondary winding and induces high ampere-low voltage welding supply in it.

> **This action is called the principle of mutual induction.**

The voltage at the primary coil is reduced in the secondary coil depending on the ratio of the No. of turns in the primary to that of the secondary.

Not suitable for:

Voltage at secondary coil =

$$\frac{\text{Voltage at primary coil} \times \text{No. of turns in the secondary}}{\text{No.of turns in the primary}}$$

Advantages

- Less initial cost
- Less maintenance cost
- Freedom from arc blow
- NO noise

> **The magnetic effect of DC disturbs the arc, the effect of which is called 'arc blow'.**

Disadvantages

- welding of non-ferrous metals
- bare wire electrodes
- fine current setting in welding special jobs.

> **AC cannot be used without special precautions of safety.**

Care and maintenance

Transformer body must be properly earthed.

Transformer oil must be changed after recommended period, in the oil cooled transformers.

Always follow the operating instruction manual to run and install the machine.

Do not run the machine continuously on its maximum capacity.

Switch off the main supply of the machine while cleaning internally or externally.

Do not change the current when welding is going on.

Always keep and install the machine on dry floor.

Give proper protection to the machine while working outside in rain or dust.

D.C welding generator

Necessity of DC welding generator

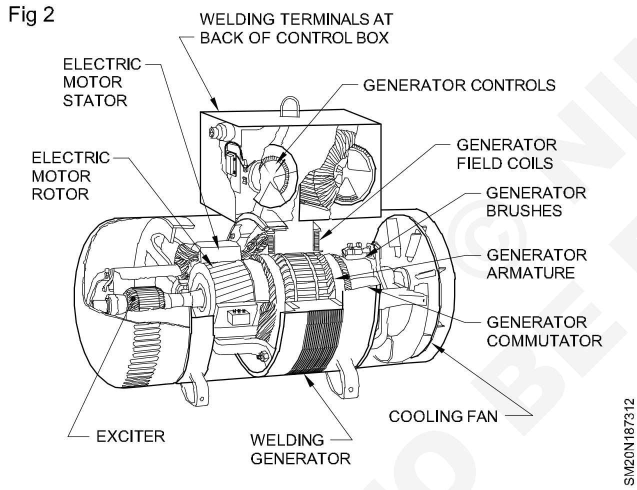
DC welding generators are used to:

- generate DC welding supply with the help of AC main supply
- generate welding supply where electricity (main supply) is not available, with the help of engine driven sets
- get relative advantages of polarity i.e. heat distribution between the electrode and the base metal and welding of non-ferrous metals.

Constructional features of DC welding generator (Fig.2)

A DC welding generator (Fig.2) consists of the following parts.

Fig 2



Main poles: These are connected to the body or yoke to produce magnetic lines of force, also called FIELD COILS.

Body or yoke: It is the body of the generator which covers all the parts and helps in completing the magnetic circuit to generate electricity.

Armature: It is a laminated steel drum with longitudinal stole which accommodate copper conductors.

It is mounted on a shaft which rotates in suitable bearing arranged at its ends.

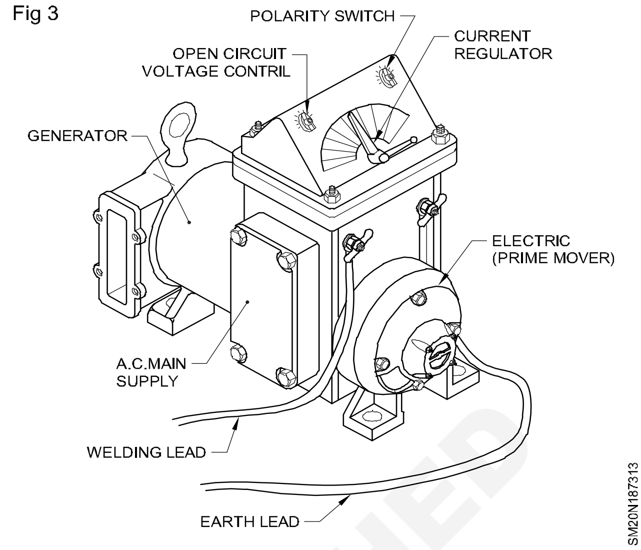
It is also mounted on the shaft along with the armature and is connected to the armature conductors.

Carbon brushes: These are mounted on the body to have contact with the rotating commutator and are connected to the output terminals.

Fan: It is meant for cooling the generator.

Prime mover: It is the driving source as motor or engine used to rotate the armature in the generator. (Fig 3)

Fig 3



Working principle of DC welding generator: The armature is made to rotate with the help of a prime mover between the main poles, where a strong magnetic field exists

The armature cuts the magnetic lines of force, generating emf in its conductors. The commutator, being connected to the armature conductors, changes the generated alternating current into DC. The generated DC is then taken to the generator terminals through the carbon brushes. Where the main supply electricity is available; a motor is used as a prime mover. For field work or where main supply is not available, petrol or diesel engine may be used as a prime mover.

care and maintenance of arc welding generators

To make the best use of the arc welding generator and to ensure its longer life the following checkpoints are to be observed.

Checkpoints for engine of an engine driven generator.

Check the water level in the radiator and the oil level in the engine daily.

Change the engine oil after running for 250 hrs.

Lubricate the fan bearing once in a week.

Check fan belts daily for their proper tightness.

Check petrol or diesel pipe unions leakage daily.

Checkpoints for motor driven generator

Blow out the dust from the inside of the generator with dry compressed air at 1.5 to 2.0 kg/cm^2 pressure after every three months.

Check every week the contact of the carbon brushes with the commutator to ensure it is in good condition without sparking.

Lubricate the shaft bearings after six months with good quality grease.

Guard the rotating parts with suitable covers.

Do not cover the air ventilation ducts.

Do not operate the polarity switch during arcing.

Ensure a proper working of the cooling fan.

Check the electrical connections and avoid loose connections.

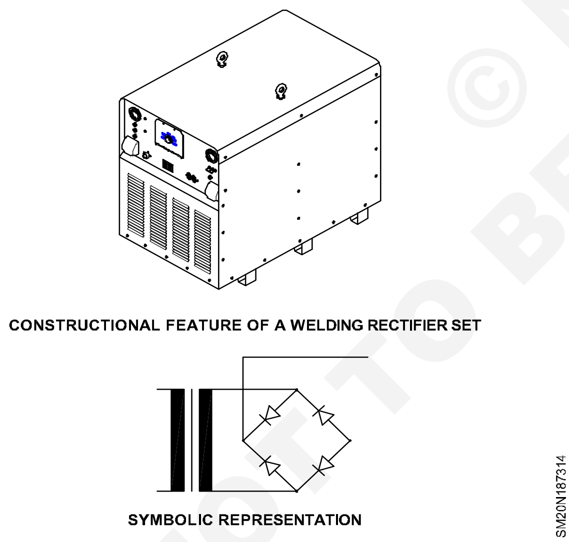
Never run the motor on a weak phase.

Ensure the electric motor is properly earthed.

Constructional features of AC/DC welding rectifier: A welding rectifier set is used to convert AC welding supply into DC welding supply. It consists of a step down transformer and welding current rectifier cell with a cooling fan. (Fig, 4) The rectifier cell consists of a supporting plate made of steel or aluminium (Fig.5) which is plated with a thin layer of nickel or bismuth, sprayed with SELENIUM or SILICON. It is finally covered with an alloyed film of CADMIUM, BISMITH and TIN.

The coating of nickel or bismuth over the supporting plate serves as one electrode (ANODE) of the rectifying cell. The alloyed film (of cadmium, bismuth and tin) serves as another electrode (CATHODE) of the rectifying cell. The rectifier acts as a non-return valve and allows current to flow one side of it as it offers very little resistance and on the other side it offers very high resistance to the flow of the current. Hence the current can flow in one direction only.

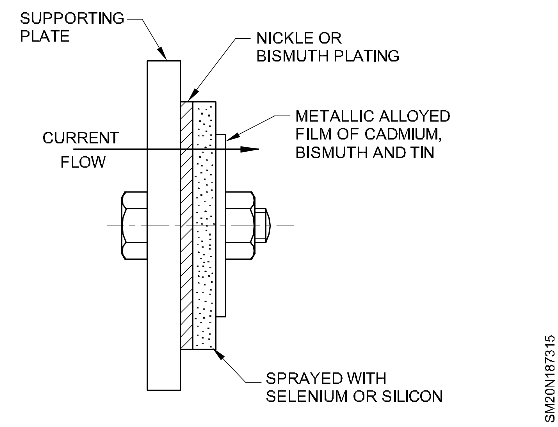
Fig 4



CONSTRUCTIONAL FEATURE OF A WELDING RECTIFIER SET

SYMBOLIC REPRESENTATION

Fig 5



Working principle: The output of the step down transformer is connected to the rectifier unit, which converts AC to DC. The DC output is connected to positive and negative terminals, from where it is taken for welding purposes through welding cables. It can be designed to provide either AC or DC welding supply by operating a switch provided on the machine.

Care and maintenance of rectifier welding set

Keep all the connections in tight condition.

Lubricate the fan shaft once in 3 months.

Do not adjust the current or operate the AC/DC switch when the welding arc is 'on'.

Keep the rectifier plates clean.

Check and clean the set at least once in a month.

Keep the air ventilation system in good order.

Never run the machine without the fan.

Advantages and disadvantages of AC and DC welding

Objectives: At the end of this lesson you shall be able to
- **compare the advantages and disadvantages of AC welding**
- **compare the advantages and disadvantages of DC welding.**

Advantages of AC welding

A welding transformer has:

- a low initial cost due to simple and easy construction
- a low operating cost due to less power consumption
- no effect of arc blows during welding due to AC
- low maintenance cost due to the absence of rotating parts
- higher working efficiency
- noiseless operation.

Disadvantages of AC welding

It is not suitable for bare and light coated electrodes.

It has more possibility for electrical shock because of higher open circuit voltage.

Welding of thin gauge sheets, cast iron and non-ferrous metals (in certain cases) will be difficult.

it can only be used where electrical mains supply is available.

Advantages of DC welding

Required heat distribution is possible between the electrode and the base metal due to the change of polarity (positive 2/3 and negative 1/3).

It can be used successfully to weld both ferrous and non-ferrous metals.

Bare wires and light coated electrodes can be easily used.

Positional welding is easy due to polarity advantage.

It can be run with the help of diesel or petrol engine where electrical mains supply is not available.

It can be used for welding thin sheet metal, cast iron and non-ferrous metals successfully due to polarity advantage.

It has less possibility for electrical shock because of less open circuit voltage.

It is easy to strike and maintain a stable arc.

Remote control of current adjustment is possible.

Disadvantages of DC welding

DC welding power source has:

- a higher initial cost
- a higher operating cost
- a higher maintenance cost
- trouble of arc blow during welding
- a lower working efficiency
- noisy operation in the case of a welding generator
- occupies more space.

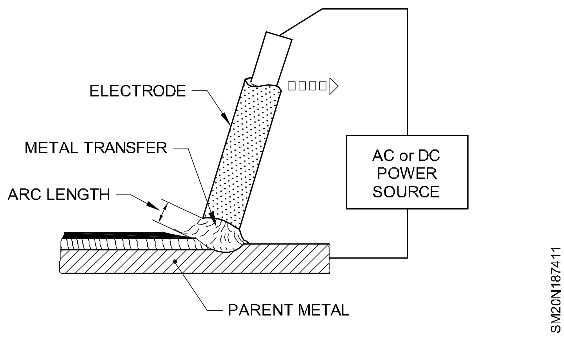
Arc length and its effects

Objectives : At the end of this lesson you shall be able to
- **define and identify the different types of arc lengths**
- **explain the effects and uses of different arc lengths.**

Arc length (Fig 1): It is the straight distance between the electrode tip and the job surface when the arc is formed. There are three of arc lengths.

- Medium or normal
- Long
- Short

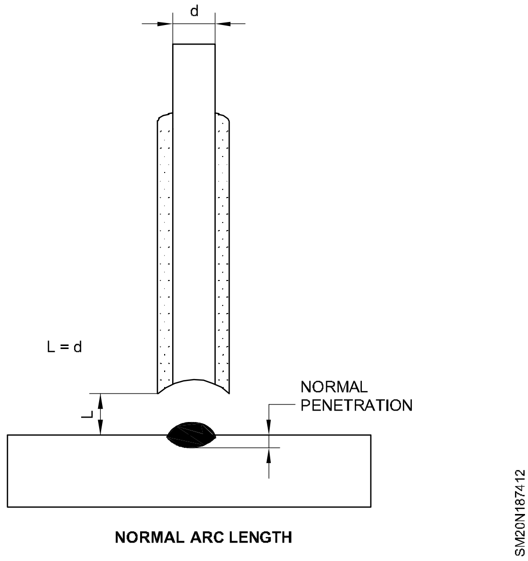
Fig 1



Medium, normal arc (Fig 2): The correct arc length or normal arc length is approximately equal to the diameter of the core wire of the electrode.

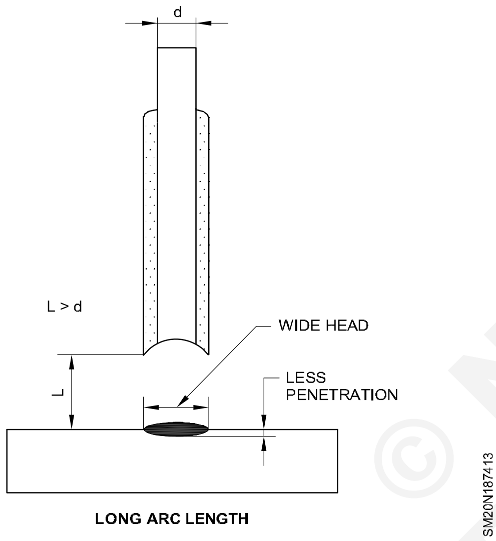
Long arc (Fig 3): If the distance between the tip of the electrode and the base metal is more than the diameter of the core wire it is called a long arc.

Fig 2



NORMAL ARC LENGTH

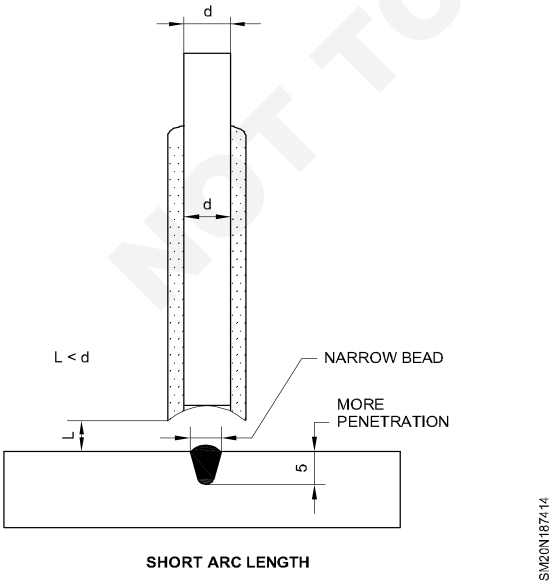
Fig 3



LONG ARC LENGTH

Short arc (Fig 4): If the distance between the tip of the electrode and the base metal is less than the dia. of the core wire it is called a Short arc.

Fig 4



SHORT ARC LENGTH

Effects of different arc length

Long arc

It makes a humming sound causing:

- Unstable arc
- Oxidation of weld metal
- Poor fusion and penetration
- Poor control of molten metal
- more spatters, indicating wastage of electrode metal.

Short arc: It makes a popping sound causing:

- the electrode melting fastly and trying to freeze with the job
- higher metal with narrow width bead
- less spatters
- more fusion and penetration.

Normal arc: This is a stable arc producing steady sharp crackling sound and causing:

- even burning of the electrode
- reduction in spatters
- correct fusion and penetration
- correct metal deposition.

Uses of different arc lengths

Medium or normal arc: It is used to weld mild steel using a medium coated electrode. It can be used for the final covering run to avoid undercut and excessive convex fillet/reinforcement.

Long arc: It is used in plug and slot welding. for restarting the arc and while withdrawing the electrode at the end of a bead after filling the crater. Generally long arc is to be avoided as it will give a defective weld.

Short arc: It is used for root runs to get good root penetration, for positional welding and while using a heavy coated electrode, low hydrogen, iron, powder and deep penetration electrode.

Defects in arc welding - its effect

Objectives: At the end of this lesson you shall be able to
- **name different weld defects in arc welded joints**
- **define weld defect**
- **state the effect of defects on the welded joints**
- **differentiate between external and internal defects.**

Introduction: The strength of a welded joint should be more than or equal to the strength of the base metal. If any weld defect is in a welded joint, then the joint becomes weaker than the base metal. This is not acceptable.

So a strong or good weld should have uniformly rippled surface, even contour, bead width, good penetration and should not have defect.

Definition of a weld defect/fault: A defect or fault is one which does not allow the finished joint to withstand or carry the required load.

Effects of weld defect/fault: Always a defective welded joint will have the following bad effects.

- The effective thickness of the base metal is reduced.
- The strength of the weld is reduced
- The effective throat thickness is reduced
- The joint will break, when loaded, causing accident.
- The properties of base metal will change.
- More electrodes are required which will also increase the cost of welding.
- Waste of labour and materials.
- The weld appearance will be poor.

Since the weld defects will give bad effects on the joint, always proper care and action has to be taken before and during welding to avoid/prevent the defects. If the defects have already taken place then proper action has to be taken to correct/rectify the defect after welding.

The action/measure taken to avoid/prevent and correct/rectify a weld defect is also called as a remedy.

So some remedies may help to avoid/prevent a weld defect and some remedies may help to correct/rectify a weld defect which has already taken place.

Weld defect may be considered under two heads.

- External defects
- Internal defects

The defects which can be seen with bare eyes or with a lens on the top of the weld bed, or on the base metal surface or on the root side of the joint are called external defects.

Those defects, which are hidden inside the weld bead or inside the base metal surface and which cannot be seen with bare eyes or lens are called internal defects.

Some of the weld defects are external defects, some are internal defects and some defects like crack, blow hole and porosity, slag inclusion, lack of root penetration in fillet joints, etc. will occur both as external and internal defects.

External defects

1 Undercut
2 Cracks
3 Blow hole and porosity
4 Slag inclusions
5 Edge plate melted off
6 Excessive convexity/Oversized weld/Excessive reinforcement
7 Excessive concavity/insufficient throat thickness/insufficient fill
8 Incomplete root penetration/lack of penetration
9 Excessive root penetration
10 Overlap
11 Mismatch
12 Uneven/irregular bead appearance
13 Spatters

Internal defects

1 Cracks
2 Blow hole and porosity
3 Slag inclusions
4 Lack of fusion
5 Lack of root penetration
6 Internal stresses or locked-up stresses or restrained joint.

Resistance welding machines

Objectives: At the end of this lesson you shall be able to
- **explain the principle and types of resistance welding process**
- **explain the main elements of a resistance welding machine**
- **state the applications of resistance welding in industry and its advantages.**

Principle of resistance welding: Resistance welding is a welding process wherein coalescence is provided by the heat obtained from the resistance offered by the work to the flow of electric current in a circuit and the joint is effected by the application of pressure.

The fundamental principle on which all resistance welding is based is as follows.

The heat is generated due to the resistance offered by the parts to the passage of heavy electric current for a fraction of a second.

Heat produced at the junction is calculated by the formula I^2Rt

where I stands for the amount of current in amps.

R for resistance offered in ohms

t - time taken for duration of current flow in seconds.

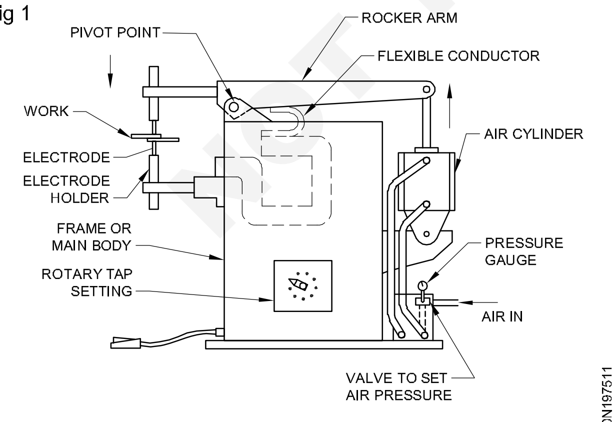
This heat at the junction of the two parts changes the metal to a plastic state, and when combined with the correct amount of pressure, fusion takes place.

The different types of resistance welding machines are spot welding, seam welding, projection welding, flash butt welding and upset welding machines.

A standard rocker arm type resistance welding machine is shown in Fig.1. The main parts are:

1) **The frame:** It is the main body of the machine which differs in size and shape for the stationary and portable types.

Fig 1



ROCKER ARM TYPE RESISTANCE WELDING MACHINE

2) **Force mechanism:** The compressed air cylinder and the pivoted rocker arm gives the necessary high pressure to the lever to which the upper electrode holder is attached.

3) **The electric circuit:** It consists of a step down transformer which provides for the necessary current to flow at the point of weld.

4) **The electrodes:** The electrodes include the mechanism for making and holding contact at the weld area.

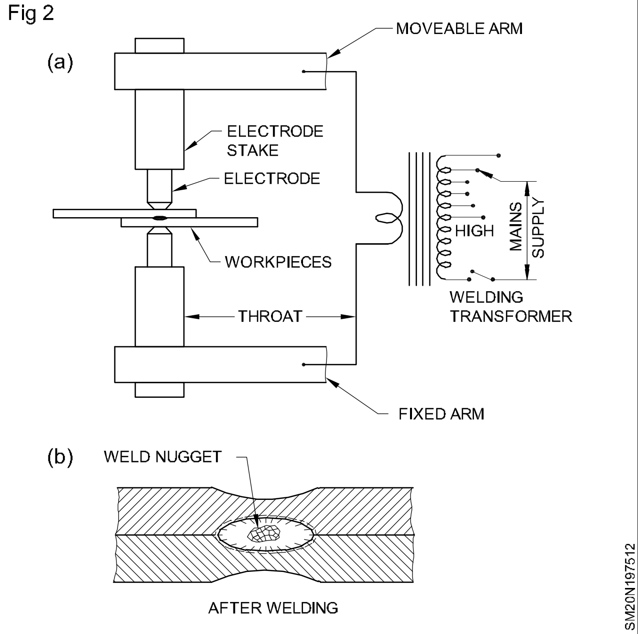
5) **The timing controls:** The switches which regulate the value of current, current flow time and contact period time as the timing controls.

6) **Water cooling system:** To circulate cooling water to the electrodes.

   This is the additional part consisting of a water reservoir and flow system.

Spot welding: This type of resistance welding machine is most commonly used for resistance welding. The material to be joined is placed between two electrodes as shown in Fig 2a. Pressure is applied after a quick shot of electricity is sent from one electrode through the job to the other electrode.

Fig 2



Spot welding is made in three steps.

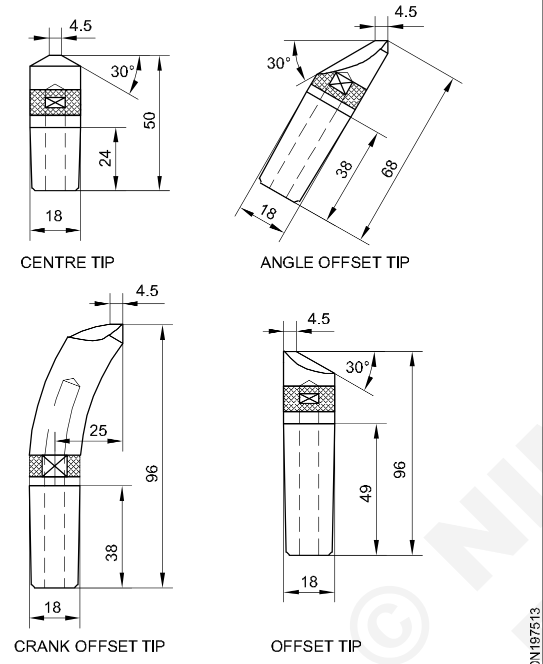
The first step is when the parts to be joined are clamped between the electrodes. In the second step, a high current is allowed to pass through the clamped members and is raised to the welding temperature. The third step sees the current being cut off and high pressure being applied to the joint and the joint completed. A nugget is formed as shown in Fig 2b.

A special copper alloy material has been developed for use as electrodes.

Cooling of the electrodes is accomplished by internally circulating water.

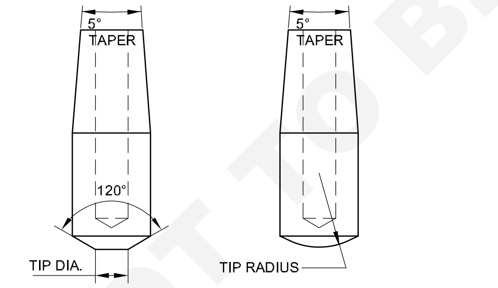
Electrodes are of many shapes and sizes, the most common being the centre tip and offset tip types. (Figs 3 and 4)

Fig 3



FOUR STANDARD TYPES OF ELECTRODES

Fig 4



THE RADIUS OF THE DOMED TIP (RIGHT) VARIES FROM 25mm FOR WELDING 26 S.W.G. MATERIAL, UPTO 150mm FOR 3 S.W.G. THE DIAMETER OF FLAT PART OF THE OTHER ELECTRODE VARIES FROM 4mm TO 12mm FOR SIMILAR MATERIAL THICKNESS.

TWO STANDARD TYPES OF CENTER TIP ELECTRODE

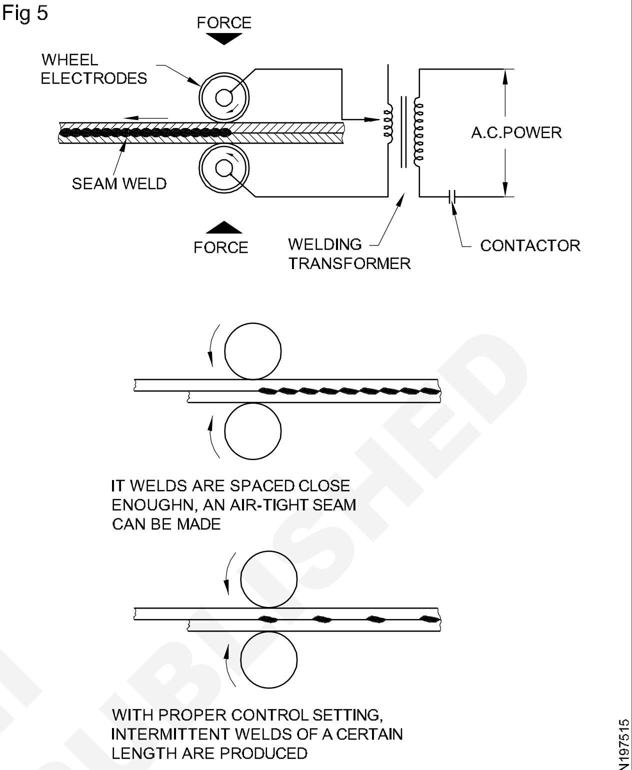
Regular spot welding leaves slight depressions on the metal. These depressions are minimized by the use of larger sized electrode tips and by inserting 1.6 mm copper sheets between the electrode and the job.

Spot welds may be made one at a time or several welds may be completed at one time.

Spot welding is utilized extensively for welding steel, and when equipped with an electronic timer, it can be used for other materials, such as aluminium, copper, stainless steel, galvanised metals etc.

Seam welding: Seam welding is like spot welding except that the spots overlap one another, making a continuous weld seam. In this process the metal pieces pass between the roller type electrodes as shown in Fig 5.

Fig 5



RESISTANCE SEAM WELDING PROCESS

As the electrodes revolve, the current is automatically turned 'on' and 'off' at intervals corresponding to the speed at which the parts are set to move. With proper control, it is possible to obtain airtight seams suitable for containers, water heaters, fuel tanks etc.

When spots are not overlapped long enough to produce a continuous weld, the process is sometimes referred to as roller spot welding.

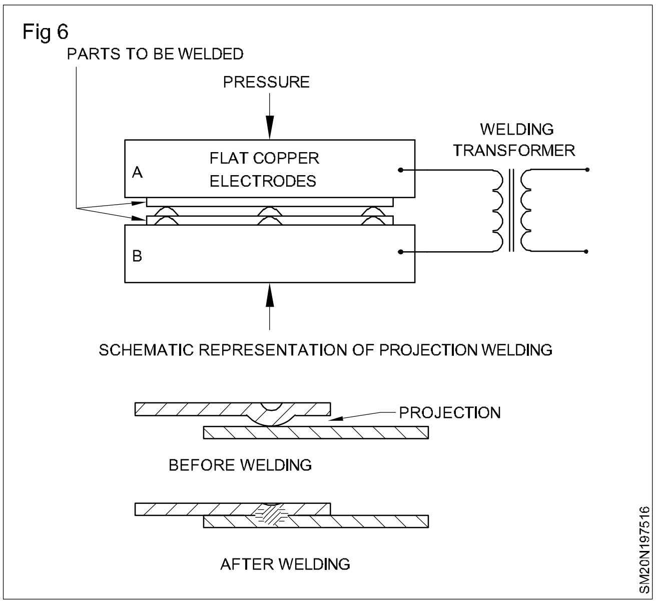
Cooling of the electrodes is accomplished either by circulating water internally or by an external spray of water over the electrode rollers.

Both lap and butt joints are welded by seam welds. In the case of butt joints, foils of filler metals are used on the joints.

Projection welding: Projection welding involves the joining of parts by a resistance welding process which closely resembles spot welding. This type of welding is widely used in attaching fasteners to structural members.

The point where welding is to be done has projections which have been formed by embossing, stamping or machining. The projections serve to concentrate the welding heat at these areas and facilitate fusion without the necessity of employing a large current. The welding process consists of placing the projections in contact with the mating part and aligning them between the electrodes (flat copper electrode) as illustrated in Fig 6.

Fig 6

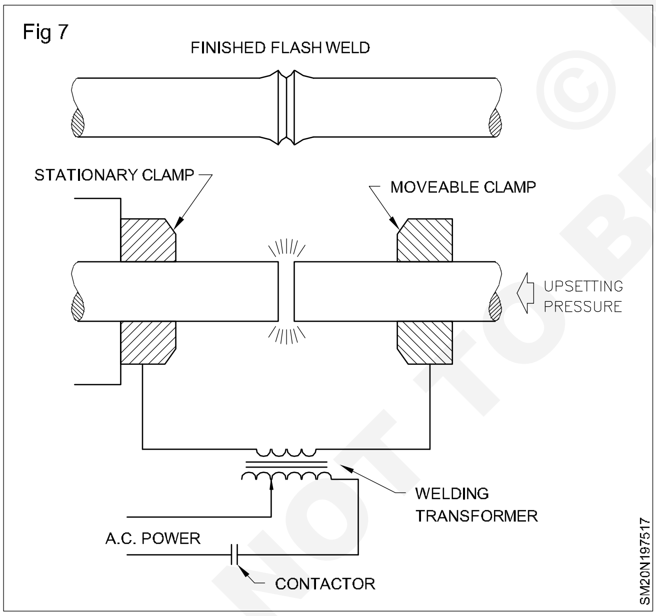


Either single or a multitude of projections can be welded simultaneously.

Not all metals can be projection-welded. Brass and copper do not lend themselves to this method because the projections usually collapse under pressure. Galvanised iron and tin plates, as well as most other thin gauge steels, can be successfully projection-welded.

Flash butt welding: In the flash butt welding process the two pieces of metals to be joined are firmly held in clamps which conduct current to the work.(Fig 7)

Fig 7



The ends of two metal pieces are moved towards and away from each other until an arc is established. The flashing action across the gap melts the metal, and as the two molten ends are forced together, fusion takes place. The current is cut off just before the heavy pressure is applied through the movable clamp.

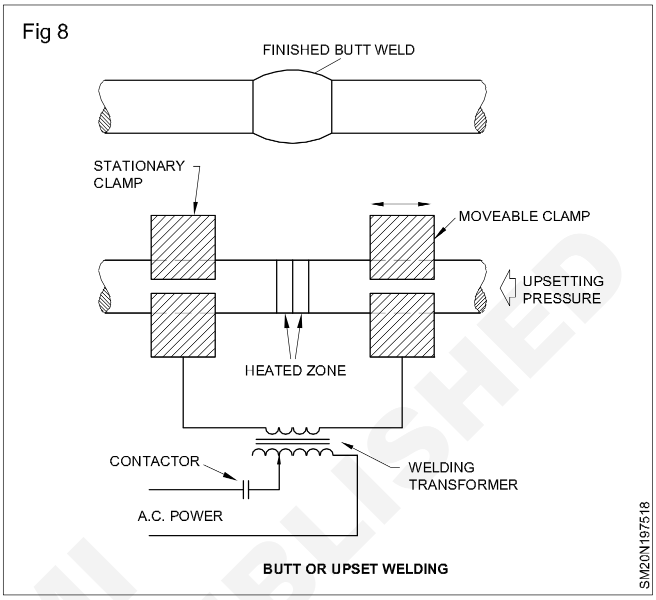
Flash butt welding is used to butt-weld plates, bars, rods, tubing and extruded sections. It is not generally recommended for welding cast iron, lead and zinc alloys.

The only problem encountered in flash butt welding is the resultant bulge at the point of the weld. It should be removed by grinding or machining if the part needs finishing.

Butt or upset welding (Slow butt weld)

In butt welding the metals to be welded are in contact under pressure. An electric current is passed through them, and the edges are softened and fused together as illustrated in Fig 8.

Fig 8



This process differs from flash butt welding in that constant pressure is applied during the heat process which eliminates flashing. The heat generated at the point of contact results from resistance. The operation and control of the butt welding process is almost identical to that of flash butt welding.

Butt or upset welding is limited to parts with a cross-section area of not more than 200-250 mm^2. Bars with cross-sectional area of 250mm^2 and above are joined by flash butt welding.

Application: Spot, seam and projection welding is widely used in the production of cars, tractors, farm machines, rail coaches etc. where thin sheets are to be joined.

Large sections like square, rectangular, cylindrical rods with regular and irregular end faces are welded without any edge preparations by flash butt or butt welding processes.

Advantages of resistance welding

– Widely used for joining sheet metals.

– Speedy process.

– No distortion.

– Less skilled operators can do the job.

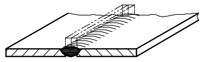
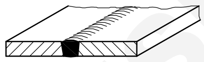
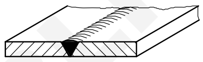
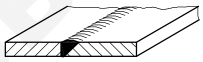
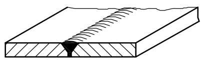
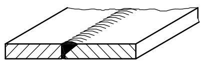
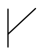
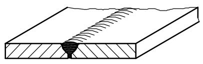
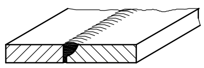
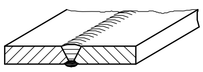
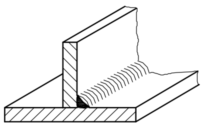
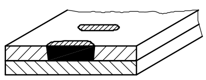
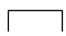
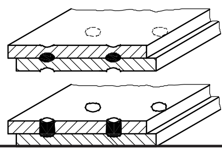
Welding symbol - Description and uses

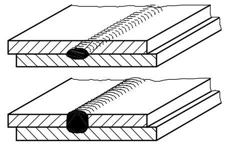
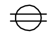
Objectives: At the end of this lesson you shall be able to
- **explain the necessity of weld symbol and welding symbol**
- **describe the elementary symbols and supplementary symbols**
- **describe a welding symbol and its application.**

Necessity: For conveying the information required for welding for designers and welders, standard symbols are used. The symbols described below provide the means of placing on drawing the information concerning type, size, location of weldment.

Elementary symbols (As per IS 813 - 1986): The various categories of welds are characterized by a symbol which in general is similar to the shape of the weld to be made. (Table 1)

TABLE 1
Elementary symbols

Sl. No.	Designation	Illustration	Symbol
1	Butt weld between plates with raised edges (the raised edges being melted down completely)		
2	Square butt weld		
3	Single V butt weld		
4	Single bevel butt weld		
5	Single V butt weld with broad root face		
6	Single bevel butt weld with broad root face		
7	Single U butt weld (parallel or sloping sides)		
8	Single J butt weld		
9	Backing run; back or backing weld		
10	Fillet weld		
11	Plug weld; plug or slot weld/USA		
12	Spot weld		

13	Seam weld		

Supplementary symbols: Elementary symbols may be complemented by another set of symbols (supplementary) (Table 2) characterizing the shape of the external surface of the weld. Supplementary symbols on elementary symbols indicate the type of weld surface required.(Table 3)

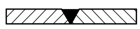
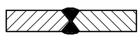
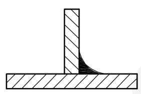
TABLE 2

Supplementary symbols

Shape of weld surface	Symbol
a) Flat (usually finished flush)	
b) Convex	
c) Concave	

TABLE 3

Examples of application of supplementary symbols

Designation	Illustration	Symbol
Flat(flush)single V butt weld		
Convex double V butt weld		
Concave fillet weld		
Flat (flush) single V butt weld with flat (flush) backing run		

Weld symbol: It represents the type of weld made on a weld joint. It is also a miniature drawing of any metal edge preparation required prior to welding.

Welding symbol: The complete welding symbol will indicate to the welder how to prepare the base metal, the welding process to use, the method of finish and the required dimensions and other details with the basic weld symbol. They consist of 7 elements as mentioned below. (Fig 1)

1 Reference line

2 Arrow

3 Welding elementary symbols

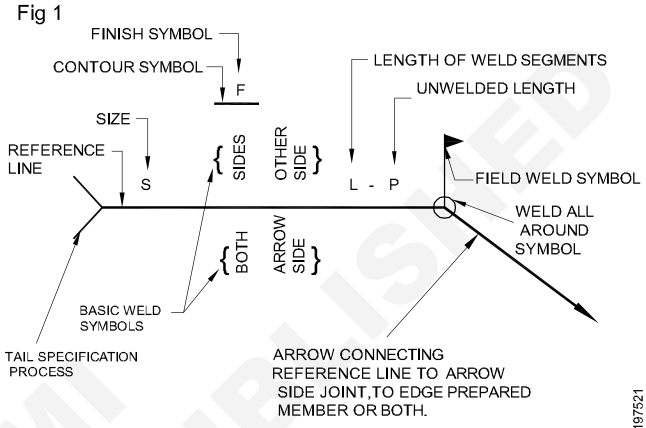
4 Dimensions and other details

5 Supplementary symbols

6 Finish symbols

7 Tail (specification, process)

Fig 1



STANDARD LOCATION OF ELEMENTS OF A WELDING SYMBOL

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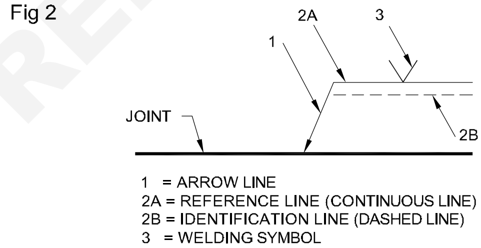
Methods of representation (Figs 2 and 3)

Fig 2

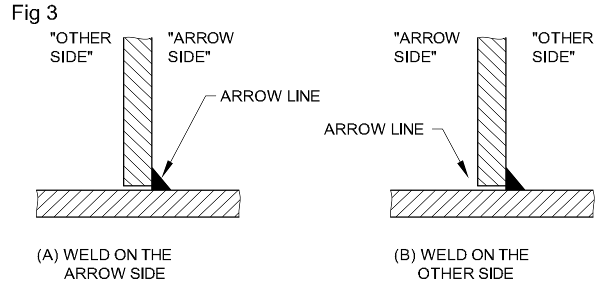


1 = ARROW LINE
2A = REFERENCE LINE (CONTINUOUS LINE)
2B = IDENTIFICATION LINE (DASHED LINE)
3 = WELDING SYMBOL

METHOD OF REPRESENTATION

SM20N197522

Fig 3



(A) WELD ON THE ARROW SIDE

(B) WELD ON THE OTHER SIDE

T-JOINT WITH ONE FILLET WELD

SM20N197523

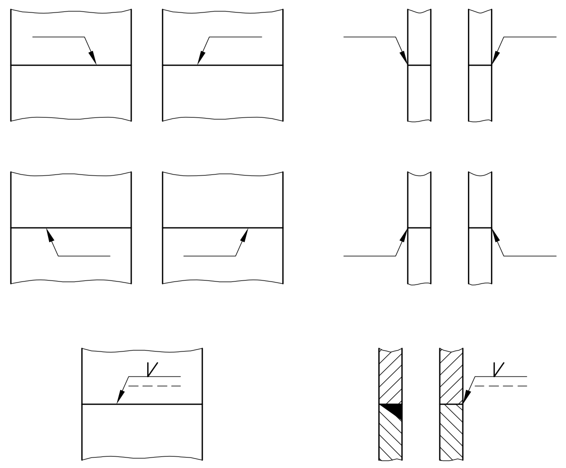
The reference line, arrow-head and tail

The reference line shown in Figs 1 and 5 is always drawn as a horizontal line. It is placed on the drawing near the joint to be welded. All other information to be given on the welding symbol is shown above or below the reference line.

Arrow: The arrow may be drawn from either end of the reference line. The arrow always touches the line which represents the welded joint. On the welding symbol the arrow side weld information is always shown below the reference line. The other side weld information is always shown on the dash–line side. (Figs 2 and 4)

Tail: The tail is used only when necessary. If used it may give information on specification, the welding process used, or other details required which are not shown in the welding symbol.

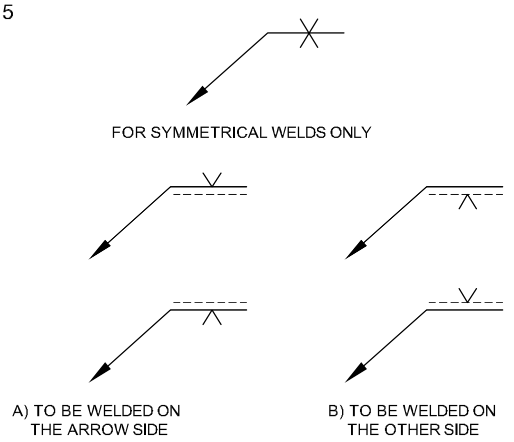
Fig 4



POSITION OF THE ARROW LINE

SM20N197524

Fig 5



POSITION OF SYMBOLS ACCORDING TO THE REFERENCE LINE

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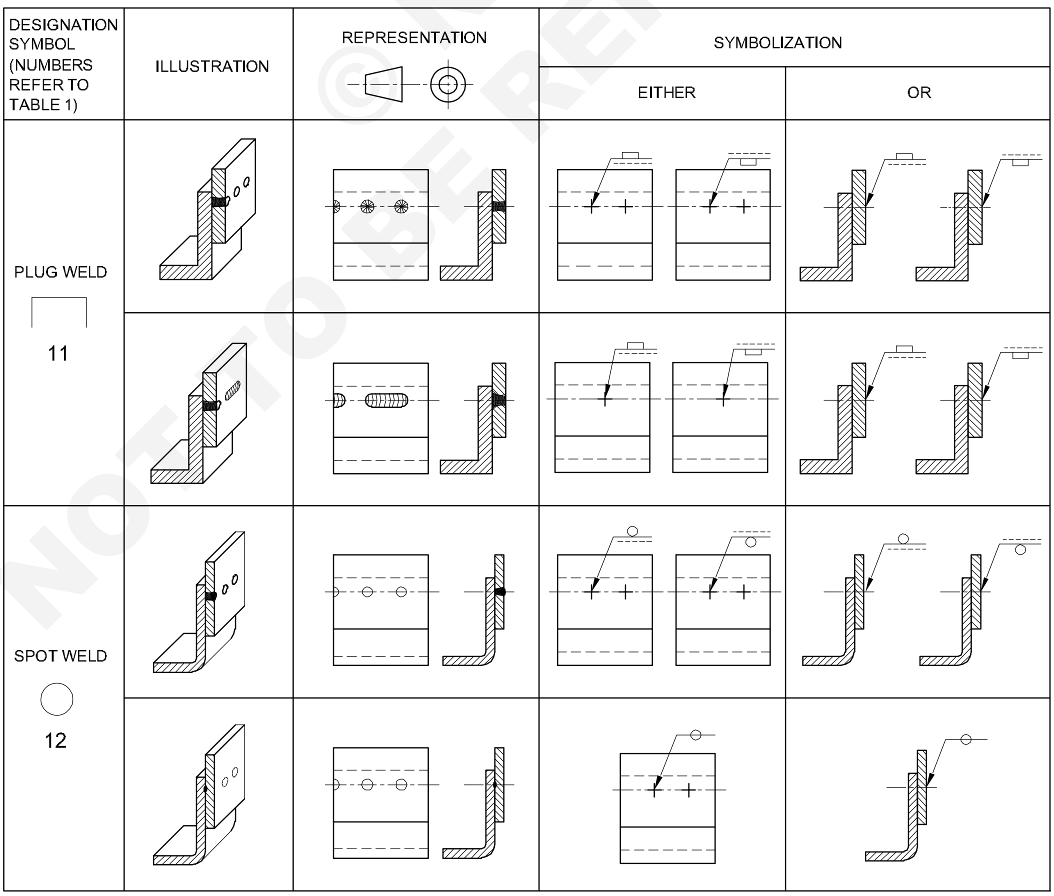
Welding/elementary symbol: Figs 6 and 7 illustrate how some of the various types of weld symbols are used in welding symbols.

Root opening and groove angle: The root opening size appears inside the basic weld symbol on the complete welding symbol. The included angle or total angle of a groove weld is shown above the basic weld symbol. (Fig 8)

Contour and finish symbols: The shape or contour of the completed weld bead is shown on the welding symbol as a straight or curved line between the basic weld symbol and the finish symbol. The curved contour line indicates a normal convex or concave weld bead. (Fig 9)

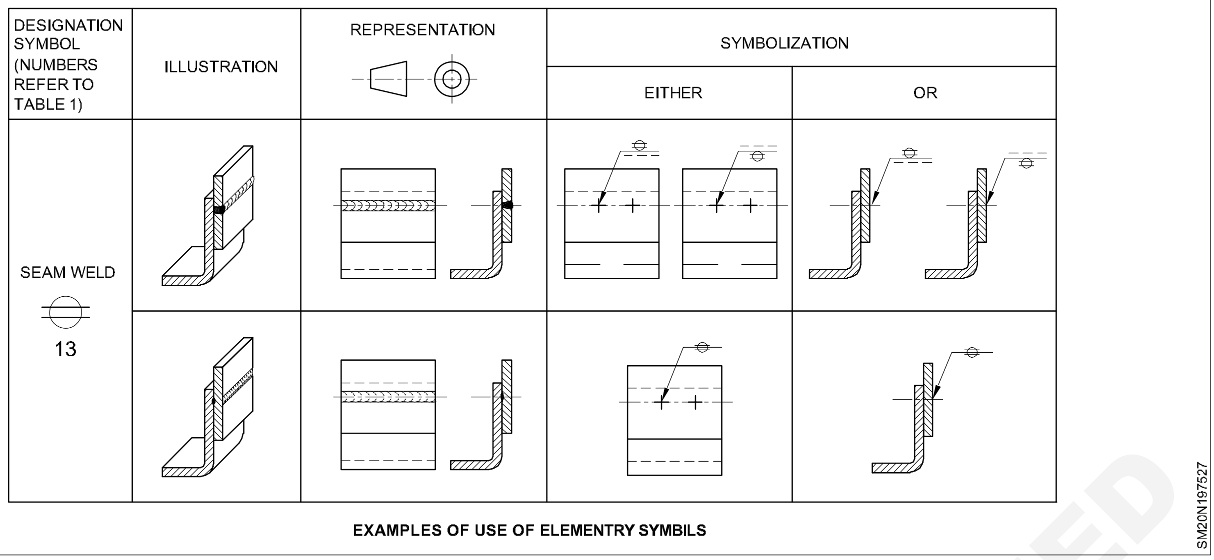
Fig 6



EXAMPLES OF USE OF ELEMENTRY SYMBOLS

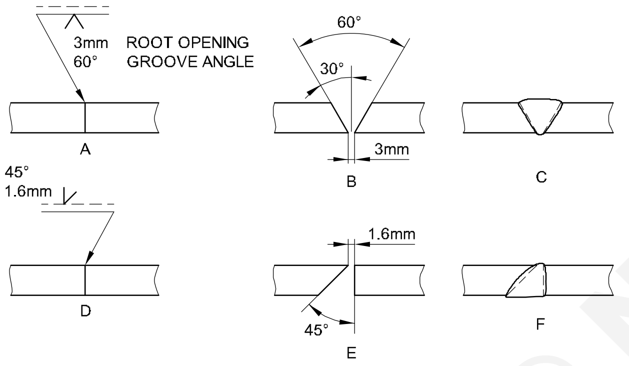
SM20N197526

Fig 7



EXAMPLES OF USE OF ELEMENTRY SYMBILS

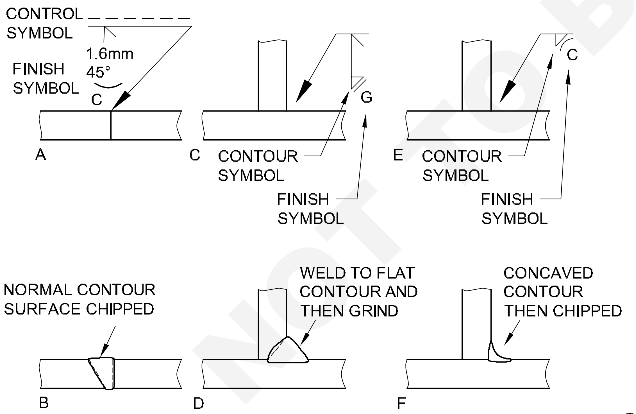
Fig 8



A AND D SHOW THE WELD SYMBOL FOR A GROOVE WELD
B AND E SHOW THE PIECES CUT AND SET UP FOR WELDING
C AND F SHOW THE COMPLEETED WELD

ROOT OPENING AND GROOVE ANGLE

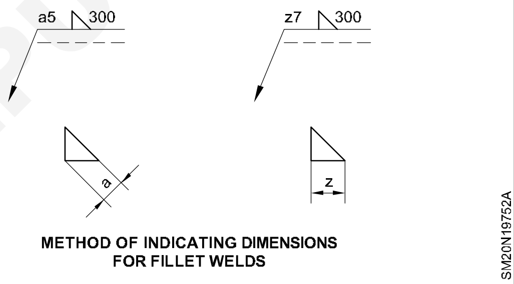
Fig 9



WELD CONTOUR AND FINISH SYMBOLS IN A,C AND FINISH E
CONTOUR AND FINISH SYMBOLS ARE SHOWN ON WELDING SYMBOL
B,D AND F ILLUSTRATE SHAPE AND FINISH OF COMPLETED WELD

Dimensions and other details: The size of a weld is important. The term 'size of weld' means different things for the fillet weld and butt weld. The dimensions of a fillet weld are shown to the left of the basic weld symbol. (Fig 10) The number 300 indicates the length of the weld is 300mm; a5 indicates that the throat thickness is 5mm; z7 indicates the leg length is 7mm.

Fig 10



METHOD OF INDICATING DIMENSIONS FOR FILLET WELDS

Co_2 welding equipment and process

Objectives: At the end of this lesson you shall be able to
- **state the main difference between shielded metal arc welding and Co_2 welding**
- **state the principle of Co_2 welding.**

Introduction to Co_2 welding: Fusion welding of metal plates and sheets is the best method of joining metals because in this process the welded joint will possess the same properties and strength as the base metal.

To achieve this, the complete protection of the molten puddle from the atmospheric oxygen and nitrogen is very essential during the welding process.

Without a perfectly shielded arc and molten puddle, the atmospheric oxygen and nitrogen will get absorbed by the molten metal. This will result in weak and porous welds.

In shielded metal arc welding (SMAW) the arc and molten metal are protected/shielded by the gases produced by the burning of the flux coated on the electrode.

The above mentioned shielding action can be done by passing an inert gas such as argon, helium, carbon-di-oxide through the welding torch/gun. The arc is produced between the base metal and a bare wire consumable electrode fed continously through the torch.

As an inert gas is used to protect the arc produced by a consumable metal electrode, this process is called Gas Metal Arc Welding (GMAW). GMAW process is also called by different names.

They are

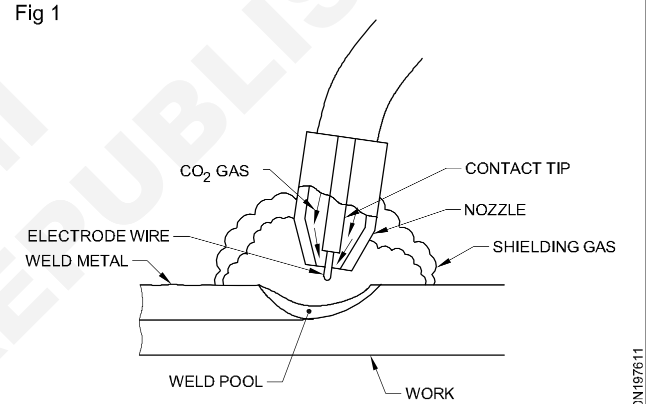
1 Metal Inert Gas (MIG) welding

2 Metal Active Gas (MAG) or Co_2 welding

When carbon-dioxide is used for shielding purposes, it is not fully inert and it partly becomes an active gas. So Co_2 welding is also called as MAG welding.

Principle of Co_2 welding: In Co_2 welding process, an arc is struck between a continuously fed consumable bare wire electrode and the base metal. The heated base metal, the molten filler metal and the arc are shielded by the flow of carbon-di-oxide gas passing through the welding torch/gun. (Fig.1)

Fig 1



PRINCIPLE OF CO_2 WELDING

Co_2 welding equipment and accessories

Objective : At the end of this lesson you shall be able to
- **name and briefly describe the parts of Co_2 welding equipment and accessories.**

The equipment and accessories used for Co_2 welding are:(Fig.1)

1 Main power source (Welding machine)

2 Control system

3 Wire reel

4 Wire feed drive motor

5 Cable assembly

6 Conduit liner

7 Torch assembly

8 Co_2 gas cylinder fitted with a valve and regulator

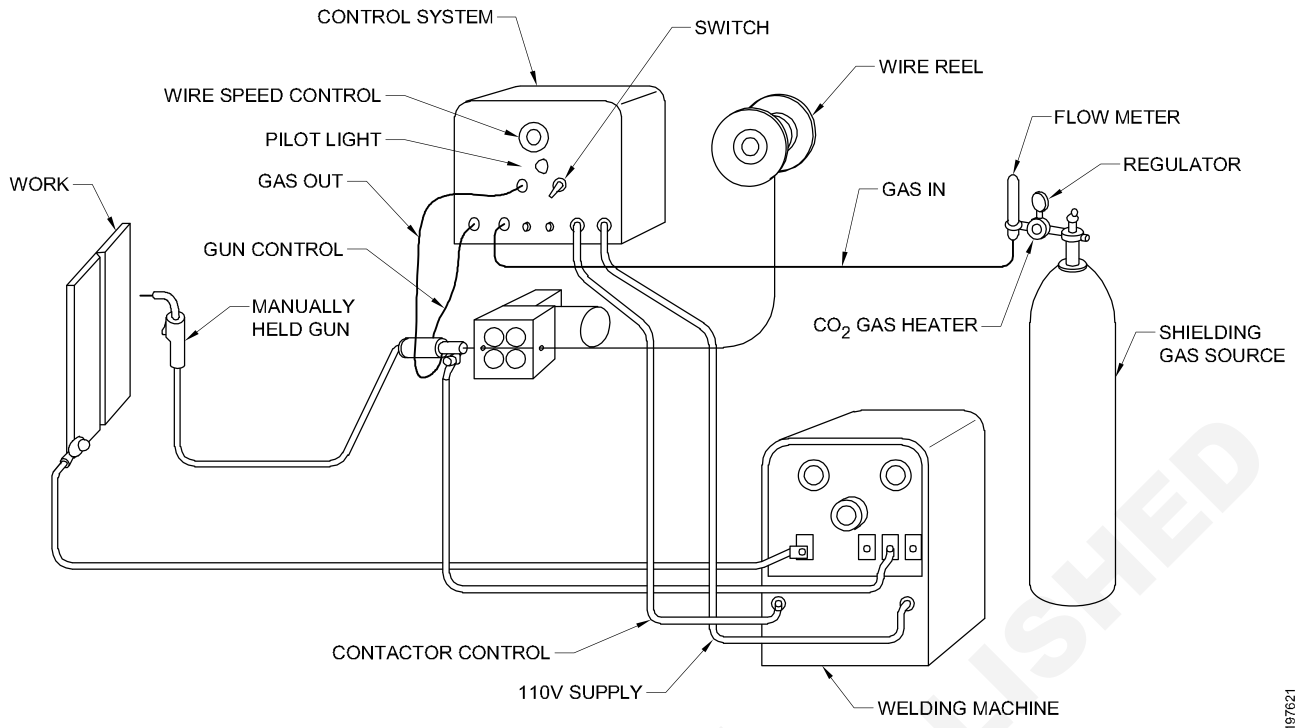
9 Gas flow meter

Main power source (welding machine): The arc welding machine used for Co_2 welding is a DC constant voltage (constant potential) type. The following types of machines are used.

(a) A.C transformer with a D.C rectifier

(b) Alternator with a D.C rectifier

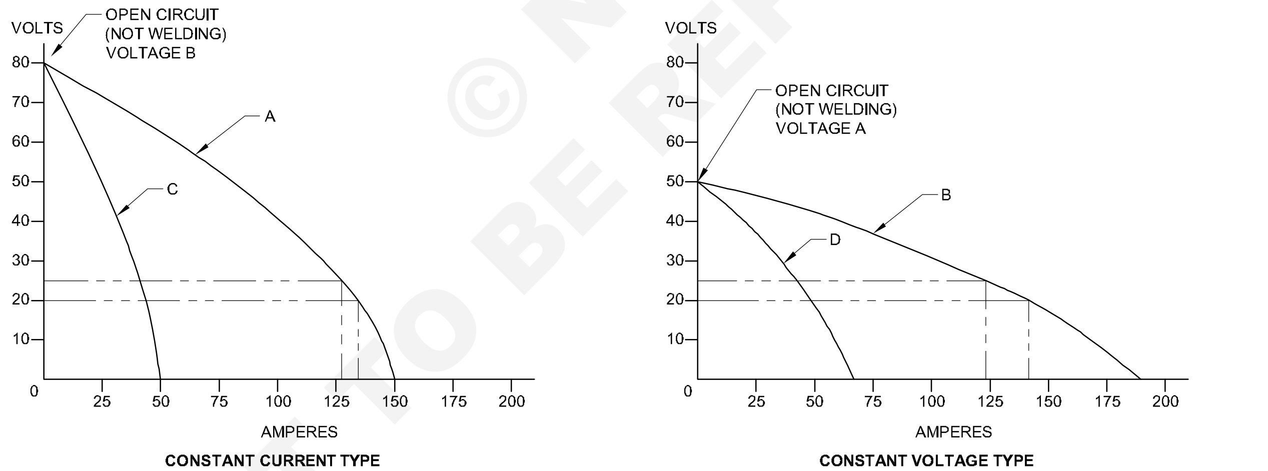
Fig 1



AC welding machines are not suitable for Co_2 welding/ GMAW.

The characteristics volt, ampere curves (A & B) are shown in Fig.2.

Fig 2



Curve A: On the output slope or voltampere curve A, a change from 20 volts to 25 volts will result in a decrease in amperage from 135 amps to 126 amps. With a change of 25 percent in voltage, only a 6.7 percent change occurs in the welding current in curve A. Thus if the welder varies the length of the arc, causing a change in voltage, there will be very little change in the current and the weld quality will be maintained. The current in this machine, even though it varies slightly is considered constant.

Curve B: The open circuit voltage curve for a setting of 50 volts on the machine is shown as curve B in the Fig.3. The same 20 volt to 25 volt (25 percent) change in the welding voltage will result in a drop in current from 142 amps to 124 amps or 13.3 percent. This slower sloping volt ampere curve output causes a large change in amperage with the same small change in voltage. A welder may wish to have this slower sloping (flatter) volt-ampere output curve.

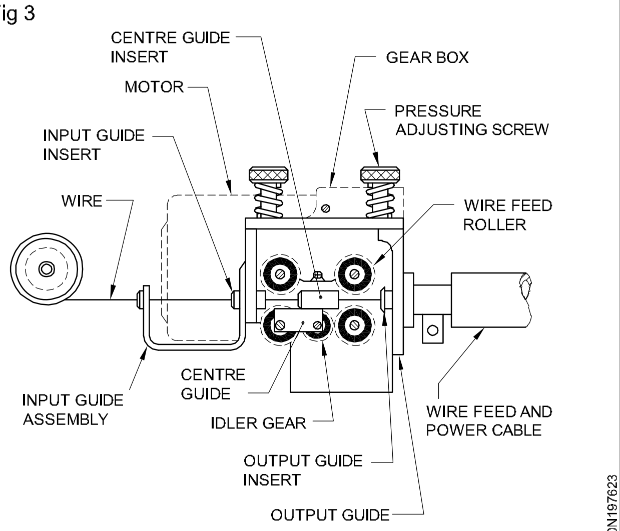
With a flatter output slope the welder can control the molten pool and electrode melt rate by making small changes in the arc length. Control of the molten pool and electrode melt rate are most important when welding in the horizontal, vertical and overhead positions.

Control system: This unit controls the wire feed rate/ welding current, "ON/OFF" switch, gas flow to the welding gun, gun control, 110V supply to the gas heater.

Wire reel: The electrode wire is wound over this wire reel in a coil form.

Wire feed drive motor: This motor draws the filler electrode wire from the wire reel through wire feed pressure rollers and feeds it to the welding gun. (Fig.3)

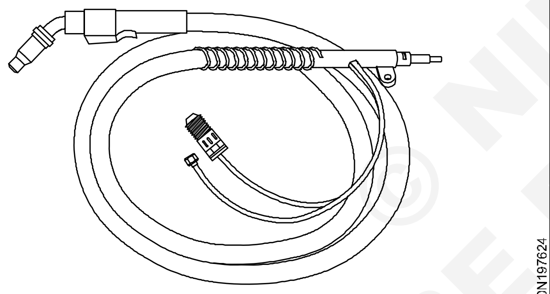
Fig 3



A SIMPLIFIED WIRE FEED MECHANISM FOR GMAW

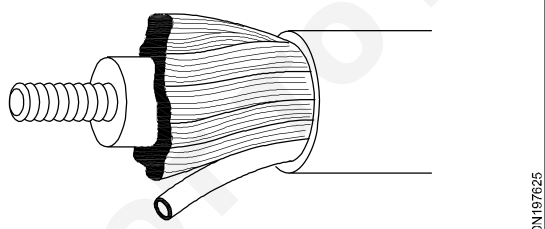
Cable assembly: The electrode wire and the Co_2 gas are fed to the tip of the welding gun through the cable assembly. (Fig.4) Since the cable assembly has to be flexible the electrode wire and the Co_2 gas are passed through the conduit liner (Fig.5).

Fig 4



CABLE ASSEMBLY

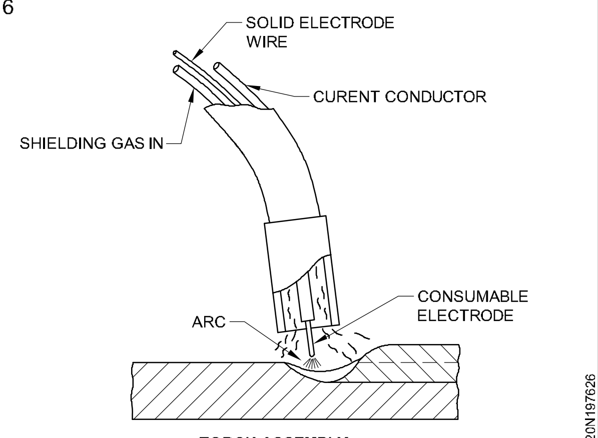
Fig 5



CONDUIT LINER

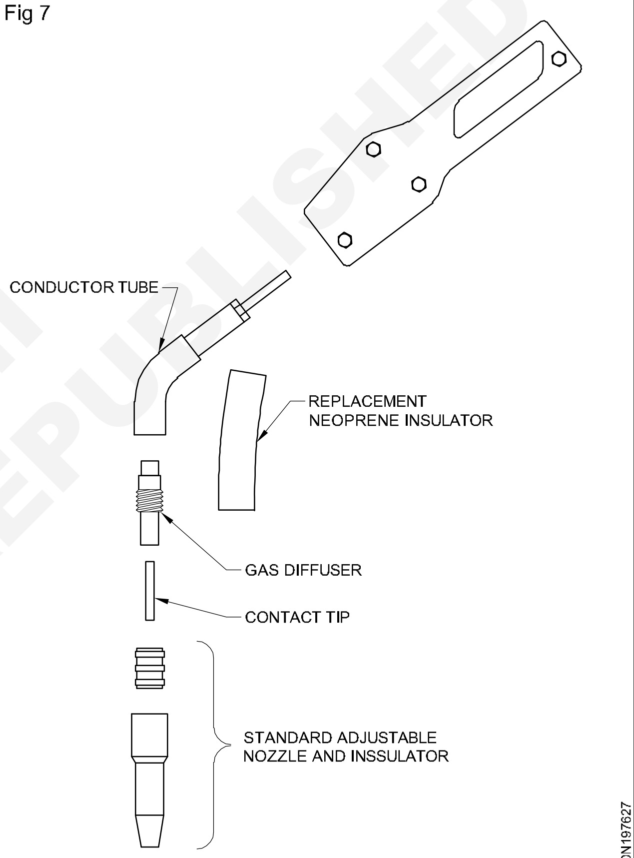
Torch assembly: The torch also called as welding gun, comprises of metallic body which includes a passage for electrode wire, current conductor, shielding gas. At the tip of the gun there will be a ceramic nozzle through which Co_2 gas flows out to the job surface. (Fig.6 and Fig.7) The contact tip (Fig.8) also fitted at the centre of the torch assembly exit and the electrode wire passes through this tip and gets the welding current from this contact tip. A trigger/switch fitted on the welding gun body is pressed to operate the wire feed motor and feed the electrode wire to the work piece to be welded.

Fig 6



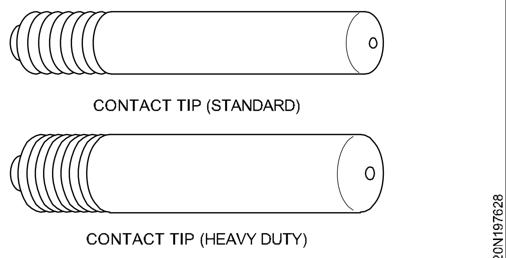
TORCH ASSEMBLY

Fig 7



WELDING TORCH

Fig 8



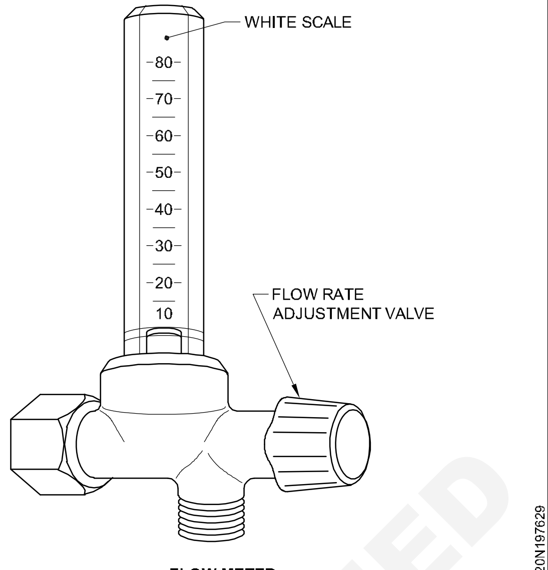
CONTACT TIP

Co_2 gas cylinder and regulator: The shielding gas required for GMAW/Co_2 welding is supplied from a gas cylinder through an outlet valve and regulator. In case of Co_2 gas cylinder, a gas heater unit is attached before the regulator. The Co_2 gas is available inside the cylinder in liquid form and when it was drawn from the cylinder it will get converted into gas. The gas temperature will be less than 0°C. Any moisture present in the regulator inlet will be converted into ice. This ice formation will block the passage of Co_2 gas into the regulator. So a heater is used to avoid the ice formation during the conversion of liquid Co_2 into Co_2 gas.

Gas flow meter: It is a unit which has graduations marked on the glass tube. A flow rate adjustment valve fixed to the flow meter controls the rate of flow of inert gas/Co_2 gas to the welding gun in litre per minute. Fig.9.

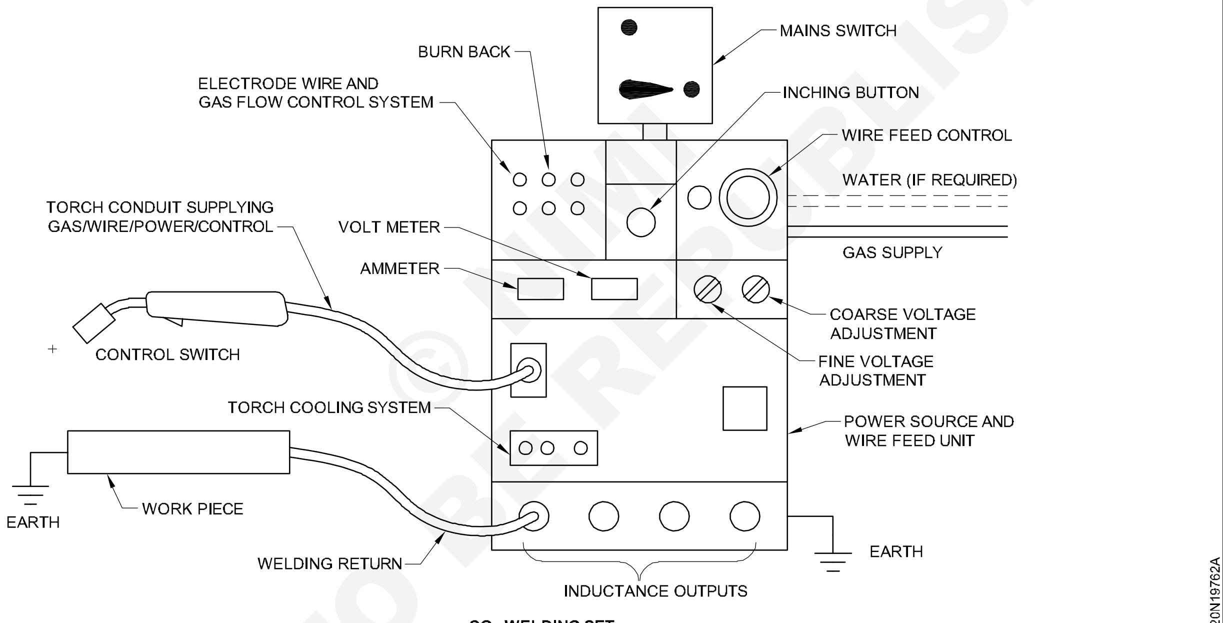
Description of Co_2 welding set: The Co_2 welding set is a rectifier welding machine which comprises of all provisions to set various welding parameters like voltage, amperage, gas flow meter, wire feed rate, cooling water flow control (for water cooled torches), inductance settings etc. It has also provision to attach the cable and hose assembly, including electrode wire, in-built wire feeding unit, etc. Fig.10.

Fig 9



FLOW METER

Fig 10



CO_2 WELDING SET

Advantages, disadvantages of Co_2 welding over SMAW process and application of Co_2 welding

Objectives: At the end of this lesson you shall be able to
- **state the advantages and disadvantages of Co_2 welding over shielded metal arc welding process**
- **state the applications of Co_2 welding.**

Advantages: Welding is economical due to less edge preparation and no stub loss.

Produces joints with deep penetration.

Thin and thick materials can be welded.

It can be used for welding of carbon steels, alloy steel, stainless steel, copper and its alloys, aluminium and its alloys. Welding in all positions can be done.

Deposition rate is more.

No solid flux is used. So needs no cleaning of slag after each run.

Reduced distortion.

Produces X-ray quality weld.

Disadvantages

Welding equipment is more costly, more complex and less portable.

Since air drifts may disturb free flow of the shielding gas, GMAW may not work well in outdoor welding.

The cooling rates of the weld metal are higher.

Applications of Co_2 welding process: This process can be used for welding carbon, silicon and alloy steels, stainless steel, aluminium, copper, nickel and their alloys, titanium etc.

Light and heavy fabrication work.

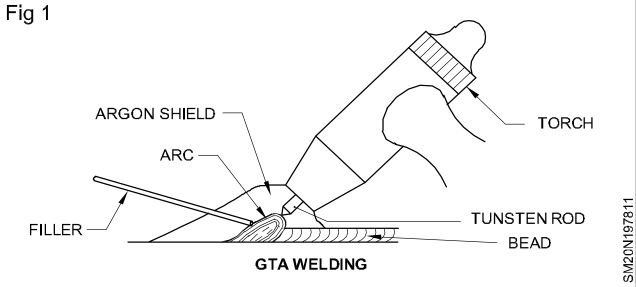
This process is successfully used in ship building fabrication of pressure vessels, automobile and aircraft industries.

TIG Welding process and equipment

Objectives: At the end of this lesson you shall be able to
- **state the principle of TIG welding process**
- **state its application**
- **identify a TIG welding equipment**
- **name the parts of a TIG welding equipment**
- **state the purpose of different parts.**

Introduction to TIG welding: The Gas Tungsten Arc Welding (GTAW) process fuses metals by heating them between a non consumable (does not melt) tungsten electrode and workpiece. The heat necessary for fusion (mixing or combining of molten metals) is provided by an arcing electric current between the tungsten electrode and the base metal. Fig.1

Fig 1

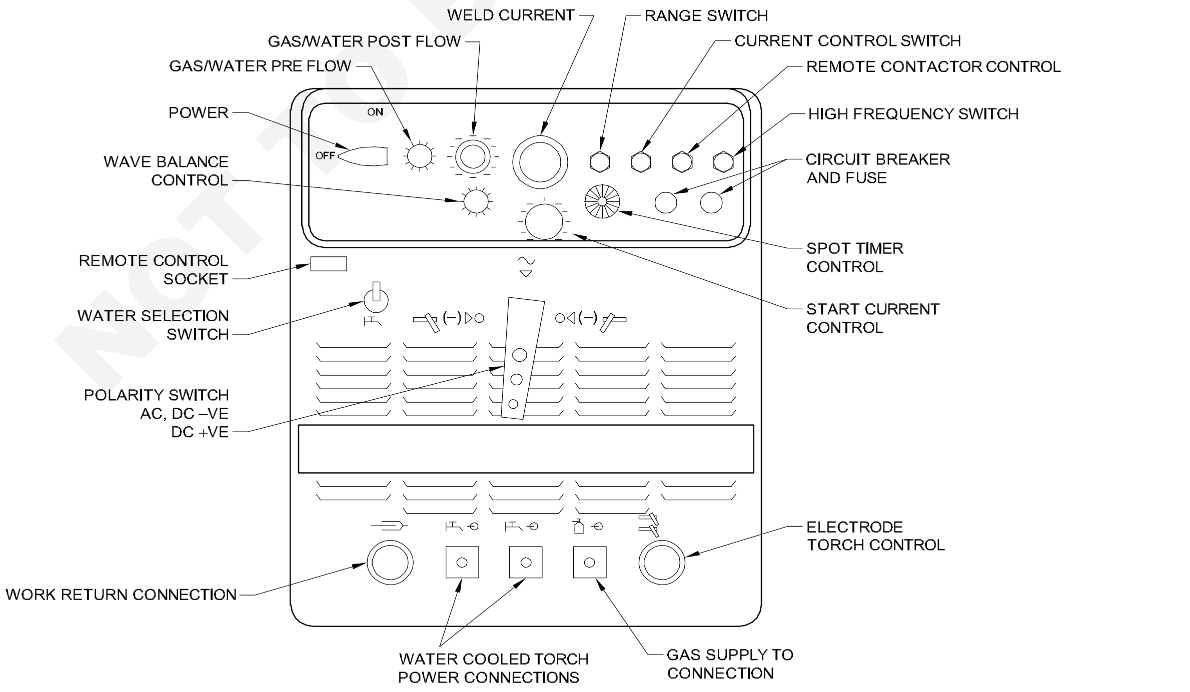


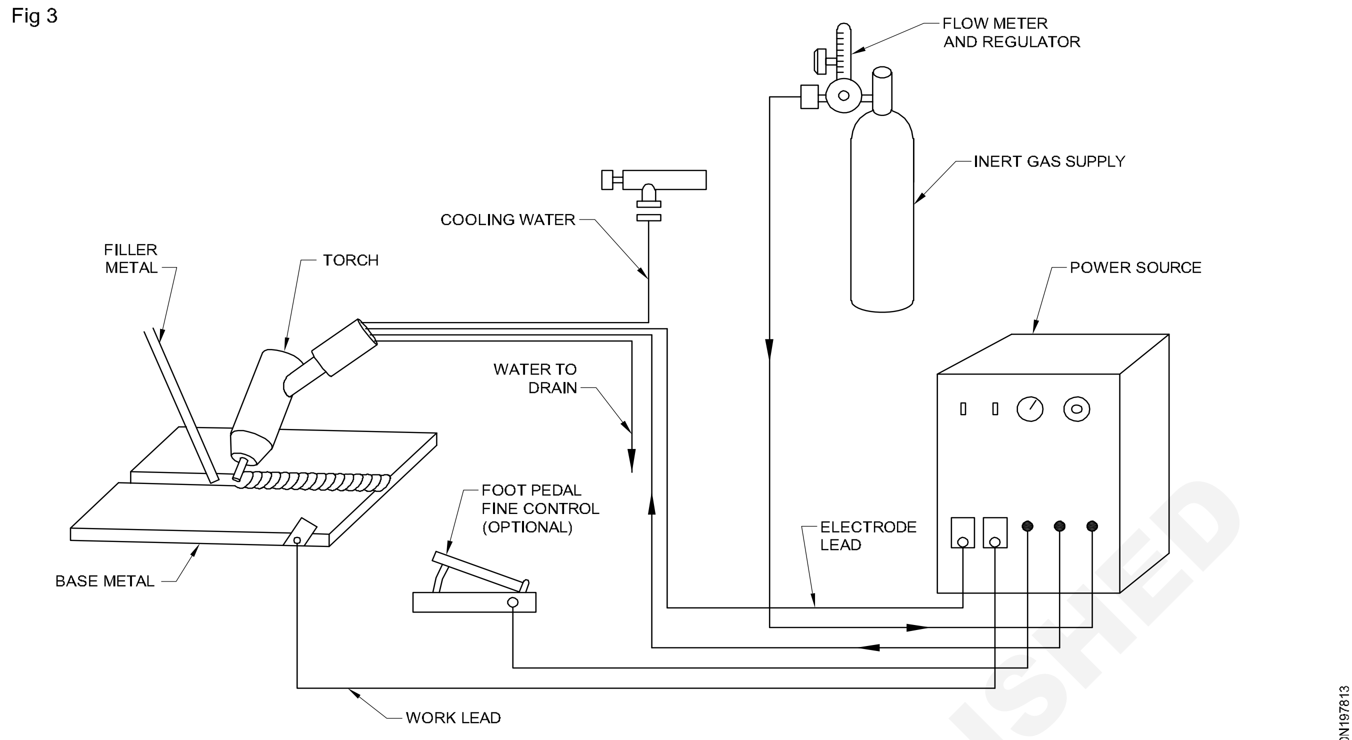
This type of welding is usually done with a single electrode. The tungsten electrode and the weld zone (area being welded) are shielded from the atmosphere (air around it) by an inert gas, such as argon or helium. Filler metal may or may not be used. This process is also called TIG (Tungsten Inert Gas) welding. Gas tungsten arc welding, is particularly used when welding stainless steel, aluminium, titanium and many other non-ferrous metals.

TIG welding equipment

- An AC or DC arc welding machine. Fig. 2 & 3
- Shielding gas cylinders or facilities to handle liquid gases
- A shielding gas regulator
- A gas flowmeter
- Shielding gas hoses and fittings
- A welding torch (electrode holder)
- Tungsten electrodes
- Welding rods
- Optional accessories
- A water cooling system with hoses for heavy duty welding operations
- Foot rheostat (switch)
- Arc timers

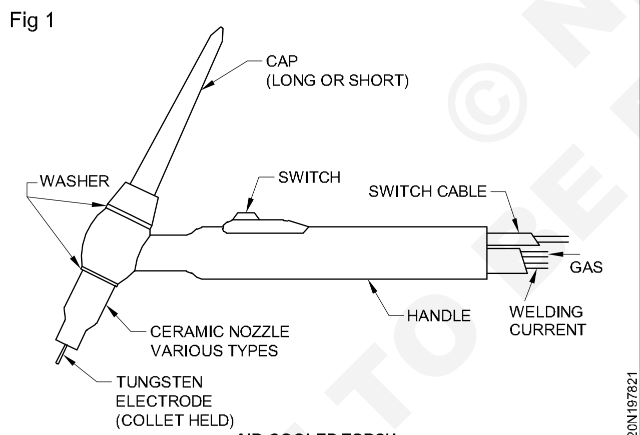
Fig 2





A DIAGRAMMATIC DRAWING OF A COMPLETE GAS TUNGSTEN ARC WELDING

Torch: There is a variety of torches available varying from light weight air cooled to heavy duty water cooled types. Fig.1 & 2. The main factors to be considered in choosing a torch are:



AIR-COOLED TORCH

- Current carrying capacity for the work in hand
- Weight, balance and accessibility of the torch head to the work in hand.

The torch body holds a top loading compression-type collet assembly which accommodates electrodes of various diameters. They are securely gripped, yet the collet is easily slackened for removal or reposition of the electrode. As the thickness of plate to be welded increases, size of torch and electrode diameter must increase to deal with the larger welding currents required.

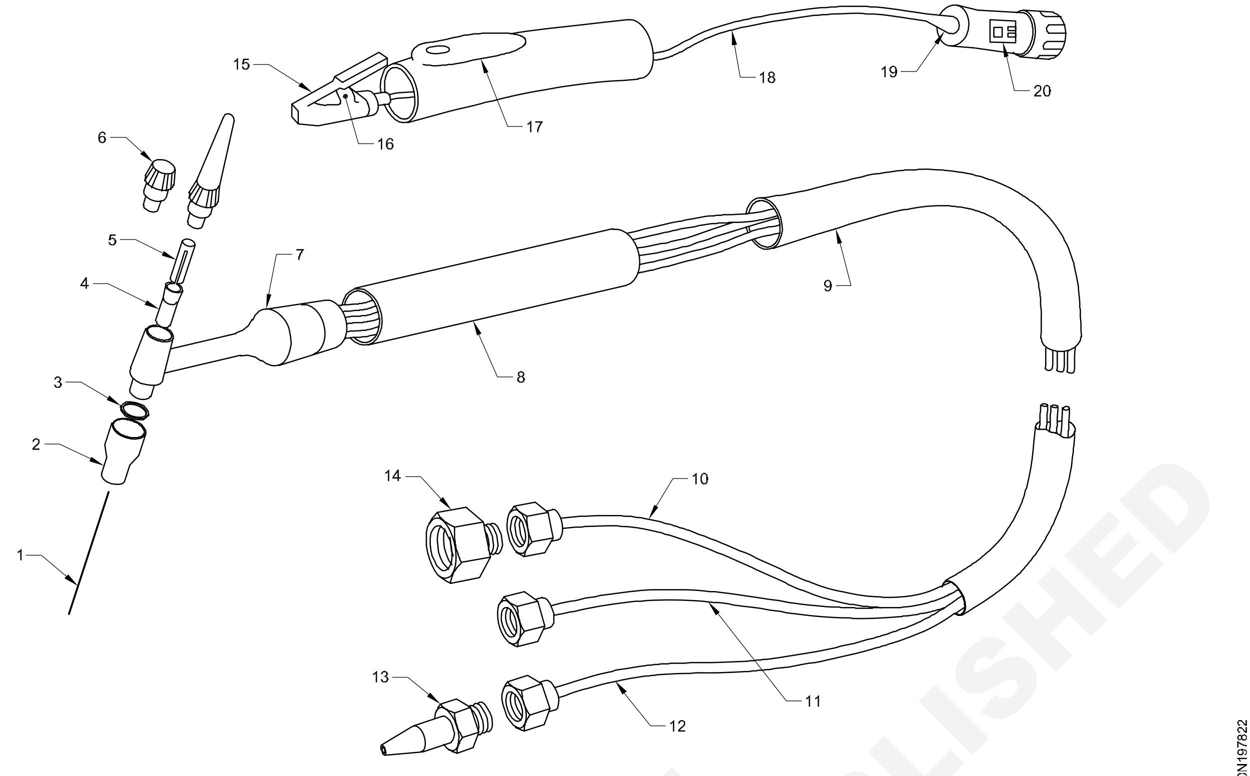
Gas regulator, flowmeter (Fig 3 & 4): The gas regulator reduces the pressure in the argon cylinder from 175 or 200 bar down to 0-3.5 bar for supply to the torch.

The flowmeter which has a manually operated needle valve, controls the argon flow from 0-600 litres/hour to 0-2100 litres/hour according to type.

Parts of water cooled torch Fig.2

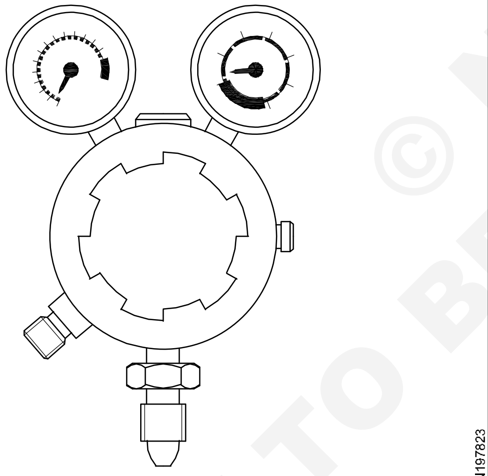
1 Thoriated or Zirconiated tungsten electrode
2 Ceramic shield/nozzle
3 "O" ring
4 Collet holder
5 Collet
6 Electrode cap (short & long)
7 Body assembly
8 Sheath
9 Hose assembly cover
10 Argon hose assembly
11 Water hose assembly
12 Power cable assembly
13 Adaptor (power cable)
14 Adaptor (argon gas hose)
15 Switch actuator
16 Switch
17 Switch retaining sheath
18 Cable (2 core)
19 Insulating sleeve
20 Plug

Fig 2



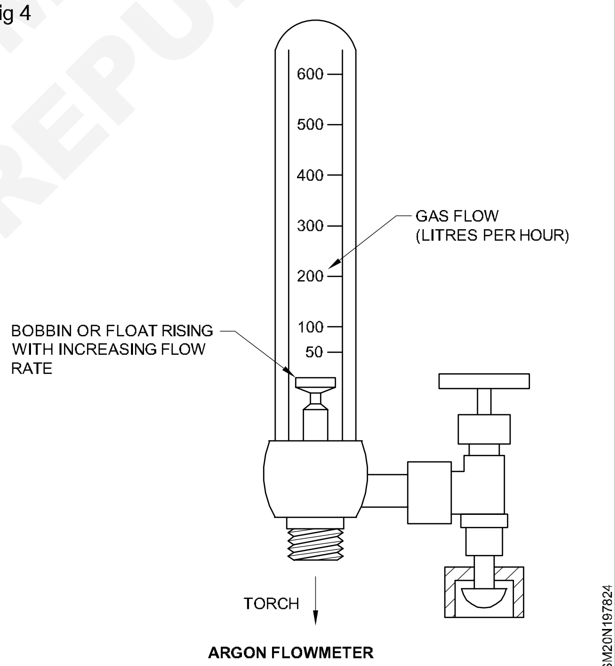
WATER COOLED TORCH

Fig 3



TWO STAGE ARGON REGULATOR

Fig 4



ARGON FLOWMETER

Advantages of TIG welding process over manual metal arc welding and gas welding

Objectives: At the end of this lesson you shall be able to
- **state the advantages of TIG welding process over manual metal arc Welding**
- **state the advantages of TIG welding process over oxy-acetylene welding process.**

Advantages of TIG welding process over manual metal arc welding

TIG welding process	Manual metal arc welding process
TIG process introduces only heat to the part being welded without depositing the metal. With this process the 'filler' metal is only added when it is needed and this need not be linked to the welding current.	MMAW cannot introduce the heat without depositing the metal. Hence, there are risks of lack of fusion, inclusions due to slags from the electrode coating and lack of penetration, associated in welding.
TIG welding process neither adds nor subtracts elements from the metal which it simply brings to fusion. Hence the process is highly suitable for joining reactive metals like stainless steel, aluminium, magnesium etc. This process is most suitable for the following materials.	MMA welding uses consumable electrodes with the operating weldability is governed by elements in the flux covering, sometimes introduces elements which, from a metallurgical point of view, are undesirable. These consumable electrodes can also increase of hydrogen absorption (e.g moisture in the coatings).
Stainless steel 0.5-3mm thickness unprepared. Aluminium and its alloys of 1.5 - 8mm thickness. Copper, cupro-nickel and aluminium bronze.	With difficulty stainless steel plates and sheets more than 3mm thickness can be welded. Coated electrodes are specially made with coating flux containing alloying elements to make up for the loss during welding.
Carbon steels and low alloy steels. Highly reactive materials like Titanium and Magnesium and their alloys.	Largely, the process is restricted to only Mild steel and Carbon steels. Process is not at all suitable for sheets and plates of aluminium and other reactive metals.
TIG welding process offers exceptionally perfect clean weld and an absence of spatter.	MMA welding generally suffer from arc spatter and and hence hot spots in the base metal near the weld joint.
These advantages make TIG the high quality welding process which is the easiest to automate for the production of joints of small dimensions or very difficult to access.	Stick electrodes in MMAW does not offer flexibility for automation.
TIG welding process produces sound weld because there is very little smoke, fumes or sparks. Since the shielding gas around the arc is transparent, the welder can observe the weld easily.	In MMA welding with stick electrodes, there is every danger of smokes, fumes leading to gas porosity in the weld.
	Oxy - acetylene welding process
Arc temperature is as high as 6000^{0}C and hence welding heat is much higher, it is possible to weld with narrower preparations which means more economical use of filler wire and higher welding speed.	In oxy acetylene welding, the flame temperature is not more than 3500^{0}C for the neutral flame, and lower heat input in the flame calls for the wider preparations for the weld joint hence larger amount of filler wire and slower welding speed.
Shielding gases Argon, Helium are totally inert and non-active. Welding done by this process is always clean and without any oxidation.	Thermal source in oxy-acetylene welding is only by burning of acetylene in oxygen, hence there is always a chance of oxygen getting in touch with hot weld metal and hence oxidation of the weld pool and oxide defects or porosity by the liberated carbon-monoxide.
Suitability for joining/welding reactive materials is excellent.	Since it is oxy-fuel, the reactive materials can be welded only in the presence of lower melting flux fed along with the filler rod. This does not ensure 100% defect free weld deposits.

Types of polarity and its application in TIG welding

Objectives: At the end of this lesson you shall be able to
- **define polarity and state the types of polarity**
- **state the application of polarity for welding different metals**
- **state the effects of selecting a wrong polarity.**

DC power sources: **Two types of electrode connections are possible. In DC, the electode connection to the negative (DCEN) of the power source is the preferred type of connection, it is observed that the penetration is more for this type of connection and hence used widely. Table 1 and 2. The other type of connection DC electrode positive (DCEP) results in poor penetration and overheating of the torch. Fig.1. Hence, normally this is not done except for metals like aluminium and magnesium. In the case of these metals a thin tough oxide layer is always present on the surface and as soon as it is removed by any cleaning methods, it forms again very quickly. During welding this layer can cause defects like oxide inclusions or lack of fusion. It is observed that this oxide layer can be cleaned by the arc itself in the DCEP. As already mentioned, this connection gives a poor penetration.**

AC power sources: In AC, the polarity is alternating and the electrode polarity goes through a half cycle during which the oxide is cleaned. Hence for aluminium and magnesium and their alloys, AC is preferred. Table.3.

The Table on Guide to TIG welding given in Related Theory for Ex.No.2-2-11 shows that different materials are welded with preferred polarity. Different types of power sources are available to provide a constant current either in DC or AC.

Fig 1

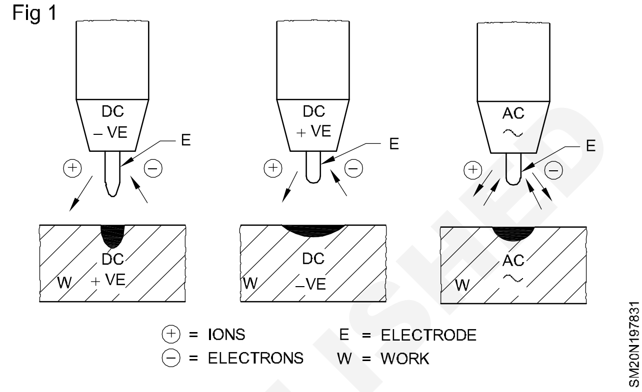


Table 1
GTAW parameters for stainless steel sheets

Characteristics	DCEN	DCEP	AC
Penetration	Deep and narrow	Shallow and wide	Medium
Heat distribution	E = 33% W = 67%	E=67% W=33%	E=1/2, W=1/2
Cleaning of oxide	Not possible	Fully possible	Only in one half cycle
Electrode	—	—	—
Capacity	3.2mm 350amps	6.3mm 120 amps	3.2mm 220 amps

Table 2
Recommended Electrode sizes and current (Direct current, electrode connected to negative pole)

Electrode size mm	Current A Min.	Max.
1.2	8	25
1.6	20	70
2.5	40	120
3.15	80	200
4.0	100	300

These current values are meant for pure tungsten electrodes. The recommendations of the manufacturers may be followed.

Table 3
Recommended electrode sizes and current for aluminium and its alloys (Alternating current)

Electrode size	Max. current (balanced)
1.6	50
2.5	80
3.15	120
4.0	160
5.0	200
5.6	240
6.3	320
8.0	450

Tungsten electrodes - types - uses

Objectives: At the end of this lesson you shall be able to
- **state the properties of tungsten**
- **name different types of tungsten electrodes used in TIG welding**
- **state the uses of tungsten electrodes**

Tungsten electrodes: In TIG welding, the electrode should by definition, be non fusible. Tungsten whose melting point is extremely high, is the metal used.

Electrodes of diameter 1.0, 1.6,2,3,4,5,6,7 and 8mm allow welding currents ranging from 10A to more than 800A. It should be noted that the currents allowed with direct current (electrode negative) are very much higher than those with alternating current.

Electrodes of four different types are used.

Pure Tungsten: These electrodes are obtained by sintering tungsten powder of atleast 99.7% purity. Their melting point is 3380°C.

They cannot support the highest current densities and are less tolerant of contamination. They are used when a soft arc is required.

The characteristics are appreciated when welding heavy metals with direct current (electrode negative) when it is necessary to use shaped electrodes to concentrate the arc to give a narrow penetration.

Tungsten with 1-2% of thorium oxide: In comparison with pure tungsten these materials emit many more electrons and support a higher current density. They also facilitate arc ignition and stability and last longer.

For the same current density, these electrodes run colder than pure tungsten electrodes.

Tungsten with 0.3-0.5% zirconium: Used only with alternating current, they have properties which fall between those of the two preceding types. Tungsten losses would be less with these electrodes than with thorium containing electrodes. Where pool contamination has occurred the tungsten inclusions are of smaller mass and more dispersed than with thorium containing electrodes.

Composite tungsten electrode with strips of tungsten with thorium attached

A thin thoriated strip is attached to and parallel with the axis of a pure tungsten electrode. Such electrodes are used for automatic welding with alternating current. They combine the arc stability given by the pure tungsten electrode with the capacity of the thorium electrode to support a dense current. However since they cannot be shaped into a point, they cannot be used with direct current.

Electrodes are normally available commercially in 150mm lengths and in France are marked as follows.

- Blue tip: pure tungsten
- Red tip:tungsten with 2% thorium
- White tip: composite tungsten with thorium section

(The code may be different in other countries).

Refer the Table on Guide to TIG welding given below, for the type of electrode used for welding various materials.

Guide to TIG welding

Material	Type of weld	Current	Shielding gas	Electrode type
Aluminium	Thin or thick sheets or cast alloys	with HF average penetration.	Argon Ar.+helium penetration	Pure or Zirconium zirc. -> quality radio
	Only thick surfaces.	Electrode -ve deep penetration.	Argon Ar. +He preferable.	With thorium(pointed)
	Only thin surfaces.	Electrode +ve.	Argon	Zirc. or thor. formation 'ball' formation necessary.
Carbon steels	Thin and medium sheets	Electrode -ve	Argon deep deep penetration.	With thorium(pointed) Ar. +He. on thick parts.
	Only thin sheets(not too tightly fixed in the	with HF average penetration.	Argon	Pure or zirc. lasts longer
Copper(use a brazing flux	Thin and medium sheets	Electrode -ve deep penetration.	Argon Ar.+He. preferable on thick parts	Thorium(pointed)
	Very fine sheets sheets.	with HF average penetration.	Argon	Pure or zirc. lasts longer.

Copper alloys	Sheets where e>12/10	electrode -ve	Ar. or Ar. +He on thick parts or with beryllium; Ar	With thorium(pointed)
	Medium sheets cast alloys	with HF Average penetration	Argon	Pure or Zirc. Zirc. radio quality
	Only thin sheets	Electrode +ve deep penetration.	Argon or Ar. +He.	Zirc. or thor. 'ball' necessary.
Nickel monel	All thicknesses	Electrode -ve	Argon	Thorium(pointed)
	Medium & thick sheets	Electrode -ve deep penetration	Argon or Ar. +He	Thorium(pointed)
	Only thin sheets	with HF average	Argon	Pure or sirc. last longer.
Titanium	All thickness	electrode -ve deep penetration	Argon	Thorium(pointed)

GTAW filler rods and selection methods (criteria)

Objective: At the end of this lesson you shall be able to
- **state the mandatory classification designators.**

In the welding process (GTAW or gas tungsten) is an arc welding process taht operates the filler rods.

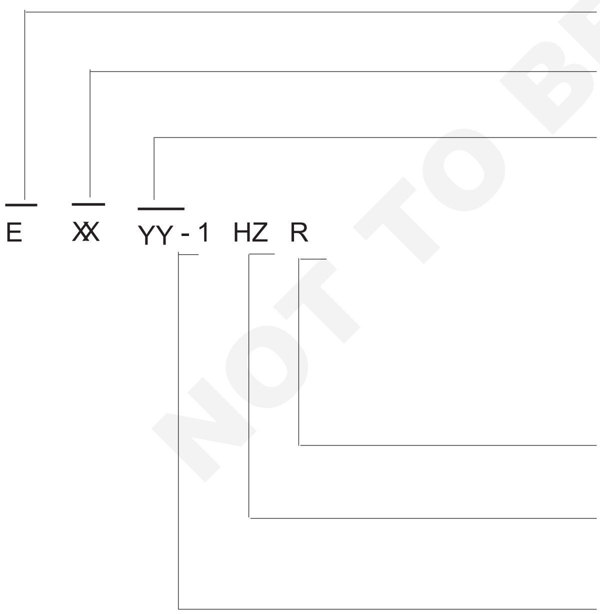
The TIG torch may be cooled by air or water and the process uses a filler metal in road form. The tungsten electrode selection and parameters for welds are guided them.

Gas tungsten arc welding also know as tungsten inert gas (TIG) welding, is an arc development within the GTAW process.

Now always the filler rods is withdraw from the weld pool each time the electrode can be changed.

Welding filler metal designators

1 Carbon steel electrodes



Mandatory classification designators

Designates an electrode

Designates minimum tensile strength, in Ksi, of the as-deposited weld metal.

Designates the welding position, the type of covering and the type of welding current for which the electrodes are suitable (See table below)

Optional supplemental designators

Designates that the electrode meets the requirements of absorbed moisture.

Designates that the electrode meets the requirements of the diffusible hydrogen test - with an average value no exceeding "Z" mL of H2 per 100gms of deposited metal.

Designates that the electrode meet the requirements for improved toughness and ductility.

Optional supplemental designators			
AWS Classification	Type of covering	Welding position	Type of current [b]
E6010	**High cellulose, sodium**	**F,V,OH, H**	**dcep**
E 6011	**High cellulose, potassium**	**F,V,OH,H**	**as or dcep**
E 7018	**Low hydrogen, Potassium, Powder**	**F,V,OH,H**	**ac or dcep**
E7024	**Iron Powder, Titania**	**H-Fillets, F**	**ac, dcep or dcen**

Note

a The abbreviations indicate the welding positions

F=Flat; V=Vertical, OH=overhead, H=Horizontal, H=Fillets = Horizontal fillets.

b The term dcep refers to direct current electrode positive (dc, straight polarity)

Also note that the above electrode classifications are the most widely used and does not include all of the available classifications. **Refer to AWS A 5.1 for complete listing.**

2 Alloy steel electrodes

Mandatory classification designators

Designates and electrode

Designates minimum tensile strength, in Ksi, of the as-deposited weld metal

Designates the welding position, the type of covering and the type of welding current for which the electrodes are suitable.

Designates the chemical composition of the undiluted weld metal produced by the electrode using SMAW process.

Optional supplemental designators

Designates that the electrode meets the requirements of absorbed moisture.

Designates that the electrode meets the requirements of the diffusible hydrogen test - with an average value not exceeding "Z" mL of H2 per 100gms of deposited metal, where "Z" is 4,8 or 16.

Refer to AWS A 5.5 for complete listing of mechanical properties, chemical composition of as deposited weld metal and testing procedures for SMAW process.

3 Stainless steel filler metal

Usability classification

Types of welding current and position of welding		
AWS classification	**Welding current**	**Welding position**
EXXX (X) - 15	dcep	All
EXXX (X) - 16	dcep or ac	All
EXXX (X) - 17	dcep or ac	All
EXXX(X) - 25	dcep	H,F
EXXX (X) - 26	dcep or ac	H,F

For more details on the usability classifications, refer to AWS A 5.4

Table 1: Carbon and low - alloy steel welding consumables for SMAW process

Legend

A AWS A 5.1 classification E 70XX low hydrogen (E7018 preferred)

B AWS A 5.1 classification E 70XX low hydrogen (E7018 preferred)

C AWS A 5.5 classification E70XX - A1, low hydrogen

D AWS A 5.5 classification E70XX - B2L or E80XX- B2, low hydrogen

E AWS A 5.5 classification E80XX-B3L or E80XX- B6L, low hydrogen

F AWS A 5.5 classification E80XX-B6 or E80XX-B6L, low hydrogen

G AWS A 5.5 classification E80XX-B7 or E80XX-B7L, low hydrogen

H AWS A 5.5 classification E90XX-B8 or E80XX-B8L, low hydrogen

1 Table 1 refers to coated electrodes (SMAW process) only. For bare wire welding (SAW, GMAW, GTAW and FCAW), use equivalent electrode classifications (AWS A 5.14, A 5.17, A5.18, A 5.20, A 5.23, At 28)

2 Higher allow electrode specified in the table should normally be used to meet the required tensile and toughness after post weld heat treatment (PWHT). If no PWHT is required, the lower alloy electrode specified may be required to meet the hardness requirements.

Types of welding current and position of welding

Base material	**Carbon steel**	**Carbon-molybdenum steel**	**1 and 1 1/4 Cr-1/2 Mo steel**	**2 1/4 Cr-1 Mo steel**	**5 Cr-1/2 Mo Steel**	**9 Cr - 1 Mo steel**
Carbon steel	AB	AC	AD	AE	AF	AG
Carbon-Molybdenum steel		C	CD	CE	CF	CH
1 and 1 1/4 Cr-1/2 Mo steel			D	DE	DF	DH
2 1/4 Cr-1 Mo steel				E	EF	EH
5 Cr - 1/2 Mo steel					F	FH
9 Cr-1 Mo steel						H

Shielding Gases

Objectives: At the end of this lesson you shall be able to
- **state the properties of argon gas**
- **compare the performance characteristics of argon and helium gas for TIG welding**
- **identify an argon gas cylinder and ceramic nozzles**
- **state the uses of argon and helium gas.**

Shielding gases

Chemical activity of shielding gases: The behaviour of gases in welding is related to their chemical activity so it is convenient to group them according to this activity.

Inert gases: These are argon and helium. Other inert gases such as krypton, Radon, xenon and neon have been tried, but their low availability results in them being expensive. Also their characteristics do not, at present, give them any particular advantage.

Argon and helium are monatomic (their molecule contains only one atom) and do not react with other bodies (in the arc plasma) and hence the designation 'inert'. This precious property allows them to protect the electrode and molten metal against the atmospheric gases. However they are not suitable in every case. Pure argon for example does not allow a smooth droplet transfer when welding carbon steels. To obtain the desired transfer mode it is necessary to add a certain proportion of oxygen or carbon di oxide.

The different ionisation potential of argon and helium cause them to behave differently.

Properties of argon and helium gas

These gases are colourless, odourless.

Argon is heavier than air and helium is lighter than air.

They do not chemically react with any metals in hot or cold conditions.

They give a good shielding action for molten metal from the atmosphere.

Gases for TIG welding of aluminium

Argon gas

An argon cylinder is identified by the peacock blue colour painted on it.

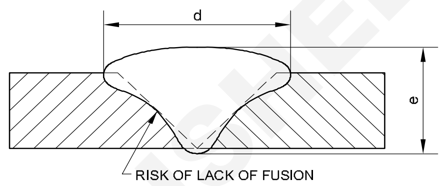
Quality : Argon gas of welding quality should be used.

The rate of flow of argon should be adequate to obtain a clean weld. This depends on several factors such as type of parent metal, current used, shape and size of nozzle, type of joint and whether the work is done indoors or outdoors. Generally a higher rate of flow is required with higher welding currents, for outside corner joints, edge welds and work outdoors. Generally flow rates 2 to 7 litres per minute will be found sufficient to weld all thicknesses.

If tungsten inert gas welding has to be done outdoors during inclement weather, especially during period of high wind, the welding area should be effectively protected. Draughts tend to break the gas shielding, resulting in porous and oxide contaminated welds.

The penetration profile of argon shielded welds has a characteristic shape in the form of a finger.Fig.1

Fig 1



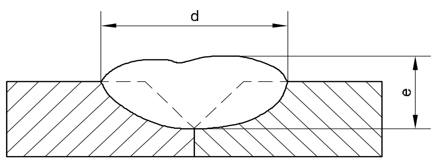
PROFILE TYPICAL OF ARGON SHIELDED WELD ($\frac{d}{e}$ = 2.5)

Helium: Helium is used mainly in TIG welding and is normally used with direct current whatever the metal being welded (light alloys, copper, etc.)

The main advantages of helium shielding are:

– Increase in welding speeds
– More intense local heating, important with metals which are good conductors of heat
– Fig.2 shows the penetration, profile typical of a helium shielded weld

Fig 2



PROFILE TYPICAL OF HELIUM SHIELDED WELD ($\frac{d}{e}$ = 3.5)

Argon gas gives more penetration than helium gas.

Characteristics and comparative performance of argon and helium as shielding gases

Argon

Low arc voltage : Results in less heat; thus argon is used almost exclusively for manual welding of metals less than 1.6mm thick.

Good cleaning action: Preferred for metals with refractory oxide skins, such as aluminium alloys or ferrous alloys containing a high percentage of aluminium.

Easy arc starting: Particularly important in welding of thin metal.

Arc stability is greater than with helium

Low gas volume: Being heavier than air, argon provides good coverage with low gas flows and it is less affected by air drafts than helium

Vertical and overhead welding: Sometimes preferred because of better weld puddle control but gives less coverage than helium.

Automatic welding: May cause porosity and undercutting with welding speeds of more than 60cm per min. Problem varies with different metals and thicknesses and can be corrected by changing to helium or a mixture of argon and helium.

Thick work metal: For welding metal thicker than 5mm a mixture of argon and helium may be beneficial

Welding dissimilar metals: Argon is normally superior to helium

Helium

High arc voltage: Results in a hotter arc, which is more favorable for welding thick metal (over 5mm) and metals with high heat conductivity.

Small heat affected zone: With high heat input and greater speeds, the heat affected zone can be kept narrow. This results in less distortion and often in higher mechanical properties.

High gas volume: Helium being lighter than air, gas flow is normally 1 1/2 to 3 times greater than with argon. Being lighter, helium is more sensitive to small air drafts, but it gives better coverage for overhead welding and often for vertical position welding.

Automatic welding: With welding speeds of more than 60cm per min. welds with less porosity and undercutting may be attained (depending on work metal and thickness).

Comparision between argon and helium shielding

Argon	Helium
1 Smoother arc.	1 Smaller heat affected zone.
2 Easy starting.	2 Best for thicker metal welding due to higher arc voltage.
3 Best for thinner metal welding due to lower arc voltage.	3 Better for welding at higher speed.
4 Good cleaning action while welding Al.	4 Gives better coverage in vertical and overhead positions.
5 Heavier than air - Lower flow rates.	5 When used in back shieldings flatens the root face.
6 Lowe cost, more availability.	
7 Better for welding dissimilar metals.	
8 Better control of puddle on positional joints.	

Defects causes and remedy

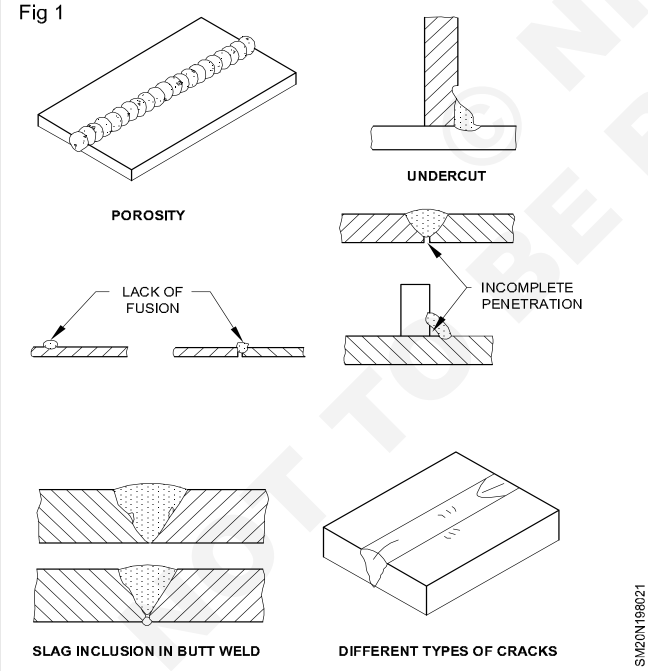
Objectives: At the end of this lesson you shall be able to
- **state the different type of defects in GTAW**
- **state the causes and remedies of GTAW defects.**

The following table relates to the cause and prevention of the more common defects encountered in welds made by the TIG welding process. (Fig. 1)

Defect	Appearance	Cause	Remedy
Porosity	Pin holes in the weld.	Insufficient shielding gas. Bore of gas nozzle too small arc length too long. Surplus degreasing agent.	Satisfactory supply gas. Correct ceramic shield. Remove all degreasing agents and dry. Shorten arc length.
Undercut	Irregular grooves or channels	Incorrect welding technique. Current too high. Incorrect welding speed.	Correct current. Correct rod manipulation. Clear weld surface. at the toes of the weld.
Lack on fusion. (side root or inter run)	Surface on to which weld is deposited has not been melted. Not always visible. Usually	Incorrect current level. Incorrect filler rod manipulation. Unclean plates surfaces. detected by bend test or by	Correct current. Use correct rod manipulation. Clean plate surfaces.

		non-destructive techniques (e.g.ultrasonic flaw detection).	
Lack of Penetration	Notch or gap at the root of a weld.	Incorrect preparation and set up. Incorrect current level. Welding speed too fast.	Use the correct preparation and set up. Correct current. Correct weld speed.
Inclusions	Usually internally and only detected by suitable testing techniques. Normally oxide or tungsten inclusions.	Oxide inclusions. Inadequate cleaning of parent material before welding. Contamination onsurface of filler rod. Inadequate protection of underside of a weld.Loss of gas shield.	Clean all metal surfaces. Ensure a satisfactory supply of shielding gas. Excluide draughts.
Cracking	Cracks can occur in the weld metals and in the parent metal alongside the weld. They may not be visible on the surface and may only be detected by the use of suitable testing techniques.	The type of crack and therefore its cause will depend on the material being welded. The correct diagnosis of the cause of a crack frequently calls for expert knowledge.	Use correct welding procedure. Pre-heating and post heat treatm-ent. Use correct preparation Set up current. Use correct filler rod. Always adhere strictly to the procedure specified when welding materials that are susceptible to cracking. Always ensure the correct type of filler is used and the correct amount of filler metal is added.

Fig 1



Plasma arc cutting

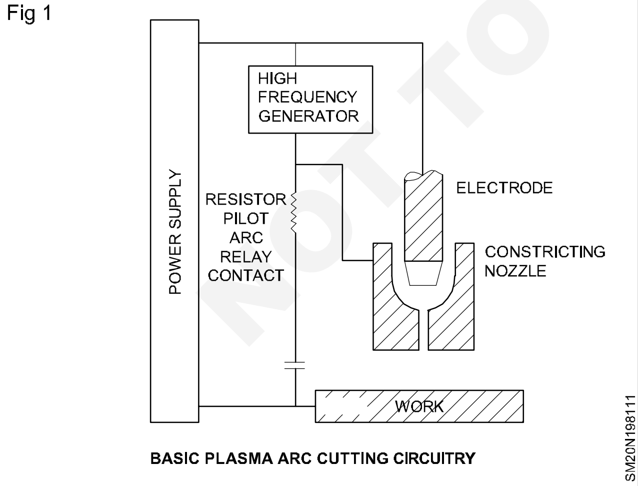
Objectives : At the end of this lesson you shall be able to
- **state the principle of plasma arc cutting**
- **state the various process of plasma arc cutting**
- **advantages of plasma arc cutting.**

Plasma arc cutting process, was introduced in the industry in the mid 1950s. The process is used to cut all metals and non-metals. The common oxy-fuel cutting process (based in a chemical process) is suitable for cutting carbon steel and low alloy steel cutting only. Materials such as copper, aluminium and stainless steels were earlier separated by sawing, drilling or sometimes by powder flame cutting. These materials are now cut using a plasma torch, at faster rates and more economically. The Plasma cutting process is basically a thermal cutting process, free of any chemical reaction, that means, without oxidation. In plasma arc cutting an extremely high temperature and high velocity constricted arc is utilised.

Principle of operation

Plasma arc cutting is a process resulting from ionizing a column of gas (argon, nitrogen, helium, air, hydrogen or their mixtures) with extreme heat of an electric arc. The ionized gas along with the arc is forced through a very small nozzle orifice, resulting into a plasma stream of high velocity (speed up to 600 m/sec) and high temperature (up to 20000°K). When this high speed is reached, high temperature plasma stream and electric arc strike the workpiece, and ions in the plasma recombine into gas atoms and liberate a great amount of latent heat. This heat melts the workpiece, vaporizes part of the material and the balance is blasted away in the form of molten metal through the heat.

Fig 1



BASIC PLASMA ARC CUTTING CIRCUITRY

Plasma cutting system

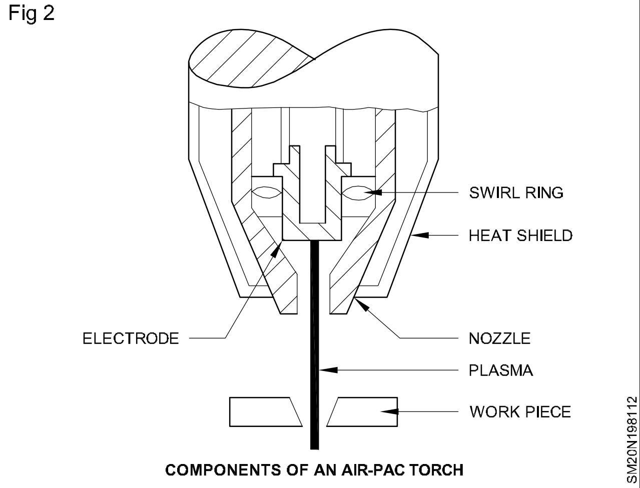
Plasma cutting requires a cutting torch, a control unit, a power supply, one or more cutting gases and a supply of clean cooling water (in case water-cooled torch is used).

Equipment is available for both manual and mechanical cutting. A basic plasma arc cutting circuit is shown in Fig 1. It employs direct current straight polarity (DCEN). The nozzle surrounding the electrode is connected to the workpiece (positive) through a current limiting reisitor and a pilot arc relay contact.

The pilot arc between the electrode and nozzle is initiated by a high frequency generator connected between the electrode and nozzle. The orifice gas ionized by the pilot arc is blown through the constricting nozzle orifice and forms a low resistance path to ignite the main transferred arc between the electrode and the workpiece when the ON/OFF switch is closed. The pilot arc relay may be opened automatically when the main arc ignites, to avoid unnecessary heating of the constricting nozzle. The constricting nozzle is of copper and normally water cooled to withstand the high plasma flame temperature (about 20000°K) and to have longer life.

In conventional gas plasma cutting, discussed above, the cutting gas can be argon, nitrogen, (argon + hydrogen), or compressed air. For all the cutting gases other than compressed air, the non-consumable electrode material is 2% thoriated tungsten. In air plasma cutting (Fig 2) where dry, clean compressed air is used as the cutting gas, the electrode of hafnium or zirconium. Is used because tungsten is rapidly eroded in air. Wet and dirty compressed air reduces the useful life of consumable parts and produces poor quality.

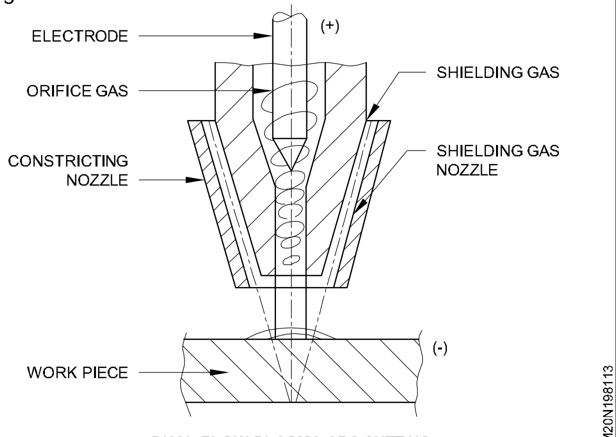
Fig 2



COMPONENTS OF AN AIR-PAC TORCH

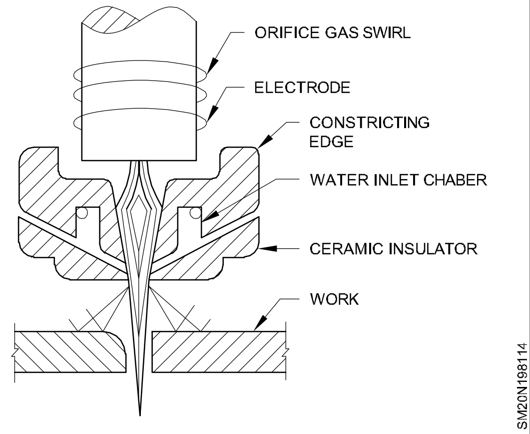
Several process variations are used to improve the cut quality for particular applications. Auxiliary shielding in the form of gas or water is used (Fig 3) to improve the cut quality and to improve the nozzle life. Water injection plasma cutting (Fig 4) uses a symmetrical impinging water jet near the constricting nozzle orifice to further constrict the plasma flame and to increase the nozzle life. Good quality cut with sharp and clear edges with little or no dross is possible in water injection plasma cutting.

Fig 3



DUAL FLOW PLASMA ARC CUTTING

Fig 4



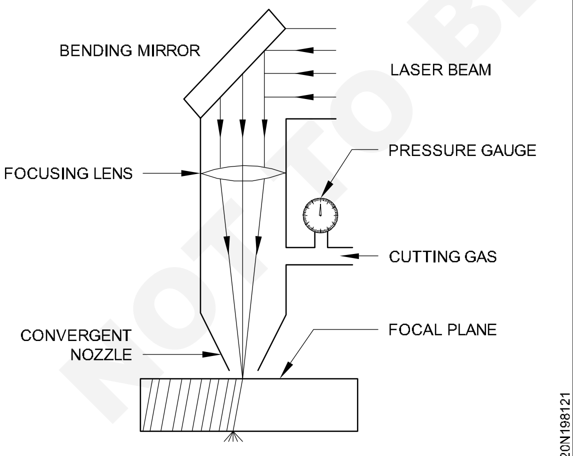
Laser cutting

Objectives : At the end of this lesson you shall be able to
- **features of laser cutting**
- **compression between various cutting processes.**

Laser Cutting

The Laser beam is able to cut through most materials by evaporating the material and creating a hole and traversing it. With materials that melt, a coaxial gas jet is used to blow the molten product away (Fig 1). Failure to do this would produce a weld. This gas jet can also add heat in the cutting zone, if the material reacts exothermically with it (eg. steel and O?). The heat-affected zone is, in any case, narrow due to the high processing speeds and highly localized nature of energy.

Fig 1



SCHEMATIC DIAGRAM OF LASER GAS CUTTING HEAD

The main features of laser cutting are as follows.

i) The cut has a very narrow kerf, thus effecting saving in material.

ii) The cut has a very narrow heat-affected zone (HAZ), and, therefore, gives low thermal distortion.

iii) It gives an almost machine-smooth cut surface reducing the need for subsequent trimming.

iv) The cut has square edges.

v) There is no tool wear.

vi) The workpiece does not need holding against tool drag, and work-holding demands are reduced to merely a locating role.

vii) It is possible to cut through friable, brittle, soft or hard materials with almost equal ease.

viii) It is a non-contact method with no cutting forces and is ideal for cutting flexible materials such as cloth, rubber, corrugated cardboard etc.

ix) It is non-directional; therefore, it cuts equally well in all directions and it can be started anywhere.

x) Blind cuts can be made.

xi) The cutting speed is high as compared to other methods.

xii) Multi-station operations from one laser are possible.

It is easily automated by numerical control.

Possible to weld the cut edges directly.

There are five different ways, in which a laser can be used to cut different materials.

i) Vaporization - The beam energy heats the substrate to above its boiling point, and the material leaves as vapour and gets ejected.

ii) Melting and blowing the beam energy melts the substrate and a jet of inert gas blows the melt out of the cut region.

iii) Burning in reactive gas:

iv) The beam energy heats material to the kindling temperature, which then burns in a reactive gas jets; as in (ii) the jet also clears the dross away.

v) Thermal stress cracking or controlled fracturing - The beam energy sets up a thermal field in a brittle material. Eg. Glass such that it can guide a crack in any direction.

vi) **Scribing:** A blind cut is used as a stress raiser allowing mechanical snapping along the scribed lines.

What distinguishes these five mechanisms is how the heat is subsequently coupled and its effects on the workpiece.

Lasers have been particularly successful in cutting titanium for the aircraft industry. Before lasers were used, this difficult material was cut with a plasma arc.

This produced a wide kerf and a wide HAZ, which had to be machined off. The narrow HAZ from laser cutting simply requires a minimal post machining step to clean the edge surface. A comparison of metal-cutting techniques is given in Table 1. As can be seen, laser cutting is far more efficient than either plasma arc or oxyacetylene cutting.

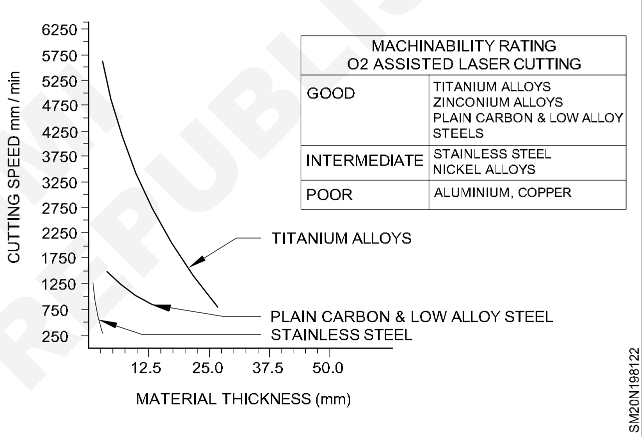
TABLE 1

Comparison of various cutting processes

	Laser	Oxy-acetylene	Plasma-arc
Heat affected zone	0.25 mm to 0.76 mm	6.35 mm	2.54 mm
Kerf width	0.89 to 1.4 mm	2.03 mm	7.92 mm
Edge machining allowance	1.27 mm	9.52 mm	5.08 mm

A reactive cutting process is used in the laser cutting of metals. In this process, oxygen is supplied by a coaxial gas jet. It is this oxygen that actually makes the cut, While the laser sustains the reaction. The variations in laser cutting rates for different metals are shown in Fig 2.

Fig 2



Among many applications of laser cutting, both for metals and non-metals, only a few examples are given here. One example is than in the cutting of stainless steel helicopter blades, the laser took 1.6 minutes compared to the previous method which took 35 minutes in addition to 6 special cutters. Another example is the manufacturing of air-conditioning units. Using a numerically controlled laser obviates the need to mark out the work while ensuring the cut is distortion-free through galvanized or plastic coated steel sheets. This application gave a saving of US dollars 50,000, in one year in 1976, approximately the cost of the laser.

Water jet cutting

Objectives : At the end of this lesson you shall be able to
- **principle of water jet cutting**
- **benefits of water jet cutting**
- **edge quality of water jet cutting.**

A water jet cutter, also known as a water jet or waterjet, is an industrial tool capable of cutting a wide variety of materials using a very high-pressure jet of water, or a mixture of water and an abrasive substance. The term abrasive jet refers specially to the use of a mixture of water and abrasive to cut hard materials such as metal or granite, while the terms pure waterjet and water-only cutting refer to waterjet cutting without the use of added abrasives, often used for softer materials such as wood or rubber.

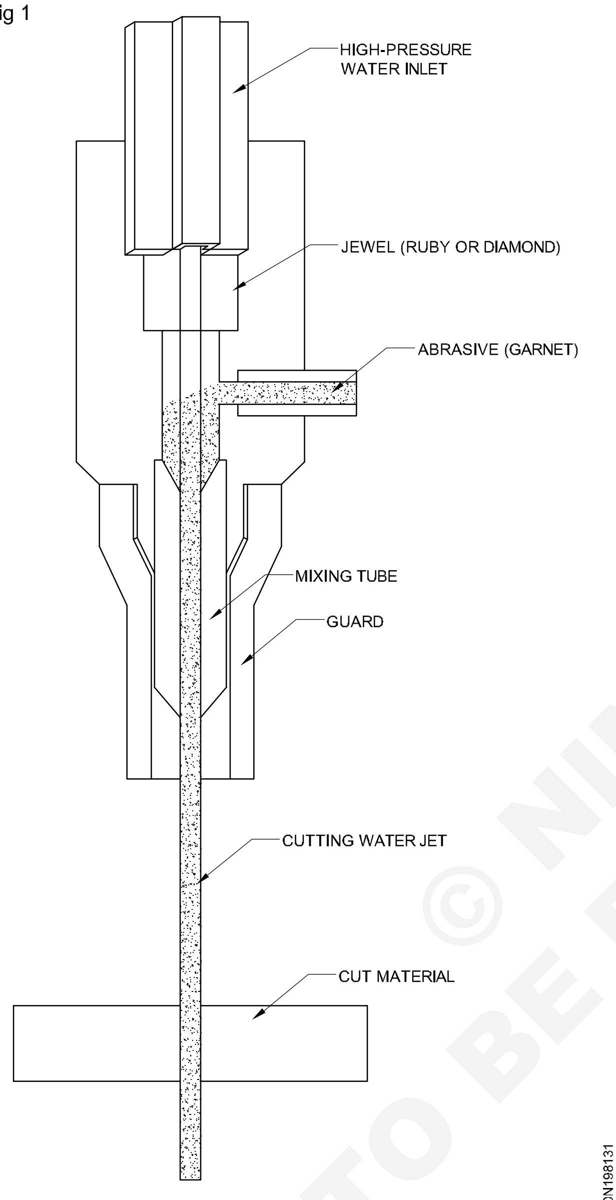
Waterjet cutting is often used during fabrication of machine parts. It is the preferred method when the materials being cut are sensitive to the high temperatures generated by other methods. Waterjet cutting is used in various industries, including mining and aerospace, for cutting, shaping, and reaming.

High pressure

High-pressure vessels and pumps became affordable and reliable with the advent of steam power. By the mid-1800s, steam locomotives were common and the first efficient steam-driven fire engine was operations. By the turn of the century, high-pressure reliability improved, with locomotive research leading to a sixfold increase in boiler pressure, some reaching 1600 psi (11 MPa). Most high-pressure pumps at this time, though, operated around 500-800 psi (3-6 MPa).

High-pressure systems were further shaped by the aviation, automotive, and oil industries. Aircraft manufactures such as Boeing developed seals for hydraulically boosted control systems in the 1940s, while automotive designers followed similar research for hydraulic suspension systems. Higher pressures in hydraulic systems in the industry also led to the development of advanced seals and packing to prevent leaks.

Fig 1



A WATER JET CUTTER

These advances in seal technology, plus the rise of plastics in the post-war years, led to the development of the first reliable high-pressure pump. The invention of Marlex by Robert Banks and John Paul Hogan of the Phillips Petroleum company required a catalyst to be injected into the polyethylene. McCartney Manufacturing Company in Baxter Springs, Kansas, began manufacturing these high-pressure pumps in 1960.

Operation

The cutter is commonly connected to a high-pressure water pump there the water is ejected from the nozzle, cutting through the material by spraying it with the jet of high-speed water. Additives in the form of suspended grit or other abrasives, such as garnet and aluminium oxide, can assist in this process.

Benefits

An important benefit of the water jet is the ability to cut material without interfering with its inherent structure, as there is no "heat-affected zone"(HAZ). Minimizing the effects of heat allows metals to be cut without harming or changing intrinsic properties.

Water jet cutters are also capable of producing intricate cuts in material. With specialized software and 3-D machining heads, complex shapes can be produced.

The kerf, or width, of the cut can be adjusted by swapping parts in the nozzle, as well as changing the type and size of abrasive. Typical abrasive cuts have a kerf in the range of 0.04" to 0.05" (1.016 to 1.27 mm), but can be as narrow as 0.02" (0.508 mm). Non-abrasive cuts are normally 0.007" to 0.013" (0.178 to 0.33 mm), but can be as small as 0.003" (0.076 mm), which is approximately that of a human hair. These small jets can permit small details in a wide range of applications.

Water jets are capable of attaining accuracies down to 0.005" (0.13 mm) and repeatabilities down to 0.001" (0.025 mm).

Due to its relatively narrow kerf, water jet cutting can reduce the amount of scrap material produced, by allowing uncut parts to be nested more closely together than traditional cutting methods. Water jets use approximately one half to one gallon (2 to 4 liters) per minute (depending on the cutting head's orifice size), and the water can be recycled using a closed-loop system. Waste water usually is clean enough to filter and dispose of down a drain. The garnet abrasive is a non-toxic material that can be recycled for repeated use; otherwise, it can usually be disposed in a landfill. Water jets also produce fewer airborne dust particles, smoke, fumes, and contaminants, reducing operator exposure to hazardous materials.

Meatcutting using waterjet technology eliminates the risk of cross contamination since there is no contact medium (namely, a blade) between different animals in the slaughterhouse.

Versatility

Because the nature of the cutting stream can be easily modified the water jet can be used in nearly every industry; there are many different materials that the water jet can cut. Some of them have unique characteristics that require special attention when cutting.

Materials commonly cut with a water jet include rubber, foam, plastics, leather, composites, stone, tile, metals, food, paper and much more. Materials that cannot be cut with a water jet are tempered glass, diamonds and certain ceramics. Water is capable of cutting materials over eighteen inches (45 cm) thick.

Availability

Commercial water jet cutting systems are available from manufactures all over the world, in a range of sizes, and with water pumps capable of a range of pressures. Typical water jet cutting machines have a working envelope as small as few square feet, or up to hundreds of square feet.

Ultra-high-pressure water pumps are available from as low as 40,000 psi(276 MPa) up to 100,000 psi(689 MPa).

Process

There are six main process characteristics to water jet cutting:

Uses a high velocity stream of abrasive particles suspended in a stream of Ultra High Pressure Water (30,000-90,000 psi) which is produced by a water jet intensifier pump.

Is used for machining a large array of materials, including heat-sensitive, delicate or very materials.

Produced no heat damage to workpiece surface or edges.

Nozzle are typically made of sintered boride.

Produces a tapper of less than 1 degree on most cuts, which can be reduced or eliminated entirely by slowing down the cut process.

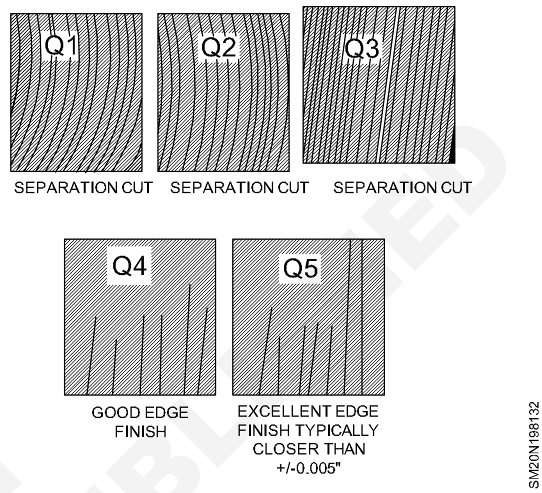
Distance of nozzle from workpiece affects the size of the kerf and the removal rate of material. Typical distance is. 125" (3.175 mm).

Temperature is not as much of a factor.

Edge Quality

Edge quality for water jet can parts is defined with the numbers 1 through 5. Lower numbers indicate rougher edge finish; higher numbers are smoother. For thin materials, the difference in cutting speed for quality 1 could be as much as 3 times faster than the speed for quality 5. For thicker materials, quality 1 could be 6 times faster than quality 5. For example, 4" thick aluminium Q5 would be 0.72 ipm (18 mm/min) and Q1 would be 4.2 ipm (107 mm/ min), 5.8 times faster.

Fig 2



Specification of aluminium section

Objectives: At the end of this lesson you shall be able to
- **state different types of aluminium section**
- **state the application of aluminium section.**

Proportion

1) Corrosion resistance
2) Excellent mechanical properties
3) Dimensional tolerance
4) High durability
5) Resistance against corrosion
6) Excellent finish
7) High strength

Aluminium sheet & Plate aluminium in its various forms is stocked in a range of strengths varying utility sheet, is used for all general sheet metal work such as flashings, ductwork, lining walls, etc. Also primarily for spinning and deep drawing operations such as utensils, ornaments, etc.

Thickness : 0.15 - 150 mm

Width : 20 - 2000 mm

Length : 1000 - 6000 mm.

Good plasticity and conductivity.

Generally used in individual and construction applications.

Aluminum strips

Available in varied standard sizes and grades, these strips are widely used to make engine sheets.

Properties

1) Rustproof
2) Dimensionally stable
3) Fine finish

Aluminium tubes

Wide and remarkable range of aluminium tubes are available, as per standards of industry laid norms and guidelines.

Properties

1) Resistance to abrasion
2) Ability to withstand high temperature
3) Highly durable

Aluminium angle

Aluminium angles that have wide usage in different industries like Pharmaceutical, Chemical, Food, Agriculture and many more. The salient features like durable finish standards, withstand high temperature and abrasion resistant are available in standard sizes.

Widely used in the following sectors:

1) Aircraft fittings
2) Fuse parts
3) Missile parts
4) Worm gears and keys
5) Aircraft
6) Aeroscope
7) Defense applicaions

Aluminium channels

Aluminium channel is manufactured using high grade of aluminium. These are extensively used in various industry applications, owing to features like elegant design, study construction and durable performance.

Properties

1) Easy installation
2) Dimensionally accurate
3) Corrosion resistant
4) Sturdy

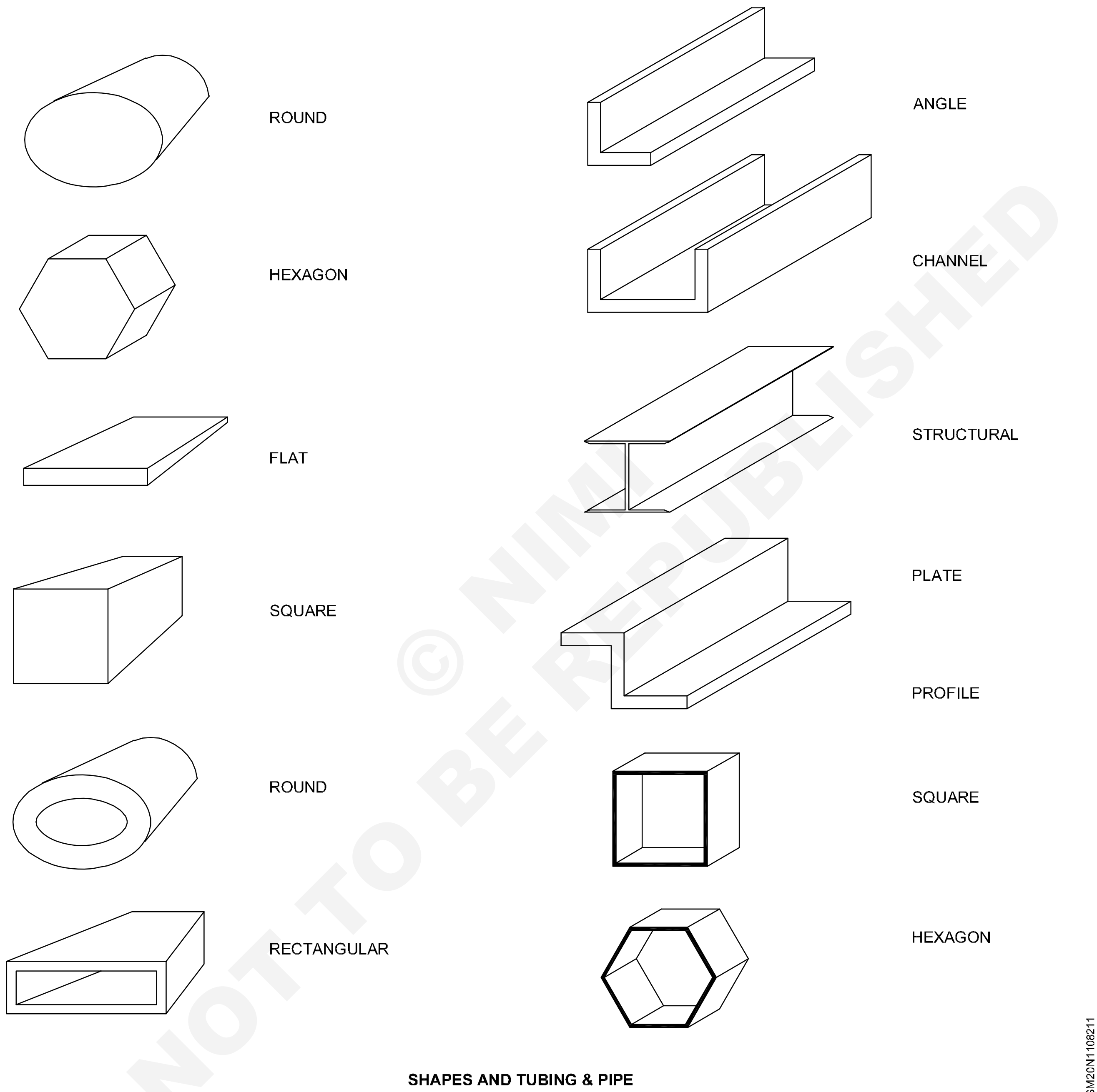
Aluminium channels are constructed using a vertical web with top and bottom flanges at a 90 degree angle to the web. Inside radius corners provide additional strength to the structure, further increasing the strength of the material. The high strength and high heat properties of aluminium make it a good material for use in electronic, electrical and machinery enclosures. Due to its corrosion resistance it is used for housings exposed to weather and channels in window and door frames for buildings and vehicles.

Channels are one of the most widely used extruded aluminium profile shapes because the aluminium alloy's malleability permits the extrusion of a wide array of different channel profile shapes and sizes suitable for many industrial, manufacturing and construction applications. Extruded aluminium channels is widely used in railroad car windows and other components inside the train itself, in addition to the construction of the outer bodies of heavy vehicles such as trucks, since both require strength and less weight to maximize fuel efficiency. Many different metal profile shapes are referred to as "Channels"; however it is generally accepted that they fit into several widely-used categories. These shapes include U-Channel, J-Channel, C-Channel, both square and rectangular open seam tubing, hat channel and almost any other unusually shaped aluminium extrusion profile for which there isn't another name, such as Z-channel.

Aluminium channel;s excellent joining characteristics and ability to accept applied coatings also make this product an excellent choice in aircraft and marine fittings and hardware.

Sharp, defined edges, is an excellent choice for lightweight cosmetic and structural applications and is also usually available in smaller profile sizes than other types of aluminium channel.

Fig 1



SHAPES AND TUBING & PIPE

Aluminium partition section's

Objectives: At the end of this lesson you shall be able to
- **identify aluminium partition sections used for making aluminium partitions**
- **state the application of aluminium partition sections**
- **explain the advantages of aluminium partitions.**

Introduction

Nowadays, aluminium partitions are commonly used in making offices, cabins, showrooms, factories etc and very popular in public and commercial buildings.

Old type fabricated steel frames at windows are getting replaced by aluminium window frames.

Use of aluminium sections substantially decreased use of wood in the above applications.

Aluminium partition sections are decorative in appearance, easy to construct, air leak proof, light in weight, easy fitting of glasses or prelaminated particle boards in the frames and ease in availability in market make these sections widely accepted all over. Interior decorators are recommending the use of aluminium partitions.

Aluminium partition sections are made of aluminium alloy extrusions (as per IS 733-1983 and IS 1285-1975). They are available in natural and electrolytic colour anodised finish. These are available in wide range of sizes.

The aluminium partitions are slim and attractive, elegant and functional in design, enabling optimum utilisation of available space. They are very durable and easy to maintain.

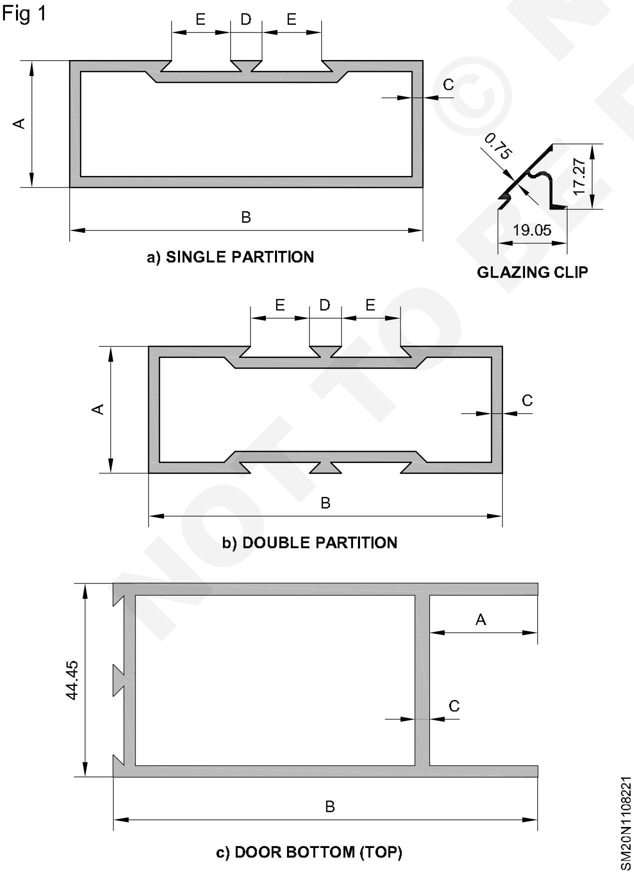
Frames should be wiped with a soft piece of cloth only.

Aluminium Partition Sections

Fig 1 shows different partition sections, used to construct partitions. Single partition, double partition, rectangular tubes, partition split, glazing clips are different partition sections.

Single partition is used when prelaminated particle boards or glasses are to be fitted on one side only. Double partitions are used where glasses or prelaminated particle boards are fitted on both sides of it.

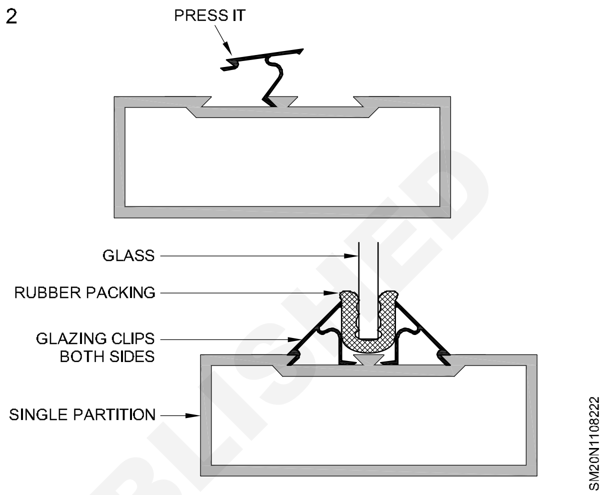
Fig 1



Glazing clips are engaged in the grooves of the single or double partition from side facing each other and glasses alongwith rubber packing or prelaminated particle board which are fitted between their gap. Because the gap between the glazing clips is maintained 2 to 3 mm less than the thickness of prelaminated particle board or glasses with rubber packing and the thickness of the section is 1 to 1.5 mm, the prelaminated particle board or glasses gets fitted with slight pressure from sides and gets tight.

Fig 2 shows, the fitment of glass on single or double partition using glazing clips. When prelaminated particle boards or Novapans are to be fitted, no rubber packing is required.

Fig 2



Partition sections are fitted to each other at right angles, using aluminium angle piece and metal screws. (Fig 3) while joining the sections, drill the holes of diameter equal to root diameter of screw. While rotating the screw, as it is an aluminium material and section is thin, the screw gets tightened by self tapping. (Fig 4)

Partition frames are fixed to the walls and grout with metal screws and rowl plugs in holes.

Fig 3

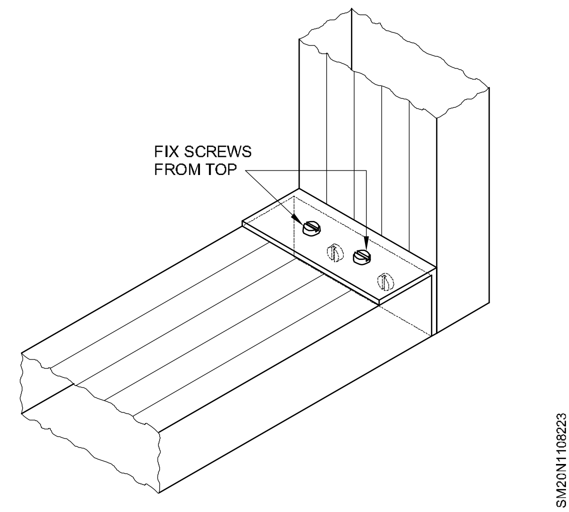
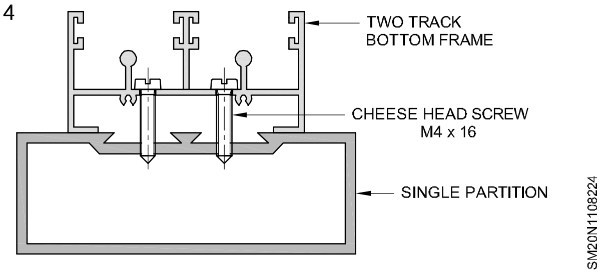


Fig 4



Aluminium door sections

Objectives: At the end of this lesson you shall be able to
- **identify different aluminium sections used for making doors**
- **state the application of different aluminium door sections.**

Fig 1 shows different aluminium door sections.

Door verticals are used as vertical members of the door frame. They are two types of door verticals. One is having groove for rubber packing and other is not having groove.

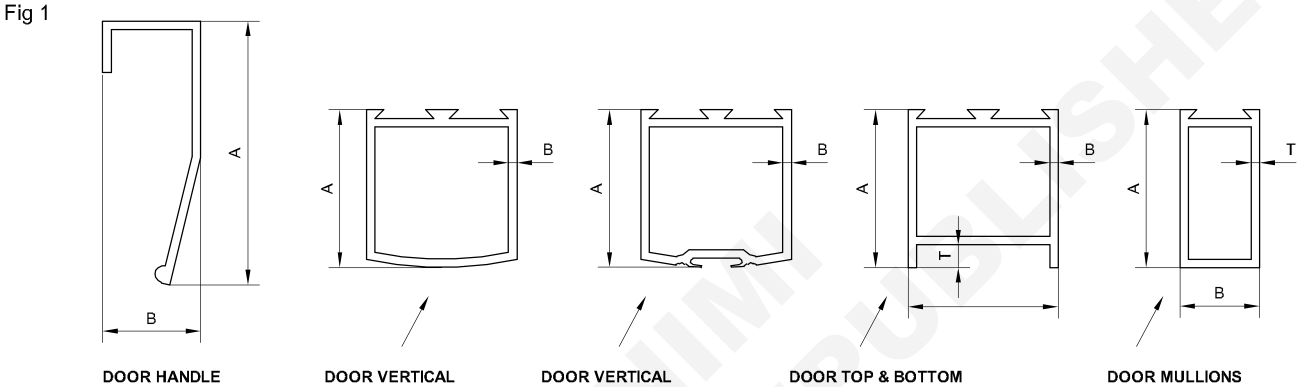
For Air conditioned cabins or rooms, door vertical with groove is used. Rubber packing is inserted in it and made air proof.

Door top and bottom are used as top and bottom members of door frame. They are having grooves like single/double partition on one side. This facilitates fixing of glass or prelaminated particle board using glazing clips.

Door mullions are used as central member of door frame. Grooves for glazing clips are provided on both sides of them, to fix glass or prelaminated particle boards.

Door handle is fixed on door mullion by screws.

Fig 1



DOOR HANDLE

A	B	Kg/m
100.00	30.00	0.988

DOOR VERTICAL

A	B	Kg/m
50.00	2.50	1.319
85.00	2.00	1.365

DOOR VERTICAL

A	B	Kg/m
50.00	1.80	0.901
50.00	2.50	1.202
85.00	2.00	1.418

DOOR TOP & BOTTOM

A	B	T	Kg/m
50.00	1.50	9.50	0.759
50.00	2.50	9.50	1.299
100.00	2.50	25.00	1.974
109.00	1.85	25.00	1.505

DOOR MULLIONS

A	B	T	Kg/m
50.00	45.00	1.80	0.900
50.00	45.00	2.50	1.292
100.00	44.45	2.00	1.594

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Other materials used in aluminium fabrication

Objectives: At the end of this lesson you shall be able to
- **identification & specification of glasses**
- **specification of packing rubber.**

The glass has been used as an engineering material since ancient times. The glass has come out as the most versatile engineering material of the modern times. The first glass objects made by man were of natural glass such as obsidian and rock crystal. The manufactured glass dates from per-historic times in the far east, India and Egypt. But its exact place and date of origin are unknown.

With the help of techniques developed in the glass industry, the glass of any type and quality can be produced to suit the requirements of different industries.

1. A modern boeing jet plane contains more than 5000 components of glass.
2. The fibre glass reinforced with plastics can be used in the construction of furniture, lampshades, bathroom fittings, navy boats, aeroplanes, cars, trucks, etc.
3. The glass is the only material strong enough to go upto the bottom of ocean and to maintain its buoyancy. It is therefore used in the construction of noses of deep-diving vehicles.
4. The glass lining are applied on equipments likely to be affected by the chemical corrosion such as valves, pumps, pipes, etc.
5. In the construction of modern homes, the walls and ceilings of hollow glass blocks can be made. Such construction cuts off the glare. But it admits sunlight and controls sound and heat in a better way.
6. It will be interesting to note that now-a-days, it is possible to prepare the colour-changing glass. A window with such glass will be transparent during daytime and it will be a source of light at night.

7. The development and advancement of sciences of astronomy and bacteriology mainly due to the use of optical glass.
8. The mechanical strength of ordinary glass varies from 35 to 70 N/mm^2. Due to research in glass industry, it has become possible to produce glass having mechanical strength of about 420 N/mm^2.

Soda-lime glass	Na_2O, CaO, $6SiO_2$
Potash-lime glass	K_2O, CaO, $6SiO_2$
Potash-lead glass	K_2O, PbO, $6SiO_2$

Properties of glass

The properties of glass are mainly governed by factors such as composition of the constituents, state of surface, thermal treatment conditions, dimensions of specimen, etc.

Following are the properties of glass and useful:

1. It absorbs, refracts or transmits light.
2. It can take up a high polish and may be used as substituet for vry costly gems.
3. It has no definite crystalline structure.
4. It has no sharp melting point.
5. It is affected by alkalies.
6. It is available in beautiful colours.
7. It is capable of being worked in many ways. It can be blown, drawn or pressed. But it is strange to note that it is difficult to cast in large pieces.
8. It is extremely brittle.
9. It is not usually affected by air or water.
10. It is not easily attacked by ordinary chemical reagents.

Types of glass

The properties and uses of the following types of glass will now be discussed

1. Soda-lime glass
2. Potash-lime glass
3. Potash-lead glass
4. Common glass

1. Soda-lime glass

This is also known as the soda-glass or soft-glass. It is mainly a mixture of sodium silicate and calcium silicate.

Properties:

i) It is available in clean and clear state.
ii) It is cheap.
iii) It is easily fusible at comparatively low temperatures.
iv) It is possible to blow or to weld articles made from this glass with the help of simple sources of heat.

Uses:

It is used in the manufacture of glass tubes and other laboratory apparatus, plate glass, window glass, etc.

2. Potash-lime glass

This is known as bohemian-glass or hard-glass. It is mainly a mixture of potassium silicate and calcium silicate.

Uses:

This glass is used in the manufacture of glass articles which have to withstand high temperatures such as combustion tubes, etc.

3. Potash-lead glass

This is also known as the flint glass. It is mainly a mixture of potassium silicate and lead silicate.

Uses :

It is used in the manufacture of artificial gems, electric bulbs, lenses, prisms, etc.

Raw materials for each type of glass

No	Type of glass	Raw materials
1.	Soda-lime glass	Chalk, soda ash and clean sand
2.	Potash-lime glass	Chalk, potassium carbonate (K_2CO_3) and clean sand
3.	Potash-lead glass	Litharge (PbO lead monoxide) or lead sesquioxide (Pb_3O_4) potassium carbonate and pure sand
4.	Common glass	Chalk, salt cake (Na_2SO_4), coke, ordinary sand, etc.

In addition to the raw materials, the cullet and decolourisers are also added for each type of glass.

Rubber packing

Many different types of rubber packing are used between hatch covers and coaming to achieved weathertightness. Traditionally sponge rubber packing was used pressing it against the compression bar. Over the years ships became much larger and so having bigger movement between the coaming and the hatch covers. To solve this issue sliding rubber packing was used. By pressing sliding rubber packing against a flat surface the hatch cover sealing system was able to adapt to bigger hull deformations.

Hatch cover rubber packing supplied by Cargo care solutions is made of high quality material to guarantee a long life time. Our sliding rubber offers low friction for better sliding together with a minimum wear. Furthermore it is UV raditation resistant and applicable in a big temperature range. Our sponge rubber has a strong solid skin to reduce damage on the packing. The sponge core is fabricated from a strong natural rubber offering the best compression and a minimum wear.

Sponge rubber

1) Mostly used on side rolling and folding hatch covers.
2) Consists of a solid skin with a sponge rubber core.
3) Standard compression : 12 mm
4) Produced to guarantee long life time.

Sliding rubber

1) Mostly used on pontoon hatch covers or large vessels with folding hatch covers.
2) Consists of EPMD material.
3) Standard compression : 12 mm
4) Produced to guarantee long life time.

Prelaminated MDF board:

Medium density fibre board (MDF) is a type of hard board, which is made from wood, fibres, glude under heat and pressure.

It is used instead of plywood or chipboard. It is dense, flat, stiff, as no knots and it is easily machined. It is made up of fine particles it does not have any easily recongnizable surface grain.

The MDF is inexpensive, durable and a good choice for many wood working and carpentry projects, like shelving and storage cabinets. It is most versatile building material.

Applications

It is used to partitioning, paneling, cubboard shutters, false sealings, furniture, panel doors, inserts, etc. It is available in standard thickness(mm) 6, 9, 12, 18, 25, etc.

Standard size (Feet) are 8x4, 8x6, 9x6, 9x3, 6x4, 6x3, 8x3 combination size 9x4 and 9x2 etc.

Fig 1

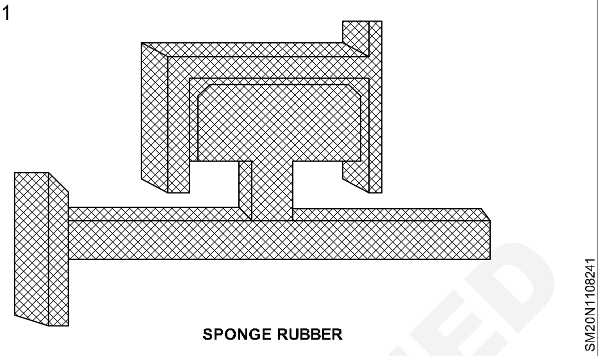
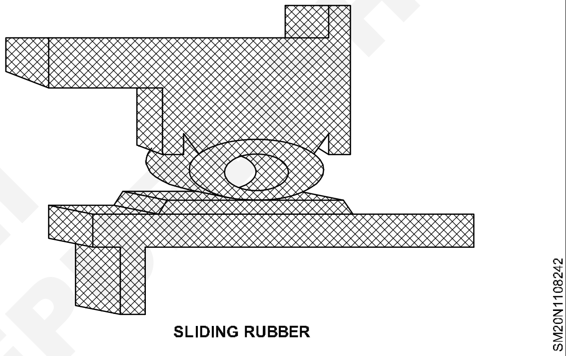


Fig 2



Tools and equipment used in aluminium fabrication work

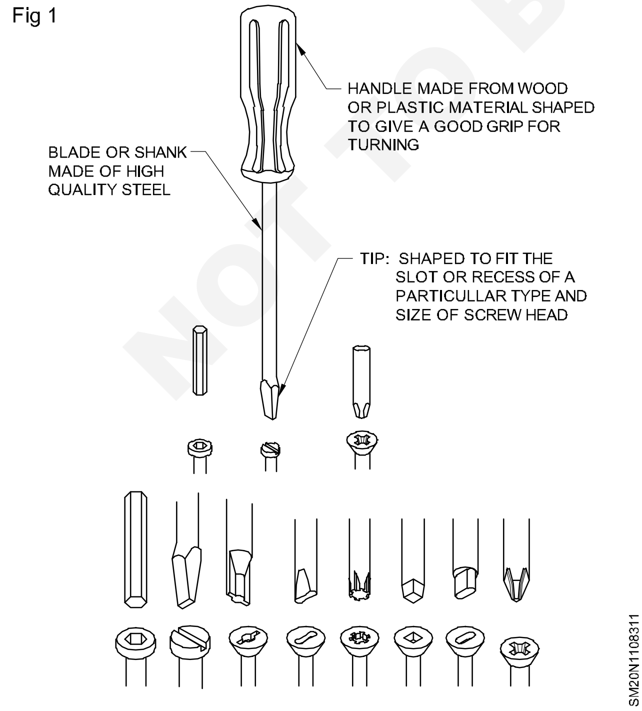
Objectives: At the end of this lesson you shall be able to
- **state the different types of tools & equipments in aluminium fabrication**
- **state the application of aluminium fabrication work, tools and equipment.**

1) Drilling machine
2) Drill bit
3) Grinder / Cutting machine
4) Grinder wheel / Cutter wheel
5) Jigsaw machine
6) Jigsaw blade
7) Pop rivet
8) Pop rivet gun
9) Screw driver
10) Screws
11) Screw driver bit for drilling machine
12) Hammering machine
13) Hammering bit
14) Glass holder (Vacuum type)
15) Allen key / Hexogonal socket wrincks
16) Hole saw cutter

Screwdrivers

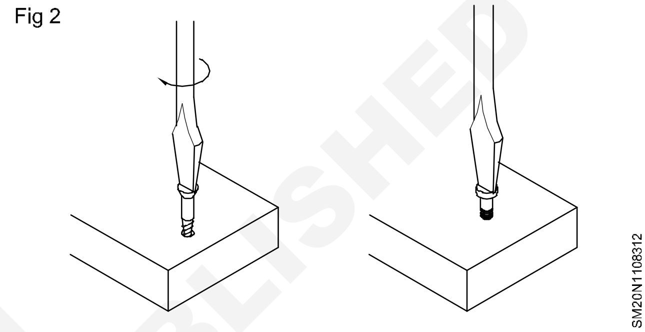
A screwdriver is a tool used to tighten or loosen screws. A simple screwdriver and its parts are shown in Fig 1.

Fig 1



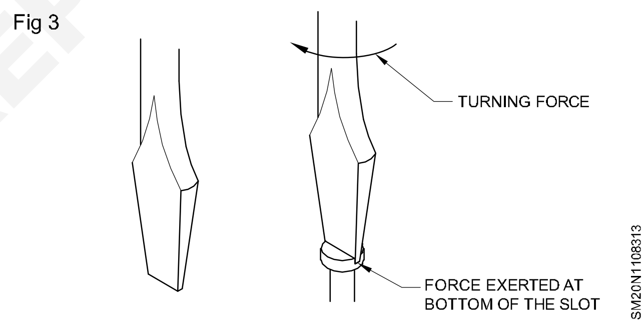
When a screwdriver is used to tighten or loosen screws. The blade axis of a screwdriver must be linked up with that of the screw axis as shown in Fig 2. If this is not taken care of, the screwdriver tip/screw head/threads in the hole will get damaged.

Fig 2



In order not to damage the slot and/or the tip of the screwdriver, it is very important that the tip is correctly shaped and matches the size of the slot as shown in Fig 3.

Fig 3



A flat screwdriver tip should be slightly hollow ground. With such a shape its turning force is exerted at the bottom of the slot which keeps the tip in the slot when turning a screw.

Fig 4 shows a flat screwdriver tip which is slightly tapered. Its turning force is exerted at the top of the slot causing the tip to be lifted out of the slot. When turning a screw downward pressure has to be exerted on the screwdriver in order to keep the tip in the slot.

It is important that the width and thickness of a flat screwdriver tip correspond to the dimensions of the slot it is used with. Its width should be slightly less than the length of the slot and its thickness should be almost equal to the width of the slot as shown in Fig 5.

A tip which is too narrow as shown in Fig 6 will exert its turning force close to the centre of the screw, causing damage to the slot and to the tip.

A tip which is too thin might get twisted when the screw-driver is turned as shown in Fig 7.

Fig 4

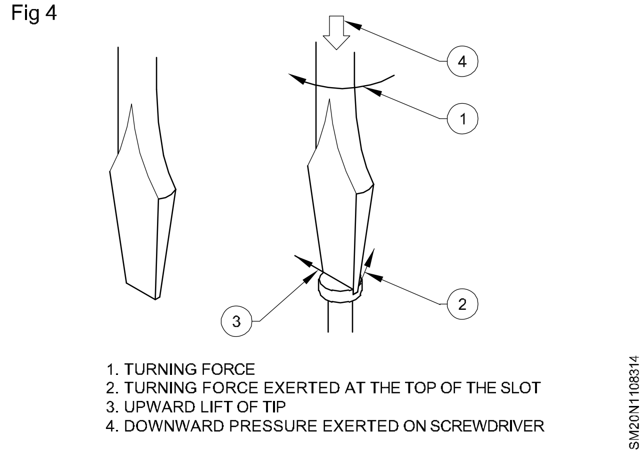


Fig 5

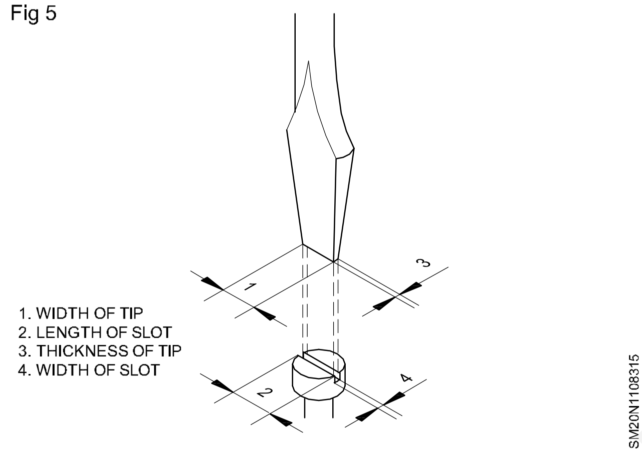


Fig 6

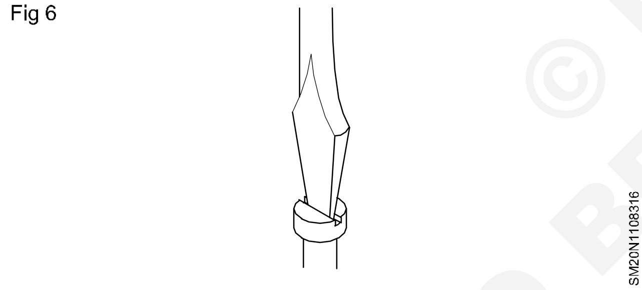
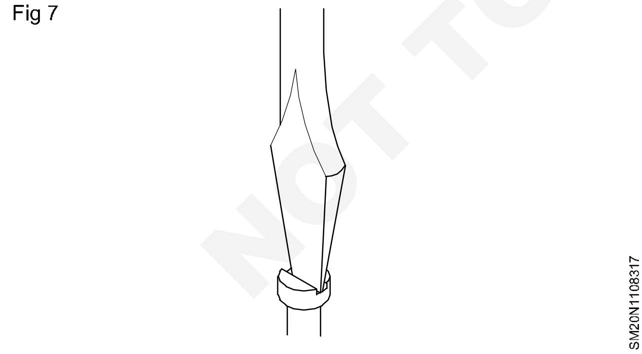


Fig 7



A flat tip which is too wide might cause damage to the workpiece as shown in Figs 8a and 8b.

Screwdrivers with flat tips are specified in size by the length of their blade and by the width of their tip as shown in Fig 9. These dimensions are given in millimetres (mm).

Screwdrivers are available in many sizes, ranging from blade lengths of 25 mm to 300 mm and widths of tips ranging from 0, 5 mm to 18 mm.

Fig 8

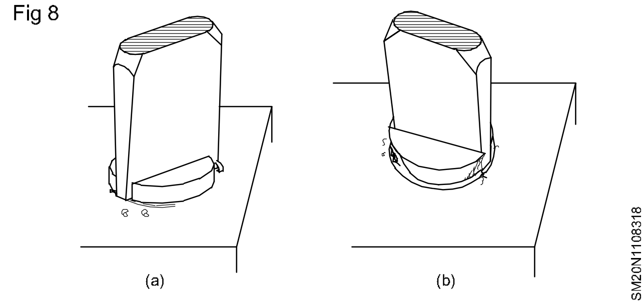
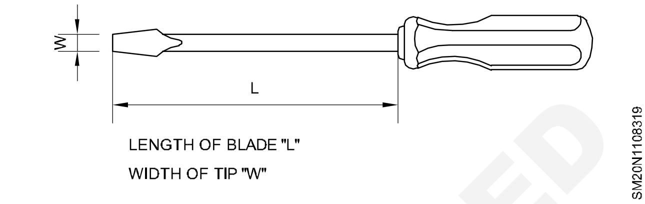


Fig 9



Length of blade *L* and Length of tip *W*

Normally there is no relationship between the length of the blade and the width of the tip of a screwdriver. A screwdriver with a 6 mm wide tip can have blade lengths ranging from 25 to 250 mm. It can also have various forms of handles as shown in Fig 10.

Fig 10

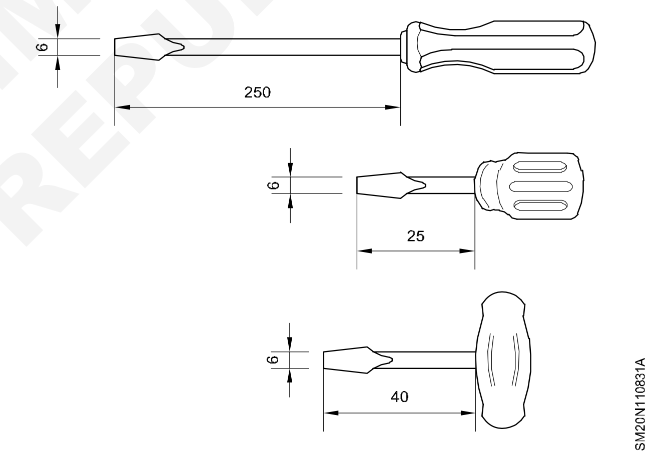
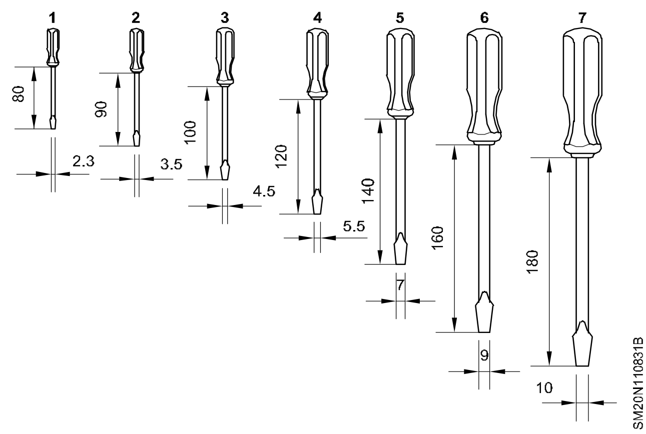


Fig 11

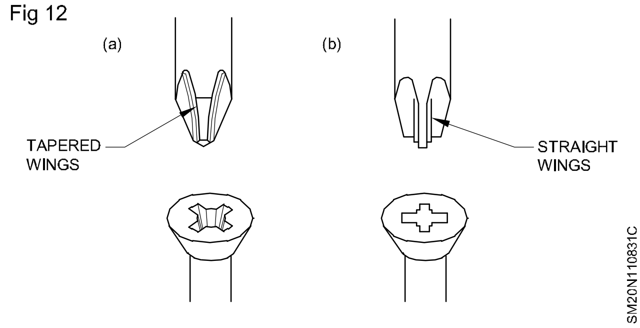


There are, however, screwdrivers which are made to an industrial specification such as DIN, ISI etc. These screw-drivers have fixed dimensions and for each size of screwdriver the width of its tip and the length of its blade is specified as shown in Fig 11.

Fig 12 shows a *Phillips* cross-type screwdriver tip. It is used to tighten and loosen screws with a *Phillips* cross-type recess.

Fig 13 shows a *POZIDRIV* CROSS TYPE screw driver tip. It is an improved type of a cross type tip. It has straight wings compared to the slightly tapered wings of the Phillips type tip. The straight wings keep the tip in the recess when turning force is applied to the screwdriver.

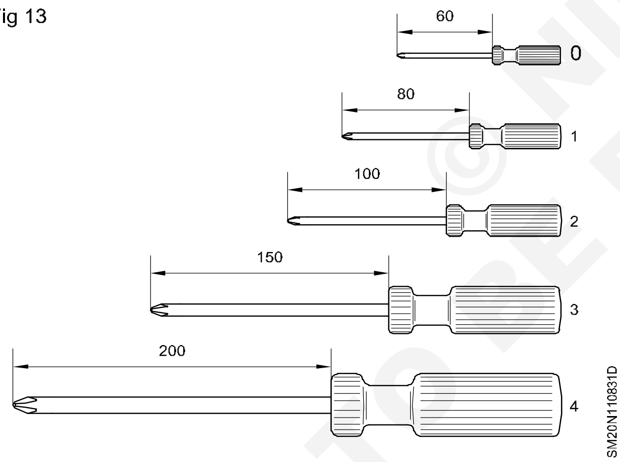
Fig 12



Straight wings and Tapered wings

The above cross type screwdriver tips are available in five standard sizes, numbers 0, 1, 2, 3 and 4 as shown in Fig 14. These five sizes of tips are used for all screws with cross type recesses from M2 to M12.7.

Fig 13



Screwdrivers with cross type tips are also available with short blades ranging in lengths from 25 to 40 mm and with various forms of handles as shown in Fig 15. To show the difference between the screwdrivers with short and long blades a '0' is placed in front of the tip number of the short version.

A few examples of other types of screwdriver tips for screwheads with various forms of recesses are shown in Fig 16.

1 Hexagonal socket head

2 Spline socket head

3 Clutch socket head

4 Slab socket head.

Fig 14

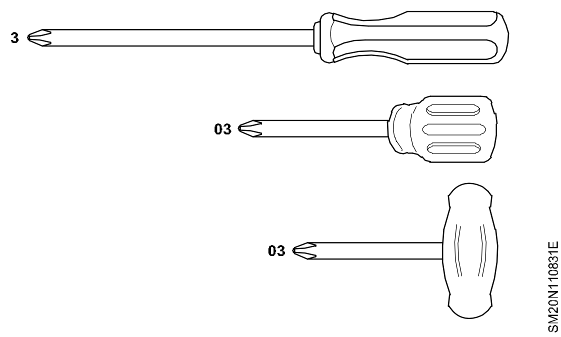
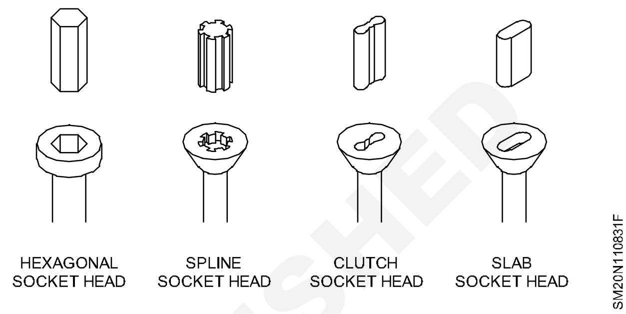


Fig 15



Never use the wrong type or size of a screwdriver as this will damage the recess of a screwhead. If in doubt, ask your instructor/ask an experienced person to tell you which tip should be used.

Instrument screwdrivers

Fig 16

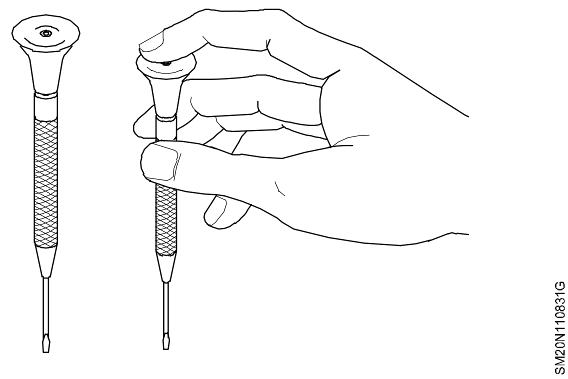


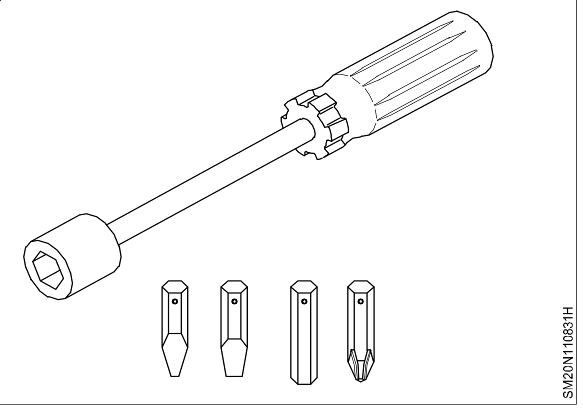
Fig 17 shows an INSTRUMENT SCREWDRIVER. It is used to turn very small screws as used in instruments, watches and clocks. It has a rotating head which is held by the forefinger, while the thumb and the middle finger are used to turn the screwdriver. Instrument screwdrivers are available in sets comprising 5 to 8 screwdrivers with the dimensions as given in the Table below.

Width of tip in mm	Overall length in mm
0.6	80
0.8	80
1.0	80
1.5	90
1.8	100
2.3	110
2.9	120
3.6	130

Large screws can be turned easily by using screwdriver bits that fit into a carpenters brace. Such bits are available in different types and sizes of tips.

Fig 18 shows a screwdriver with INTERCHANGEABLE TIPS. Such screwdrivers are available in sets comprising one handle with a universal fitting and an assortment of tips in various shapes and sizes.

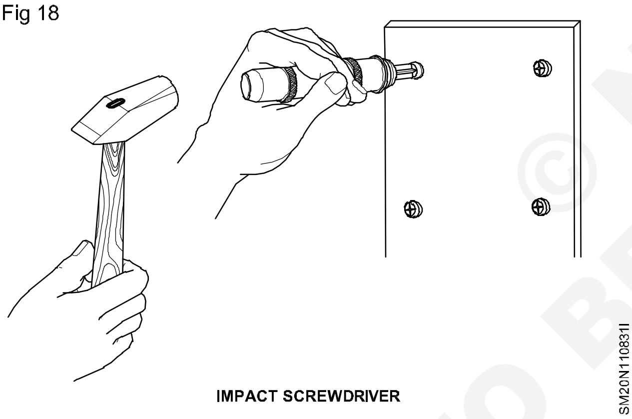
Fig 17



Impact screwdrivers

Fig 19 shows an IMPACT SCREWDRIVER. It is used to tighten screws or loosen very tight screws. When the end of its handle is struck by a hammer, a powerful turning force is applied to the screw.

Fig 18



IMPACT SCREWDRIVER

Impact screwdrivers consist of a metal handle which can be used with a variety of exchangeable tips to suit different screwheads as shown in Fig 20.

Screwdrivers for electrical work have fully insulated plastic or rubber handles. The handles are cast around the blades. Screwdrivers for heavy mechanical work often have blades which extend through the handle as shown in Fig 21b. Such screwdrivers can be struck by a hammer in certain circumstances.

Screwdrivers for electrical work often have insulated blades in the form of plastic sleeves which are fitted up to the tip of the blades as shown in Fig 22.

Special types of screwdrivers

Fig 23 shows a flat screwdriver tip with two prongs. It is used with screws having two rectangular recesses or with slotted nuts. It is available in various sizes suitable for screws and nuts ranging from M3 to M12.

Fig 19

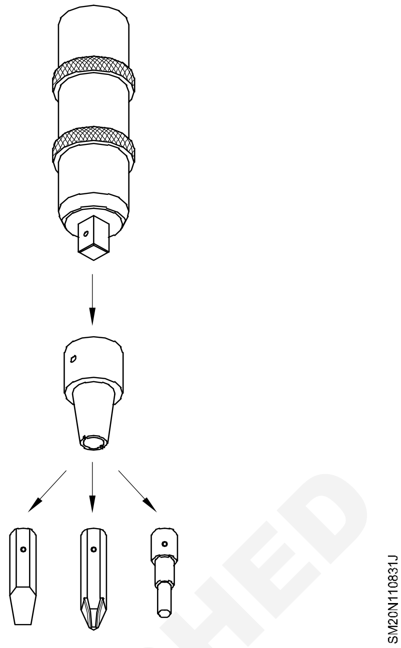


Fig 20

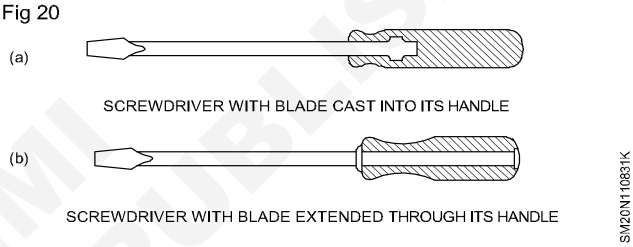


Fig 21

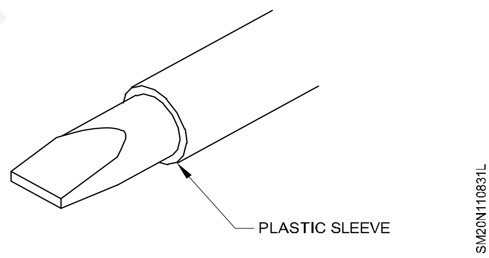


Fig 22

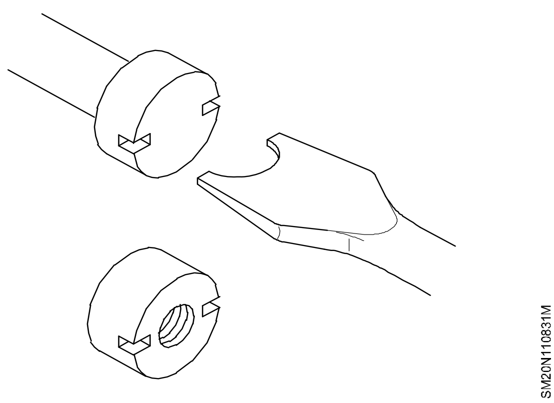


Fig 24 shows a flat screwdriver tip with two round pins. It is used with screws and nuts having two round recesses which accommodate the pins. It is also available in a number of sizes for screws and nuts ranging from M3 to M12.

Using a screwdriver

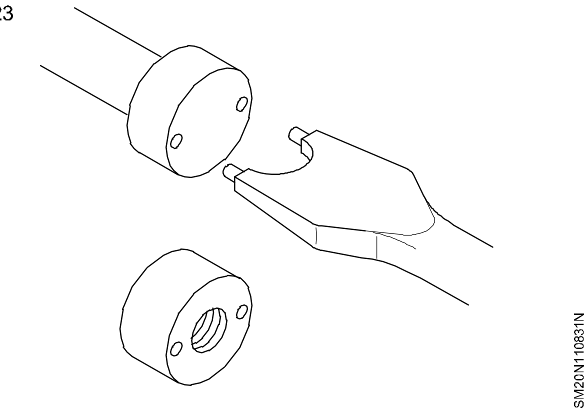
The general procedure for using a screwdriver is given below.

- Select a suitable screwdriver having the required blade length, width of tip and thickness of tip.
- Check that the tip of the screwdriver is flat and square.

Worn out tips tend to slip off while turning and may cause injury.

- Make sure your hands and the screwdriver handle are dry and free from grease.
- Hold the screwdriver with the axis in line with the axis of the screw.
- Guide the blade with one hand as shown in Fig 23. Set the tip of the screwdriver in the screw slot.

Fig 23



Assembly and Sub Assembly, Gaurding Assembling, Door Assembly, Chassis Assembly, Cabinet Assembly, Power Pack Assembly

Objectives: At the end of this lesson you shall be able to
- **Carding Assembly. Door Assembly, Chassis Assembly, and Cabinet Assembly**

Assembly and Sub Assembly

in the structure of the automobile important parts and their accessories are connected.Some of them are created important is given.

1 Guarding Assembly

2 Door Assembly

3 Chassis Assembly

4 Power pack Assembly

5 Cabinet Assembly

Carding Assembly: Young.s battery at the front of the vehicle equipments like radiator, alternator,compressor are installed for protection of leaves, grill, eater etc are installed at the front, carding assembly for safety design is called it is made of metal plate and iron rods and is fixed on the vehicle.

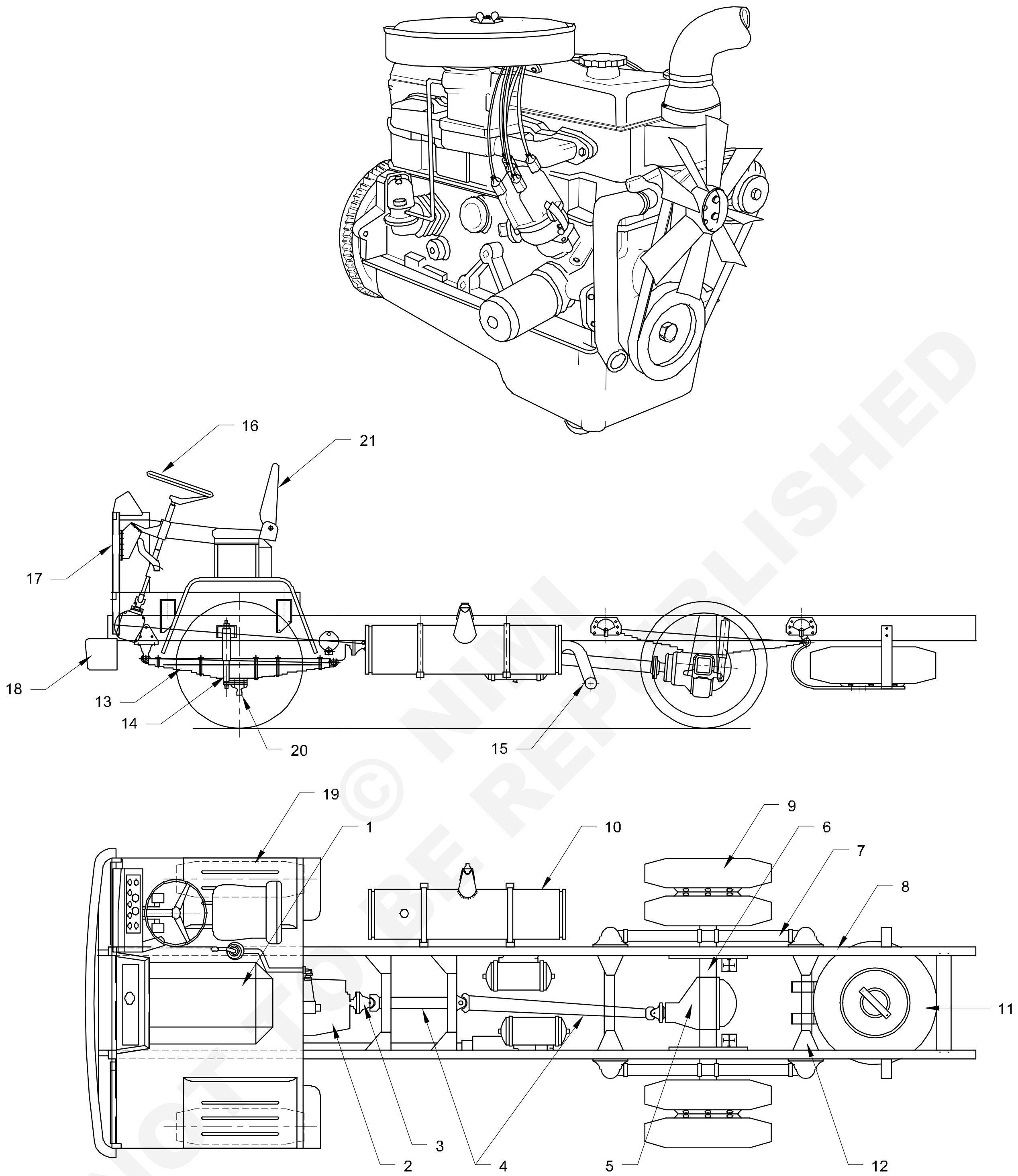
Door Assembly: Door assembly is equipped to open and close the door in the vehicle for the safety of the occupants of the vehicle . It is made using sheet metal frame,doorlock, superbeading, glass etc, Using sheet metal work, riveting,welding, screw, nutbolt etc. In light vehicle with four doors and two for passengers. One is fitted for the driver.

Chassis Assembly : The Chassis assembly consists of body at the top of the chassis and suspension system at the bottom, axes at the brake system etc. The chassis frame is constructed using techniques such as nutbolt, riveting and welding with channels cross-tempered across the chassis in two long channels. Among these three types of framed are used (1) Box frame (2) Tuber type (3) frame type

Power pack assembly: Vehicle engine running,lit Tungsten fuel system, Ignition system, audio video system etc, require electrical power to operate. As they use battery and charging system etc, to protect the electrical components elsewhere in the vehicle with a metal manufactured and installed.

Cabinet assembly : A cabinet assembly with doors is bolted to the chassis on the top half of the engine in a cage-like shape using metal sheet and channels of various sizes for driver aesthetics. A freight wagon is fitted with a cabinet at the front and a load-bearing tin sheet at the rear for loading the goods.

Fig 1



1. ENGINE
2. CLUTCH & GEAR BOX
3. U JOINT
4. PROPELLER SHAFT
5. DIFFERENTIAL
6. REAR AXLE
7. REAR SPRINGS
8. FRAME
9. REAR TYRES
10. DIESEL TANK
11. SPARE WHEEL
12. CROSS MEMBER
13. FRONT SPRING ASSEMBLY
14. SHOCK ABSORBER
15. TAIL PIPE
16. STERRING WHEEL
17. RADIATOR
18. FRONT BUMBER
19. FRONT AND STRUCTURE
20. FRONT AXLE
21. DRIVER SEAT

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Process of Painting

Objectives: At the end of this lesson you shall be able to
- **state the function of an air compressor**
- **describe the working of an air compressor**
- **state the classification of an air compressor**
- **state the technical terms of an air compressor.**

Air compressors: An air compressor is a machine that compresses air or gas from a low inlet pressure usually to a higher pressure level. This is accomplished by reducing the volume of the air/gas. Air compressors are usually positive displacement units and are either reciprocating piston type or the rotary screw or the rotary vane types. Cooling is necessary with compressors to dissipate the heat generated during compression. The fins are provided on cylinder to dissipate heat.

When the air is compressed by a compressor, it picks up heat as the air molecules come closer together and bounce on each other at faster rates. Excessive heat can damage the metal components as well as increase the input power requirements. Portable and small industrial compressors are normally air cooled. Whereas large units must be cooled by water.

An air compressor must start, run, deliver air to the system as required it must stop and start and so without an operator. Automatic controls are required to stop the compressor when it reaches the air pressure already set in the compressor. A single piston compressor can provide pressure upto about 150 psi. Compressors having more than one cylinder staging is used to improve pumping efficiency.

Staging means dividing the total pressure among two or more cylinders, by feeding the exhaust from one cylinder into the inlet of the next cylinder.

In multi-stage piston compressors, successive cylinder sizes decrease and inter cooling removes much portion of the heat of compression. This increases the air density and the volumetric efficiency of the compressor.

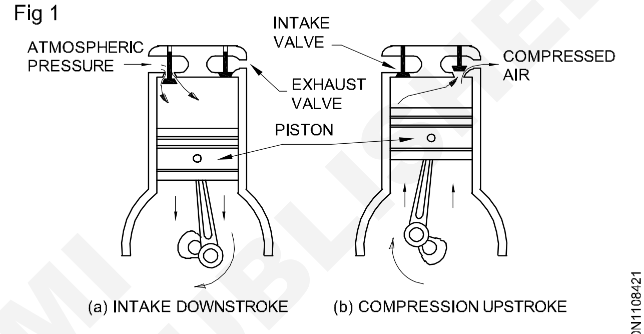
The pressure capacities for the various number of stages of a piston type compressor is shown.

Number of stages	Pressure Capacity (psi)
1	150
2	500
3	2500
4	5000

Reciprocating air compressors: (Fig 1)

An air compressor is a machine to compress the air and to raise its pressure. The air compressor sucks air from the atmosphere, compresses it and then delivers the same under a high pressure to a storage vessel, which can be conveyed by the pipeline to a place where the compressed air is used for work. The compressor must be driven by some prime mover. The compressed air is used for many purposes such as for operating pneumatic drills rivets, road drills, paint spraying in starting and super charging of internal combustion engines, in gas turbine plants, jet engines and air motors etc. Compressed air is also utilized in the operation of lifts, rams, pumps and in variety of other devices. In industry, compressed air is used for producing blast of air in Blast furnaces and Bessemer converters.

Fig 1



PISTON-TYPE AIR COMPRESSOR (SINGLE STAGE).

Classification of air compressors: Compressors are classified as (1) Reciprocating compressor (2) Rotary compressors (3) Single acting compressors (4) Double acting compressors (5) Single stage compressors (6) Multi-stage compressors.

Technical terms:

1 **Inlet pressure:** It is the absolute pressure of air at the inlet of a compressor.

2 **Discharge pressure:** It is the absolute pressure of air at the outlet of a compressor.

3 **Compression ratio or pressure ratio:** It is the ratio of the discharge pressure to the inlet pressure. The value of the compression ratio is always more than unity.

4 **Compressed capacity:** It is the volume of air delivered by the compressor and is expressed in m^3/minute or m^3/second.

5 **Free air delivery:** It is the actual volume delivered by a compressor when reduced to the normal temperature and pressure condition. The capacity of a compressor is generally given in terms of free air delivery.

6 **Swept volume:** It is the volume of air sucked by the compressor during its suction stroke. Mathematically, the swept volume or displacement of a single acting air compressor is given as

swept volume = Vs

$= \pi D^2/4 \times L$

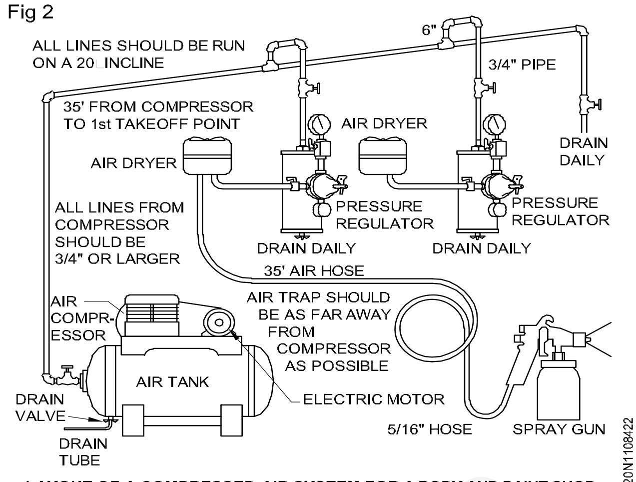
where D = Diameter of the cylinder bore

L = length of piston stroke

7 **Mean effective pressure:** As a matter of fact, the air pressure on the compressor piston keeps on changing with the movement of the piston in the cylinder. The mean effective pressure of the compressor is found out mathematically, by dividing the work done per cycle from the stroke volume.

Fig 2 shows the layout of a compressed air system for a body and the paint shop.

Fig 2



LAYOUT OF A COMPRESSED-AIR SYSTEM FOR A BODY AND PAINT SHOP.

Properties of an auto body sheet metal

Objective : At the end of this lesson you shall be able to
- **describe the properties of an auto body sheet metal.**

Properties of auto body sheet metal: The sheet metal used in the production of automobile surface panels must contain certain properties or qualities such as plasticity, elasticity and work hardening.

Direct and Indirect Damages: Damage to the body sheet metal can be classified as either direct or indirect damage.

Direct damage results from the impact of an object striking the sheet metal. The area of damage is called the point of impact. Direct damage can be in the form of deep scratches, gauges, tears in the metal or in the case of severe impact, crumpled or mangled sheet metal.

The force of the direct damage is transmitted or transferred from the impact area to different parts of the panel thus causing indirect damage. Indirect damage is the form of role buckles, valleys or sharp ridges.

When straightening a panel with direct and indirect damage, normally the indirect damage is straightened first.

Abrasives

Objective : At the end of this lesson you shall be able to
- **state the various types of abrasives used for finishing the surface before painting.**

In preparing a car for painting the surface must be properly sanded to remove all the imperfections such as chips, rust, scratches or ridges left from body repair. Any imperfections remaining on the surface will be magnified by the final colour coat.

Abrasives are usually in a disc or in sand paper form. The types of abrasives are aluminium oxide, silicon carbide, emery garmet and flint. Only aluminium oxide and silicon carbide are used in the automotive repair work. While the other three are used on softer materials such as wood.

Aluminium oxide is used for sanding high tensile materials.

Silicon carbide is used for grinding soft materials such as aluminium, copper, brass etc.

Surface cleaning

Objective : At the end of this lesson you shall be able to
- **describe the cleaning procedure of a metal surface before painting.**

Surface cleaning: The surfaces must be chemically cleaned because washing will not remove wax, silicon, road tar or other contaminants.

Cleaning procedures: Fold a cloth into a pad and apply the cleaning chemical or solvent with enough chemical to thoroughly wet the surface.

Wet a section of the panel and immediately wipe it dry with a clean cloth before the solvent dries. If the solvent dries before being wiped, remove it as the residual from the solvent can affect the adhesion.

While cleaning, start at the highest point.

Wipe thoroughly around all traces of the solvent.

• paint with a metal primer.

When dusting an automobile before painting, all wax and silicon should be removed, otherwise,they will be blown out on the panel and the paint job will be ruined. Ferrous metalic surface should be coated with a good metal primer before painting with enamel.

Spray painting

Objective : At the end of this lesson you shall be able to
- **paint the sheet metal surface to get good look using a spray gun and compressed air.**

Prepare the surface for spray painting (See Ex No.4.Module No.5)

Check the oil level of the air compressor.

Drain out the water from the tank through drain valves if any

Close the outlet valve of the compressor.

Switch 'ON' the compressor.

Clean the spray gun. (See skill sequence)

Select suitable paint.

Add suitable solvent (thinner) to get required viscosity of the paint.

Stirr the paint well.

Pour the paint in the cup of the spray gun approx. 3/4 of its capacity.Use stainer to strain out any impurity in the paint while pouring.

Fix the cup to the cap.

Connect the spray gun to the outlet nose pipe of the compressor.

Set the air pressure to approx 50 psi at the gun.

Turn the fan adjusting screw fully open.

Turn the fluid adjustment screw fully open. One thread of the screw shoud be visible.

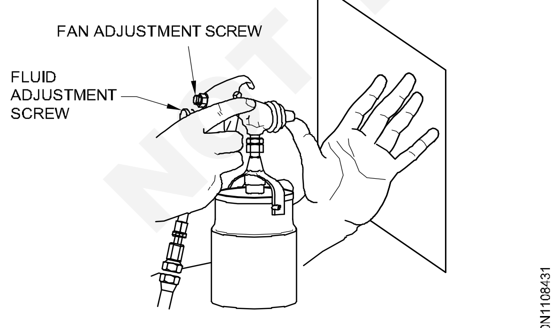
Hold the spray gun about 200mm away from the surface to be painted. Quick way to measure is shown in Fig 1

Pull the trigger back and release it quickly

Check the size and shape of the pattern of spray

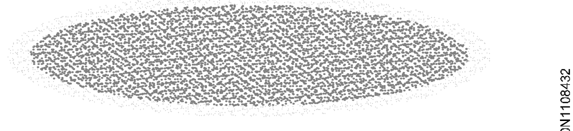
A normal spray pattern is about 200 to 250 mm high and 50 to 75mm wide. Fig 2 shows the pattern with low air pressure and Fig 3 shows the pattern with high air pressure.

Fig 1



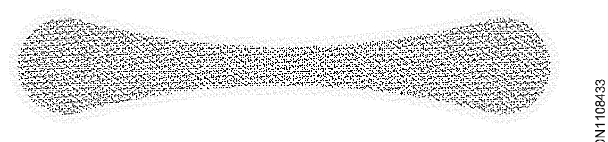
MEASURING THE CORRECT DISTANCE FOR SPRAY PAINTING.

Fig 2



LOWER PRESSURE

Fig 3



HIGH AIR PRESSURE

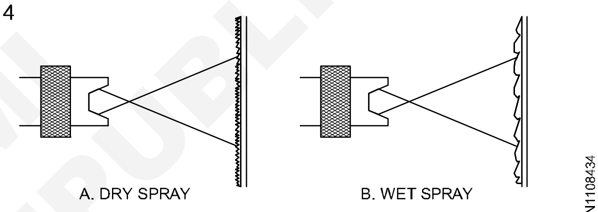
Adjust the air pressure at the gun until the desired the pattern of the spray is obtained.

If the pattern is too small (top to bottom) Turn the fan adjust screw anticlockwise to get proper height of the pattern.

Check the texture of the spray pattern.(Fig 4) .If it is dry reduce the air pressureby 5 psi or turn the fluid adjusting screw slightly open to increase the amount of paint.

If it is wet, increase the air pressure by 5 psi.Likewise set the correct texture by trial and error method.

Fig 4

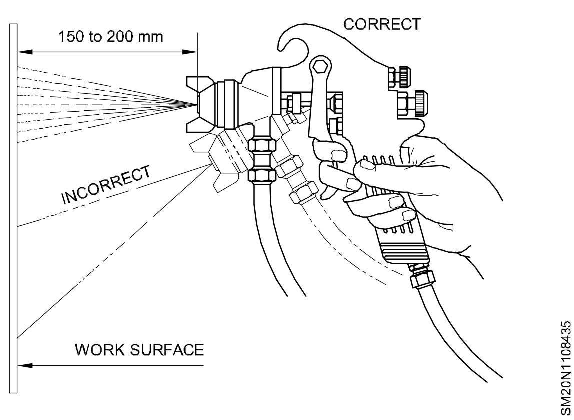


IMPROPER TEXTURE OF THE SPRAY PATTERN

Hold the gun level with and at right angle to the surface to be painted.

Use your wrist stiff and use your arm and shoulder to move the spray gun across the surfaces to be painted.Keep the gun vertical. (Fig 5)

Fig 5



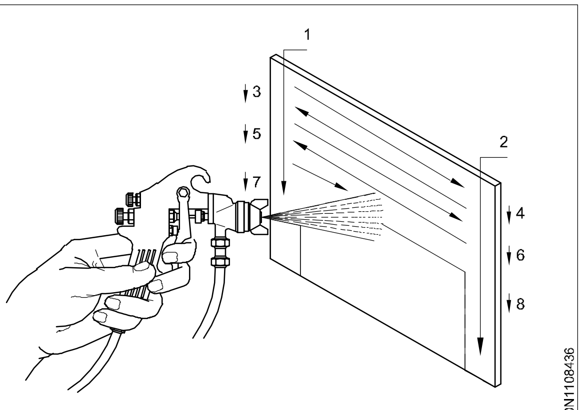
Before you trigger the gun.practice moving the gun in steady and sweeping strokes, across the surfaces to be painted.

To apply the paint, aim the gun nozzle at the top of the surface to be painted and pull the trigger.Move the gun smoothly at a constant speed of 0.3mm per second approx.Never stop the motion. Movement should be uniform.

As you reach the end of the first pass, release the trigger just enough to close the fluid needle valve.

Shift the aim downwards half of the height of the spray pattern and start the second pass. If the first pass is right to left, the second pass should be left to right.(Fig 6)

Fig 6



SEQUENCE OF PASSES WHILE SPRAY PAINTING

Continue moving the gun back and forth in a series of passes till the complete surface is painted.

If a particular spotted area of the surfaces is to be painted, then start and end each pass with the sweeping motion angling away from th work.

Sanding ;

Sanding is the process used to make difference in surface of wood working, metal or drywell project. Sanding can be done by hand as well as in tandom with power tools such as electric sanders to creat the best finishes on these materials. Sanding by hand works well for wood working and finishing especially for giving surfaces of light torch.Sanding with power tools helps scrafe off material quicker, with the added potential of shaping and leveling the materials. In is also used to prepare metals for a paint job.

Etch primers:

Etch primers are single pack metal primers formulated with a combination of resins to maximise adhesion to the various metal surfaces on which they may be used. A low level of phospheric acid is present in these primers to etch the metal surface and improve adhesion. The coatings also contain zinc phosphate anti-corrosion pigment for sheet surfaces. An important point to note is that they are formulated with low volume solids so that film builds can be kept low.

Powder coating ;

Powder coating is a dryfinishing process. Powder coating is used for a high-quality, durable finish, allowing for maximized production. improved efficiencies. and simplified environmental compliance used as functional (Protection) and decoration finished powder coatings are available in an almost limitless range of colors and textures and technologies advancements have reculfied in excellent performance properties.

Buffing:

All small scratches and imperfections must be removed by polishing. A power buffer is good for producing at high shine or luster. A buffing wheel can also be fastened to a lathe or drill press. These wheels are made of cotton, flannel, or fell. The outer surfaces of the wheels are coated with air abrasive compound for buffing. Use a different wheel for each kind of compound.

The four most commonly used natural abrasives are pumice,tripoli,rouge and whiting.

Pumice and tripoli are used for first polishing rouge or whiting are for butter to a highly polished or shiny surface. There are also many artificial abrasives such as aluminium oxked and powders mixed with a bonding agent. They are available in stick or cake form.

Different grit sizes:

The grit of sandpapers is a rating of the size of abrasive materials on the sandpaper. The higher grit number is equivalent to a fixer abrasive which created smoother surface finishers lower grit numbers represent corset abrasives the scrape off materials much quicker. The letter of which is preceded by a "P" There are two main subdivisions micro and macro with many more gradations included and mentioned chart.

Micro Grit Sandpaper

Micro grit are a class of finer abrasives. They include higher grit numbers. Micro grit -sized sandpapers are commonly used on wood and some on drywell.

Grade	Description	CAMI	FEPA	Diameter	Used for
Ultra fine	Most delicate abrasives	800 or 1000	P1500,P2000 or P2500	8,4-12.6 micrometers	Final sanding and polishing thick finishes
Super Fine	Slightly wipes away patches / small inconsistencies but not strong enough for removal	400,500 or 600	P800,P1000 or P1200	15.3 to 23.0 micrometers	Final wood finishing
Extra Fine	Slightly less fine and more abrasive than super fine	360 or 320	P400,P500 or P600	25.8 to 36.0 micrometers	Initiative methods for wood polishing
Very Fine	The least fine of the micro abrasives	240	P240,P280, P320 or P360	40.5 to 58.5 micrometers	Sanding finishes between consecutive coats and drywall and wood

Macro Grit Sandpaper.

Macro grits are a class of abrasives that range from medium to course sandpaper calibers, They feature mid to low grit numbers. Macro grit sized sandpapers are commonly used in tougher wood and metals and have a stronger clearance.

Grade	Description	CAMI	FEPA	Diameter	Used for
Very fine	A coarser material than very fine under the microabrasives	150,180or 220	P150,P180 or P220	190 to 265 micrometers	Sanding on bare wood
Fine	Cannot remove varnish or paint on wood	100 or 120	P100 or 120	115 to 162 micrometers	Prepare wood for finishing cleaning plaster and removing water stains on wood
Medium	Medium to coarse surface texture after sanding	80	P60or P80	190 to 265 micrometers	Sanding bare wood to prepare it for removing varnish and final finishing
Coarse	Has the ability to remove material rapidly	40,50 or 60	P40 or P50	336 to 425 micrometers	wiping away a layer of debris or finish with minimal effort
Extra coarse	Quickens the removal of most materials rapidly	24,30 or 36	P12,P16,P30 or P36	530 to 1815 micrometers	Initial efforts in hardwood floor sanding

Radiator

Objectives: At the end of this lesson you shall be able to
- **state the function of the radiators**
- **state the types of radiators**
- **state the parts of the radiators and their construction.**

Function of the radiator: The function of the radiator is to cool down the hot water coming out of the engine water jackets and to supply cold water to the engine jackets, to cool down the engine.

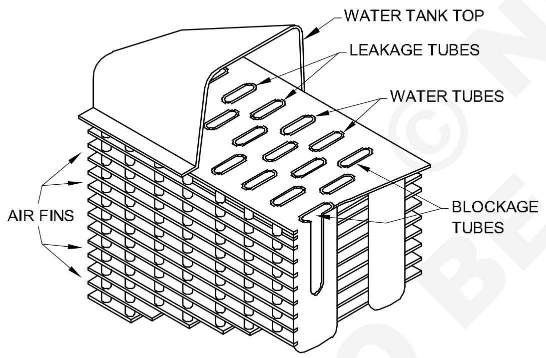
The water from the engine jackets enters the upper tank of the radiator through the inlet pipe. Then the water passes through copper tubes. Copper tubes are placed vertically, supported by horizontal air fins. While the water passes through the copper tubes, the fresh air coming from the cooling fan comes in contact with the copper tubes and takes away the heat, cooling the water inside the copper tubes.

Then the water enters the lower tank and through the outer pipe, it is supplied to the engine jackets again.

Types of Radiators: The radiators are commonly available in two types, they are

1 Tubular type (Fig 1)

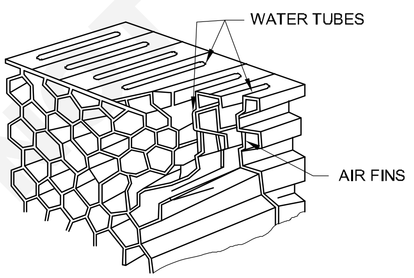
Fig 1



RADIATOR (TUBULAR TYPE)

2 Ribbon cellular or honey comb. type. (Fig 2)

Fig 2

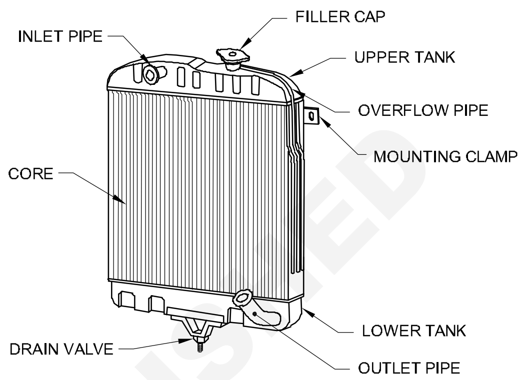


HONEY COMP OR RIBBON CELLULAR TYPE

Parts of the Radiator (Fig 3)

1 Filler cap
2 Upper tank
3 Inlet pipe
4 Overflow pipe

Fig 3



RADIATOR

5 Core (consist of tubes and fins)
6 Drain valve
7 Outlet pipe
8 Lower tank
9 Mounting clamps.

In tubular type the water flows through the tubes and air passes around them.

In cellular type, the air passes through the tube and water flows in the space between the tubes.

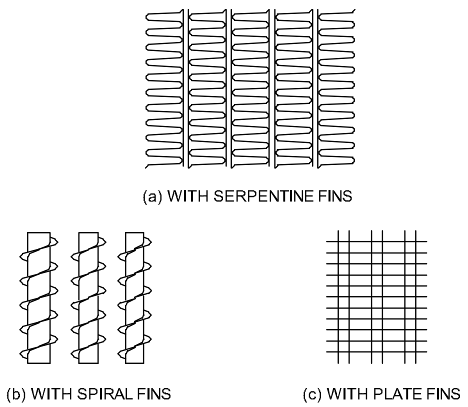
The tubular type cores are classified according to the shape of the fins around the tube. They are (1) Serpentine fins (2) Spiral fins (3) Plate fins (Fig 4)

The arrangements are made to increase the area of contact to transfer the heat from water to cooling air.

The radiator tubes are generally made of copper since they are having high resistance to corrosion, possess high thermal conductivity, form easily to required shape and easy to solder.

The thickness of the tubes is generally 28 to 30 SWG.

Fig 4



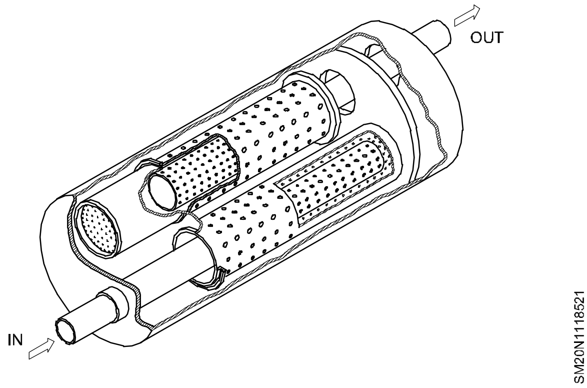
TUBULAR TYPE RADIATOR CORES

Silencer/Muffler

Objectives: At the end of this lesson you shall be able to
- **state the various types of silencers**
- **explain the constructional features of silencers**
- **explain the uses of a silencer**
- **state the cause for the blockage of a silencer.**

A loud noise is generated by the exhaust gases from the engines. To reduce the noise, the exhaust of the engine is connected via the exhaust pipe to the silencer. Silencer is also called a muffler. (Fig 1)

Fig 1

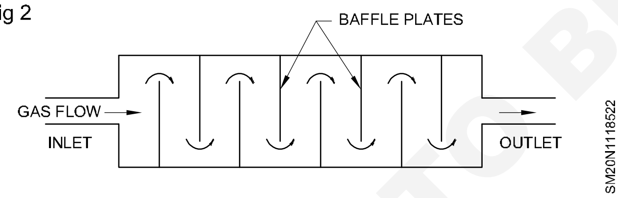


The mufflers used are of various types. They are

1 Baffle type
2 Resonance type
3 Absorber type
4 Combined resonance and absorber type

Baffle type: These type of mufflers are generally cylindrical in shape with a number of baffles spot welded inside as shown in Fig 2.

Fig 2



These baffles change the direction of the gases and absorb the noise. The gases leave behind a deposit of carbon, which become red hot, burn holes in the outside casing and block the silencer. These holes must be immediately repaired and the silencer is cleaned.

Resonance type: These are of two type (1) Straight through flow type (2) Reverse flow type

A straight through flow type silencer consists of a number of resonant chambers in series, through which a pipe containing access ports passes. The exhaust gases travel straight through this pipe and thus experience no resistance. Series of resonant chambers help in damping the frequency of exhaust noise. (Fig 3)

In the reverse flow silencer, there are separate inlet and outlet tubes. These tubes are assembled one over the other. The exhaust gases have to flow in the reverse direction for entering into the outlet pipe.(Fig 4)

Fig 3

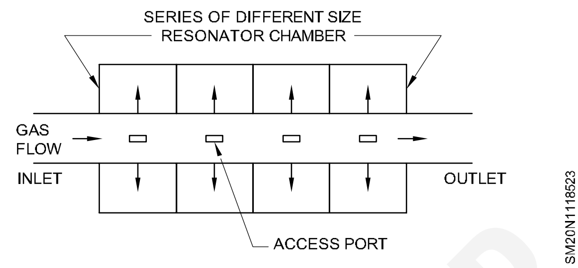
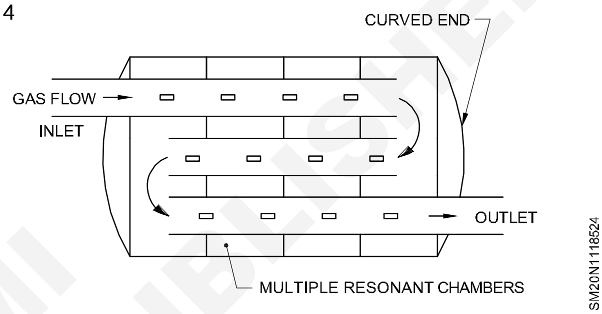


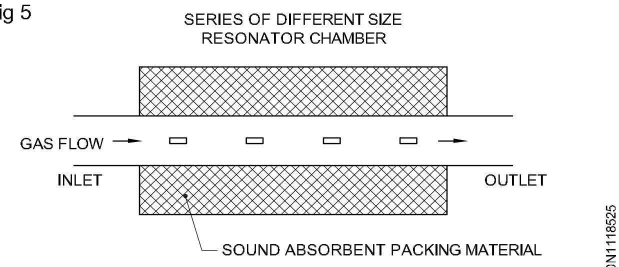
Fig 4



Absorber type: In this type of silencers, sound absorbing materials of a soft and porous nature such as glasswool or fibre glass, is placed around the perforated tube through which the exhaust gas passes.

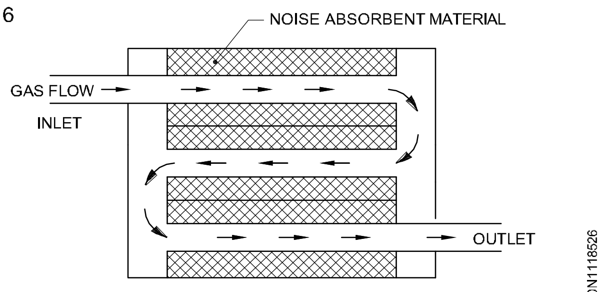
During high pressure fluctuations these gases pass through the perforation to the sound absorbing material. When these fluctuations (which are the main cause of sound) are reduced and thus the sound gets reduced in intensity. These silencers may be straight through type (Fig 5) or Reverse flow type. (Fig 6)

Fig 5



ABSORBENT SILENCER THROUGH TYPE

Fig 6

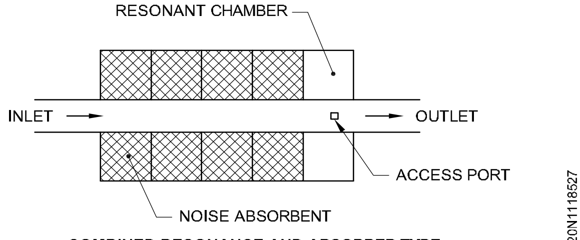


ABSORBENT SILENCER REVERSE FLOW TYPE

Combined resonance and absorber type (Fig 7): It has been found that the type of silencer is more efficient than either the simple resonance type or the absorber type of silencer. This is designed by combining both the resonance and the absorber type silencer technology.

Blocked exhaust pipe and silencer: This will cause a large quantity of burnt gases to be left inside the cylinder, which will prevent the right quantity of new mixture entering the cylinder and thereby, preventing the engine developing full power.

Fig 7



COMBINED RESONANCE AND ABSORBER TYPE

ESTIMATION OF WORK (RADIATOR & MUFFLER)

S.NO	ESTIMATION OF WORK	COST
1	Repalcement of radiator hose	300/-
2	Replacement of over blow tube	100/-
3	Replacement of radiator cap	175/-
4	Replacement of Thermostat value	500/-
5	Radiator tank packing	300/-
6	Arrest leakage in radiator	400/-
7	Fixing a crack	300/-
8	Replacing Muffler	500/-
9	Basic service fees	600/-
	Total cost	3175/-

Lifting and handling loads

Objectives: At the end of this lesson you shall be able to
- **state the types of injury caused while lifting and carrying the loads, and how to prevent them**
- **state the six points to be noted in the kinetic method of lifting.**

Many of the accidents reported involve injuries caused while lifting and carrying the loads. An electrician may need to install a heavy electric motor in a restricted space and make the correct wiring connections. Wrong lifting techniques can result in injury. A load need not necessarily be very heavy to cause injury.

What causes an injury more frequently -

a very heavy load or a wrong way of lifting?

A wrong way of lifting something too heavy causes injury. The muscles and joints are strained. This is especially true in case of injury to the back. The most common type of injury due to the wrong way of lifting is injury to the back.

Are the injuries caused as a result of strain only?

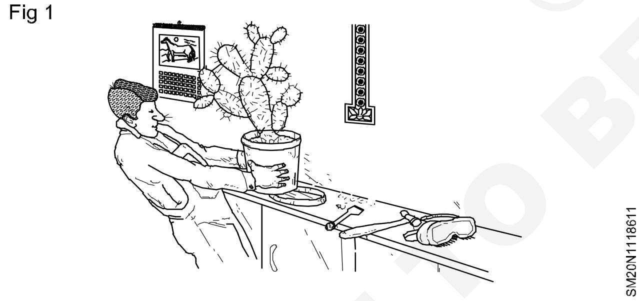
No. Injuries during lifting and carrying may be caused by tripping over an object and falling, or striking an object with a load.

Types of injury and how to prevent them

Cuts and abrasions: Cuts and abrasions are caused:

- by rough surfaces and jagged edges
- by splinters and sharp or pointed projections.(Fig 1)

Fig 1



Leather gloves will usually be sufficient for protection, but the load should be checked to make sure of this, since large or heavy loads may involve body contact as well.

Crushing of feet or hands:Feet or hands should be positioned so that they should not be trapped under the load. Timber wedges can be used when raising and lowering heavy loads to ensure that the fingers and hands are not caught and crushed.

Safety shoes with steel toe caps will protect the feet. (Fig 2)

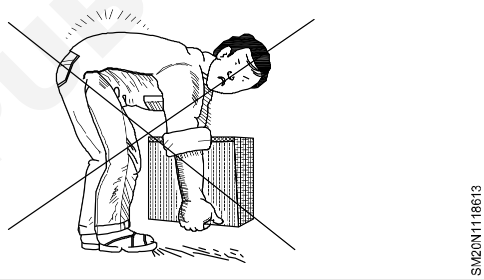
Strains to muscles and joints: Strains to muscles and joints may be the result of:

- lifting a load which is too heavy or
- lifting by wrong method.

Sudden and awkward movements such as twisting or jerking during a lift can put severe strain on the muscles. Injury to the back is most often caused by lifting the loads which are too heavy or by employing wrong methods. 'Stoop lifting' - lifting from a standing position with the back rounded (Fig 3) increases the risk of a back injury.

Fig 2

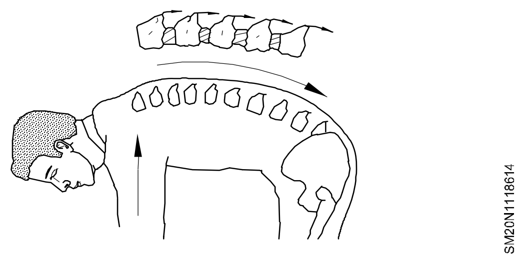
Fig 3



The human spine is not an efficient weight lifting machine, and can be easily damaged, if wrong methods are used.

The stress on a rounded back can be up to six times greater than if the spine is kept straight. Fig 4 shows an example of stoop-lifting.

Fig 4



Preparing to lift: What prepararation should you have to make before lifting?

Before lifting or handling any load ask yourself the following questions.
What has to be moved?
Where from and where to?
Will assistance be required?

A load which seems light enough to carry at first will become progressively heavier, the farther you have to carry it.

Before lifting and carrying, make sure the way is clear of obstacles and the place of unloading is without any obstructions.

The person carrying the load should always be able to see over or around it.

The weight, a person can lift will vary according to:

– the age

– the physique and

– the condition such as other health factors.

It will also depend on whether one is used to lifting and handling heavy loads.

What makes an object difficult to lift and carry?

- Weight is not the only factor which makes it difficult to lift and carry.
- The size and shape can make an object awkward to handle.
- Loads, which require the arms to be extended in front of the body, place more strain on the back and stomach than do compact objects carried close to the body.
- The absence of hand-holds or natural handling points can make it difficult to raise and carry the object.

The kinetic method of lifting: It enables the worker to make full use of the body's own weight to initiate the lift.

The natural shape of the spine is maintained throughout (although the body may be bent forward, the spine should remain straight), and the lift is powered by the strong muscles in the legs and thighs.

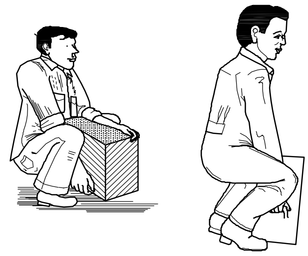
It is important to begin with the right posture, that is, the various parts of the body should be correctly positioned before beginning the lift. The following six points should be noted.

- The Feet are placed about 18 inches(45cms) wide apart, with one foot slightly forward, in the direction of movement. This gives a good balance and provides a secure basis for the lift.
- The Knees should be slightly bent (but not fully bent as in a squat).
- The Back must be straight, although the body may be inclined forward as shown in the illustration.
- The Arms should be as close to the body as possible. The farther the arms are extended the greater the strain. Elbows too should be kept in.
- The Grip must be firm and secure.
- The Head should be erect with the chin in.

Correct manual lifting techniques

- Approach the load squarely, facing the direction of the movement.
- The lift should start with the lifter in a balanced squatting position, with the legs slightly apart and the load to be lifted held close to the body. Ensure that a safe secure hand grip is obtained. Before the weight is taken, the back should be straightened and held as near the vertical position as possible. (Fig 5)

Fig 5



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- To raise the load, first straighten the legs. This ensures that the lifting strain is being correctly transmitted and is being taken by the powerful thigh muscles and bones. Look directly ahead, not down at the load while straightening up, and keep the back straight; this will ensure a smooth, natural movement without jerking or straining. (Fig 6)

Fig 6

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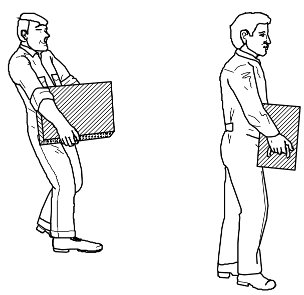
- To complete the lift, raise the upper part of the body to the vertical position. When a load is near to an individual's maximum lifting capacity, it will be necessary to lean back on the hips slightly (to counterbalance the load) before straightening up. (Fig 7)

Fig 7



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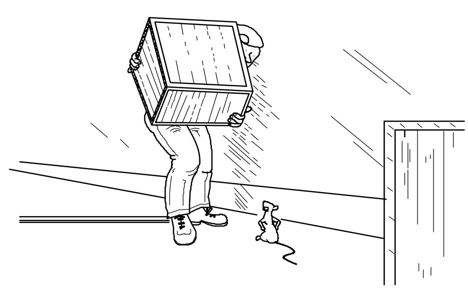
- Keeping the load well into the body, carry it to the place where it is to be set down. When turning, avoid twisting from the waist-turn the whole body in one movement.

Fig 8



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Lowering the load: Make sure the area is clear of any obstructions. (Fig 8)

Bend at the knees to a semi-squatting position; keep the back and head erect by looking straight ahead, not down at the load. It may be helpful to rest the elbows on the thighs during the final stage of lowering.(Fig 7)

Moving heavy equipment

Objectives: At the end of this lesson you shall be able to
- **name the methods followed in industry to move a heavy equipment**
- **describe the procedure to be followed for moving a heavy equipment on layers and rollers**
- **list the safety considerations while raising a load and moving a load.**

Heavy equipment is moved in industry using any of the following

- Cranes and slings
- Winches
- Machine moving platforms
- Layers and rollers.

Cranes and slings: This method is used whenever loads are to be lifted and moved. (Fig 1) Examine the slings for cuts, abrasion, wear, fraying or corrosion.

Damaged slings must not be used.

Distribute the weight as evenly as possible between the slings when using more than one sling. (Fig 2)

Fig 1

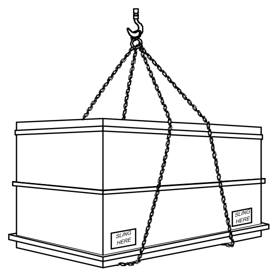
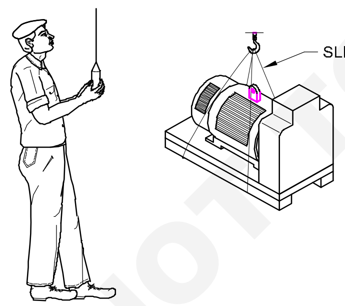


Fig 2

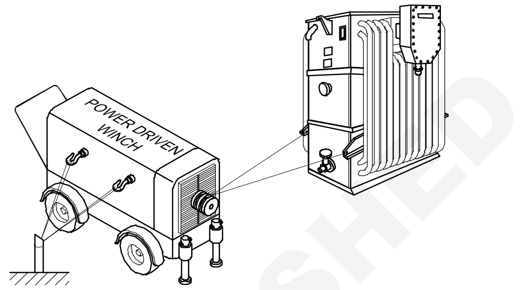


Keep the slings as nearer to the vertical as possible.

Winches: Winches are used to pull heavy loads along the ground.

Cranes and slings may be power-driven (Fig 3)

Fig 3



Ensure that the safe working load (SWL) of the winch is adequate for the task.

Secure the winch to a structure which is strong enough to withstand the pull.

On an open ground, drive long stakes into the ground and secure the winch to them.

Choose a suitable sling and pass it around the base of the load. Secure it to the hook of the winch.

Some heavy items have special lugs welded to them for the jacking and towing purposes.

Safety considerations: Before using any winch, check that the brake or ratchet machanism is in working order. You should know how to control it.

Keep hands and fingers well away from the gear wheels.

Keep the bearings and gears oiled or greased.

Machine moving platforms: This is a special device made to move heavy equipment in industry. Figs 4a and 4b show the method of loading the equipment.

Pass a suitable sling round the load at a convenient height.

Attach the sling to the hook of the winch and draw the load on the platform until its centre of gravity lies inbetween the front and rear wheels.

Lower the jacks so that the platform rests on its wheels.

For unloading follow the procedure in the reverse order.

Using layers and rollers: Sometimes a load cannot be moved along the ground because of the irregular shape of its base or because it is not rigid enough.

Place such a load on a flat-bottomed pallet or 'layer' resting on round bars. (Fig 5)

Fig 4

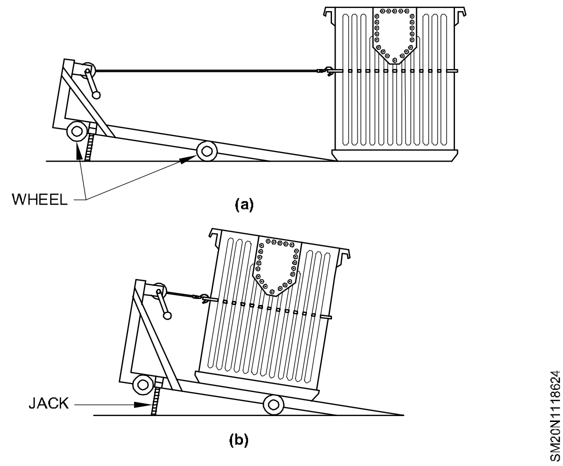
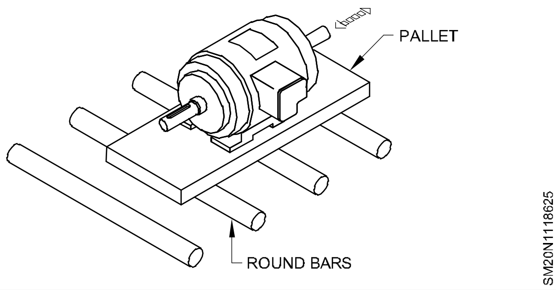


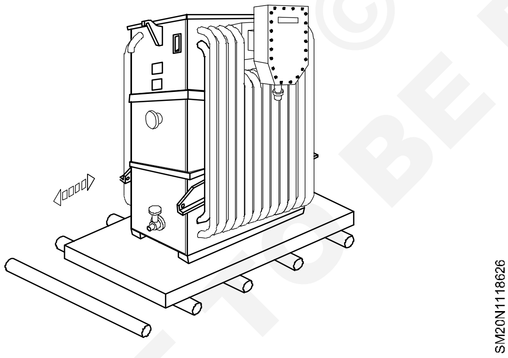
Fig 5



Ensure the Round bars (rollers) are long enough to project at each side of the load, for easy handling.

They should be large enough to roll easily over any unevenness along the route but should be small enough to be handled easily. (Fig 6)

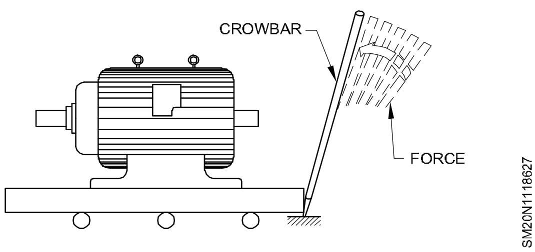
Fig 6



Two or three Round bars of equal diameter are sufficient for most loads but if four or more bars are used the load may be moved faster as there is no delay while moving the rear bar to the front. (Fig 6)

Move the load by using a crowbar. (Fig 7)

Fig 7



Caution: When a load is on rollers, only shallow slopes can be negotiated.

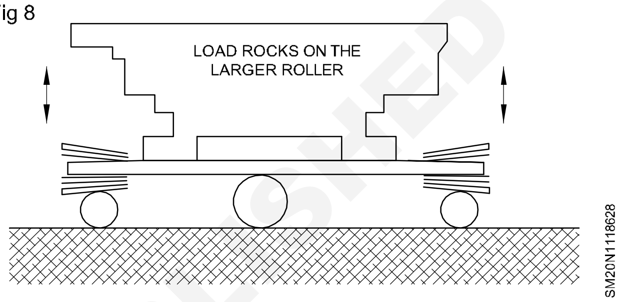
Hold the load in check all the time it is on the slope.

Use a winch with an effective brake for this operation.

To negotiate a corner on rollers: For a moderate load, insert one roller a little larger than the others as the corner is approached.

When this roller is under the centre of gravity of the load, the load can be rocked to and fro on the roller and swivelled around sideways. (Fig 8)

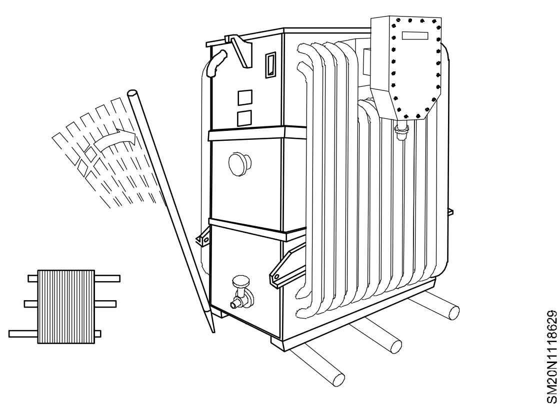
Fig 8



For heavier loads: Stop the load at the beginning of the corner.

Twist the load round on the rollers by pushing the sides with a crowbar until the load is just over the ends of the rollers. (Fig 9)

Fig 9



Place some rollers at an angle to the front of the load.

Push the load forward on to these rollers.

Twist the load further round and place the freed rollers in front of the load and at an angle to the load. (Fig 10)

Continue until the load is pointing in the desired direction.

Safety considerations

Moving heavy loads with crowbars or jacks: Make sure that the hands are clear of the load before lowering it on to packing or rollers.

Do not use the hands underneath the packing when positioning it. Use a push block.

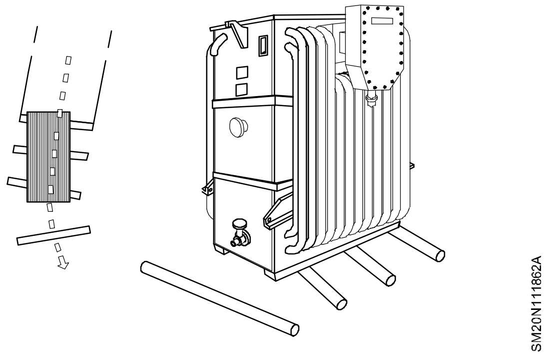


Fig 10

Place the packing on the floor and push it under the load. (Fig 11)

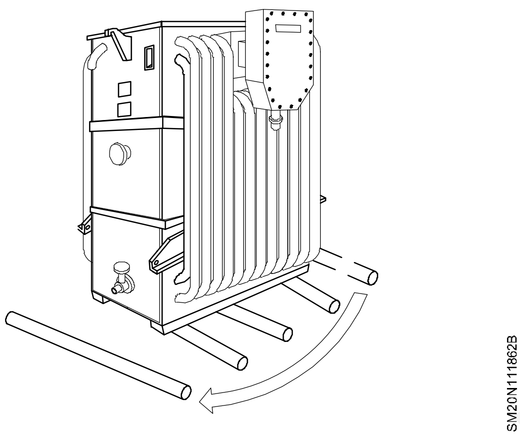


Fig 11

Hold it by its side faces keeping the fingers welll away from the lower edge of the load and from the floor. (Fig 12)

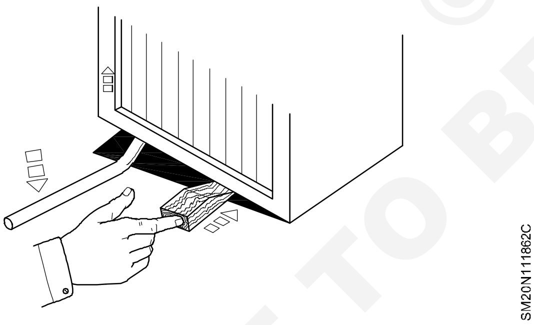


Fig 12

Raising a load: Check that the slings are correctly secured to the load and to the hook. Ensure they are not twisted or caught on a projecting part of the load.

If you cannot see an assistant on the far side of the load, verify that he is ready before starting to lift and ensure that his hands are clear of the slings.

Warn nearby workers that the lift is about to begin.

Lift slowly !

Take care to avoid being crushed against other objects as the load rises. It may swing or rotate as it leaves the ground. (Fig 13)

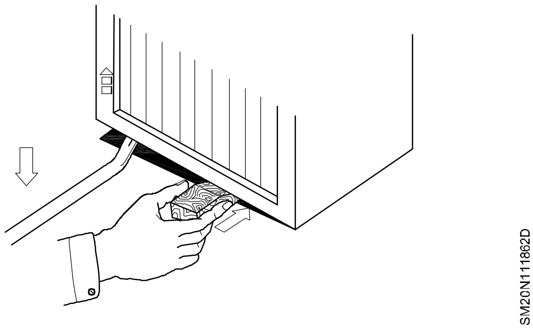


Fig 13

Minimise such movement by locating the hooks as accurately as possible above the centre of gravity of the load.

Keep the floor clear of unnecessay objects.

Moving a load: Check that there are no obstacles in the way of the crane and the load. (Fig 14)

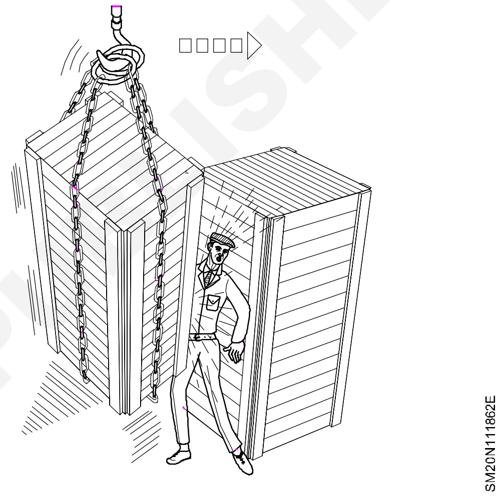


Fig 14

Stand clear off the load and move it steadily.

Be prepared to stop the load quickly, if somebody moves into its path.

Allow for the natural swing of the load when changing speed or direction.

Ensure that the load will not pass over the heads of other people. (Fig 15)

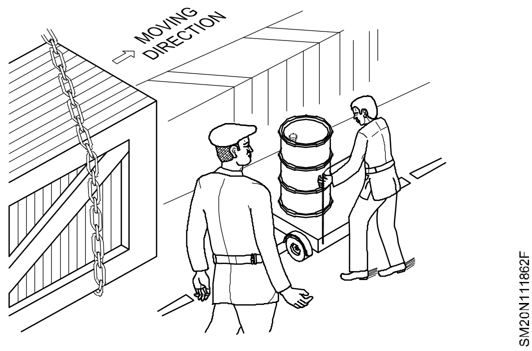


Fig 15

The tackle may fail or slip.

Warn them to stand clear before an accident is caused.

Inspection and cost estimate

Objectives: At the end of this lesson you shall be able to
- **state the different types of inspection that should be carried out for satisfactory production**
- **explain inspection parameters for different inspection types.**

Introduction

It is essential to have a thorough knowledge of a product, the purpose of use and the place of use, to inspect it for a satisfactory production.

Inspection consists of three parts:

1 Inspection of materials

2 Intermediary inspection in the course of manufacturing process

3 Inspection of finished products.

Inspection of materials: It is important to select good materials to improve the performance of a product. It sometimes happen that a sheet metal breaks during the working operation or much trouble comes for a working process due to bad selection of materials. The inspection of sheet metal working materials consists of four aspects. i.e appearance inspection, quality inspection, dimensional inspection and the inspection of mechanical intensity.

Appearance inspection: Scars on the surface, strain, lamination fault, fold and indentation marks are inspected in this stage.

a) **Scars:** Scars may cause breakage in the product. If the sheet is rolled without removing oxides on it, they will eat the texture and leave unevenness on the surface. This unevenness can be modified by painting to some extent.

b) **Lamination fault:** If the base metal is separated into two or more sheets in the course of looking, it is a lamination fault. Lamination fault can be detected by tapping it with a hammer or folding a small piece of sheet metal.

c) **Corrosion:** Too much rust on the surface is to be checked.

d) **Deformation**

Inspection of dimensions: This is to check that the dimensions of the sheet metal are the same as that of the nominal valve such as size, thickness.

Quality inspection: Quality inspection is done by chemical analysis, the spark test with the grinder will be effective to some extent.

Inspection of mechanical intensity: Mechanical intensity means, tensile strength, elasticity, hardness of material. For testing tensile strength and elasticity tension tester is used. Erichsen deep drawing cut tester is used for testing and drawing characteristics of sheet metal.

Intermediary inspection: Although one inspection of finished goods will be enough for a product made by one process, an inspection after every process is needed for a finished product after many processes. It is called an intermediary inspection to find a faulty point in any product before it is finished, without wasting time and labour. Sheet metal working consists of such operation as cutting, forming (press, handwork) riveting and assembling, welding and assembly.

Cutting: Inspection is done with a scale or plate gauge to check the cut dimension as per prescription.

Forming: The presence of crack and size are inspected for both handwork and mechanical press work. Angles are inspected by using square for the right angles, protractor for other angles. Plate gauge is ideal to check many at a time.

Welding: After removing slugs, the welding penetration is checked according to the bead waveforms and shape of the boundary between bead and base metal. It is appearance inspection. Adherence is tested by the compression test and oiling method. The resistance of weld joints against pressure is tested by water pressure and oil pressure or air pressure in the compression test.

Riveting: The shape of the rivet head and the internal are inspected by naked eye and the sound test is used to check the conditions of riveting. When a rivet head is tapped by a hammer, it will give out clear sound for a correct riveting, and dull sound if there is defect.

Boring: The location of holes, pitch, diameter and others are inspected if double diameters of the bore +3 mm are drawn before hand. A plate gauge is used for the inspection of a large number of products.

Inspection of finished goods: A product is finished when all of the workings in each sheet metal process comes to an end. It is imperative to judge dimensions according to the importance of the inspected parts. It will be of no use to expect accuracy as to the dimensions and straightness in each part as the whole.

Estimate of sheet metal processing

Objectives: At the end of this lesson you shall be able to
- **state the classification of cost accounting**
- **explain the cost elements of total cost of the product**
- **identify direct and indirect cost elements.**

Outline of cost accounting: The cost price means the expenses incurred for the manufacture of a product and cost accounting is to calculate the expenditure for a definite unit of product. So cost accounting is the basis of the selling price of a product and also the numerical data for improving the management.

Classification of cost accounting: It is classified into advance accounting and after accounting according to the performed time.

Advance accounting or estimated the accounting is the calculation before the manufacture, of a product and it is mere budget or estimate.

After accounting or actual expense accounting is done on the basis of the actual expenses after the product is finished. It is applied to every kind of business to furnish the foundation of advance accounting.

Elements of cost

The elements consisting the total cost of a product are listed hereunder:

Material costs	Direct material cost	(Raw materials, materials).
	Indirect material costs	(Auxiliary materials,consumable tools,utensils, office appliances).
	Direct labour costs	(Wage of direct workers) .
Manufacturing cost	Labour costs	
	Indirect labour costs	(Pay for factory staff, wage of indirect labourers and others).
	Expenditures	
	Direct expenditures	(Designing cost directly burdened on products, wooden patterns and others).
	Indirect expenditures	(Depreciation expense of machines, repairing expense, welfare expense, land rent, house rent,premium, power rate, gas rate, water rate,travelling expenses,retirement allowance, tax, other sundry expenses).
Total cost (Selling cost)	Selling expenses	
	General (administrative expenses)	Expenses required for the administration of the whole enterprise (The expenses related to the Head office, for example)
Selling price = Total cost + Profit		