SHEET METAL WORKER

NSQF LEVEL - 3

TRADE PRACTICAL

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 - 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 Practical - 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 Practical)** for the trade of **Sheet Metal Worker - NSQF Level - 3** (Revised 2022) under the **CG & M** Sector for ITIs.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

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

NIMI - COORDINATORS

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Shri. V. Gopalakrishnan	-	Assistant 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 intented to be used in practical workshop . It consists of a series of practical exercises to be completed by the trainees during the Course of the **Sheet Metal Worker NSQF Level - 3** supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF LEVEL - 4 (Revised 2022) syllabus are covered.

The manual is divided into Eleven modules.

Module 1	**Basic Fitting Process**
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

This manual consists of theoretical information for the course of the **Sheet Metal Worker NSQF Level-3** (Revised 2022). The contents are sequenced according to the practical exercise contained in the manual on Trade practical. Attempt has been made to relate the theortical aspects with the skill covered in each exercise to the extent possible. This co-relation 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 indicating about the corresponding practical exercise are given in every sheet of this manual.

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

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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)**	1.1.1 - 7
2	**Shears or bends the sheet wherever necessary by machine or hand shear. (Mapped NOS: NOS:CSC/N0301)**	1.2.8 - 9
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)

Induction Training

Objectives: At the end of this exercise you shall be able to
- **identify the staff structure of the institute**
- **identify the general discipline, laid down by the institute.**
- **record the general discipline, laid down by the institute.**

PROCEDURE

Familiarisation with the Institute

TASK 1 : **Visit to various sections in your ITI**

The Instructor will read the new students to various sections in the ITI

1 During the visit note down and collect all information of staff, designation, their name.

2 Identify and note down the various sections (trades) in which training is given.

3 Locate your ITI, showing nearest land marks like post office, Railway stations, Bus stop, and their approximate distance from the ITI.

4 Collect the telphone numbers of the ITI office, nearest Hospital, Police station, nearest firstation and display it.

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TASK 2 : **Familiarisation**

1 Identify the head of the institution and his deputy.

2 Classify the majot divisions of the Institute such as group Instructor, office Hostel, Stores, Medical.

3 list out the trades and the trad Instructor for each trade

4 list out the staff working under office Administration

5 list out the staff under hostel division

6 Medical division with a M.O. compounder and dresser

7 List out the general discipline to be followed with in the Institute

8 Learn and follow the rules and regulation of the Institute.

Based on the organisation structure, identify the major function of the staff listed in Table

Designation	Functions	Name
Principal		
Vice- Principal		
Medical Officer		
Accountant		
Trg & Placement officer		
Group Instructor		
Voc Instructor		
Office Supdt		
Hostel Warden		
Stores Officer		
Phy. Training Instructor		

— — — — — — — —

TASK 3 : **Listing Rules & Regulations**

The Moral image of the Institute depends on the discipline followed list out the major rules and discipline followed in the institute.

Impartance of machines used

1 Bench leaver sliears
2 Guillotine scaring machine foot operated
3 Oxy acctyless welding plant completed set
4 Cirele cutting machine
5 Pillartype drilling machine
6 D.E. padestal corinder
7 Power press
8 Nibbling machine
9 Spinning lathe
10 Buffing and polishing machine
11 Arc welding Trancformer
12 Tig welding machine

S.No.	Rules & Regulation	S.No.	Discipline in the Institute

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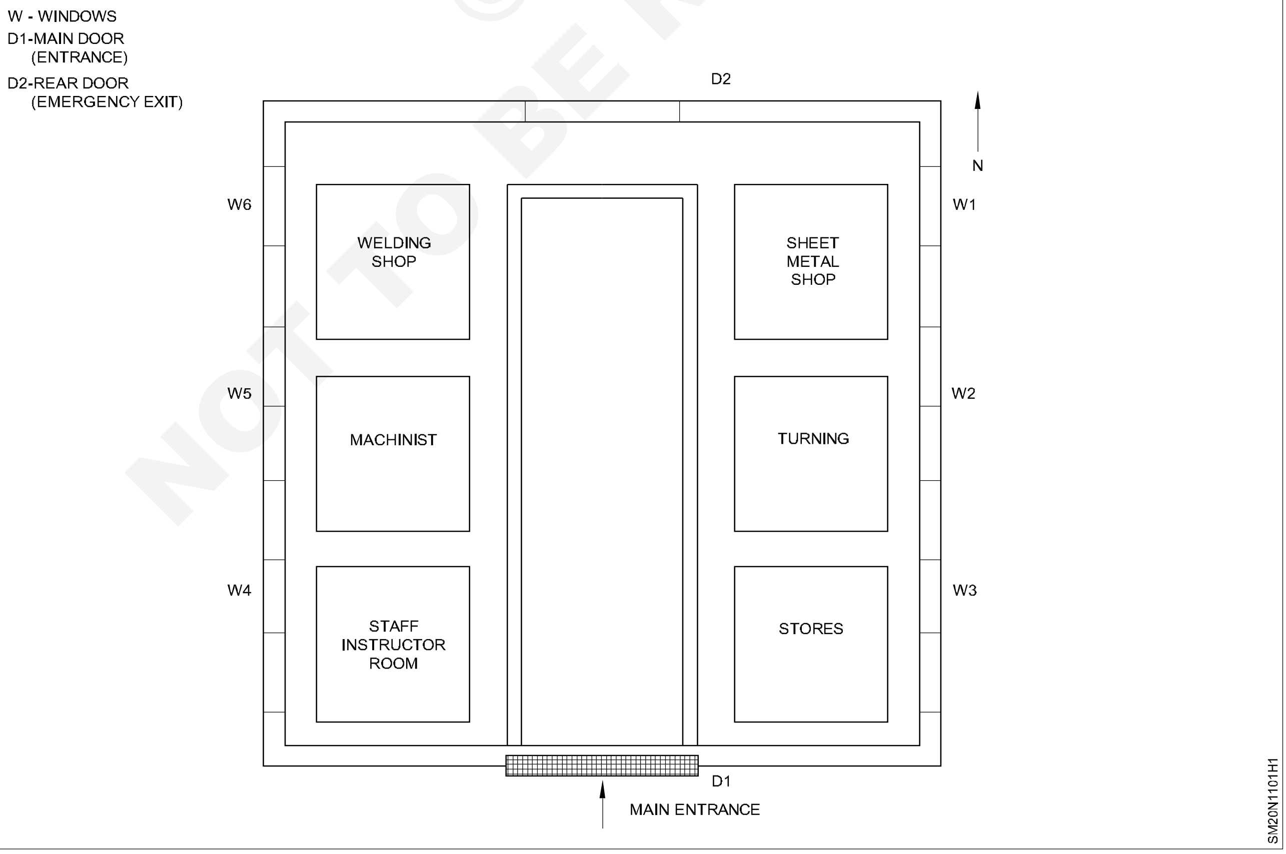
TASK 4 : **Draw LAY- OUT of Your ITI**

1 Draw the layout plan of your Institute in A4 sheet
2 Measure the length, breadth of each section, work Benches, doors and windows in the Institute.
3 Draw the pathway (A sample layout shown below)

Fig 1



Capital Goods & Manufacturing **Exercise 1.1.02**

Sheet Metal Worker- Basic Fitting Process

Induction to safety devices used in shop floor

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

- **record the meanings of the safety sign**
- **read and interpret the different types of personal protective devices from the chart.**

TASK1: **Safety Signs**

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

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

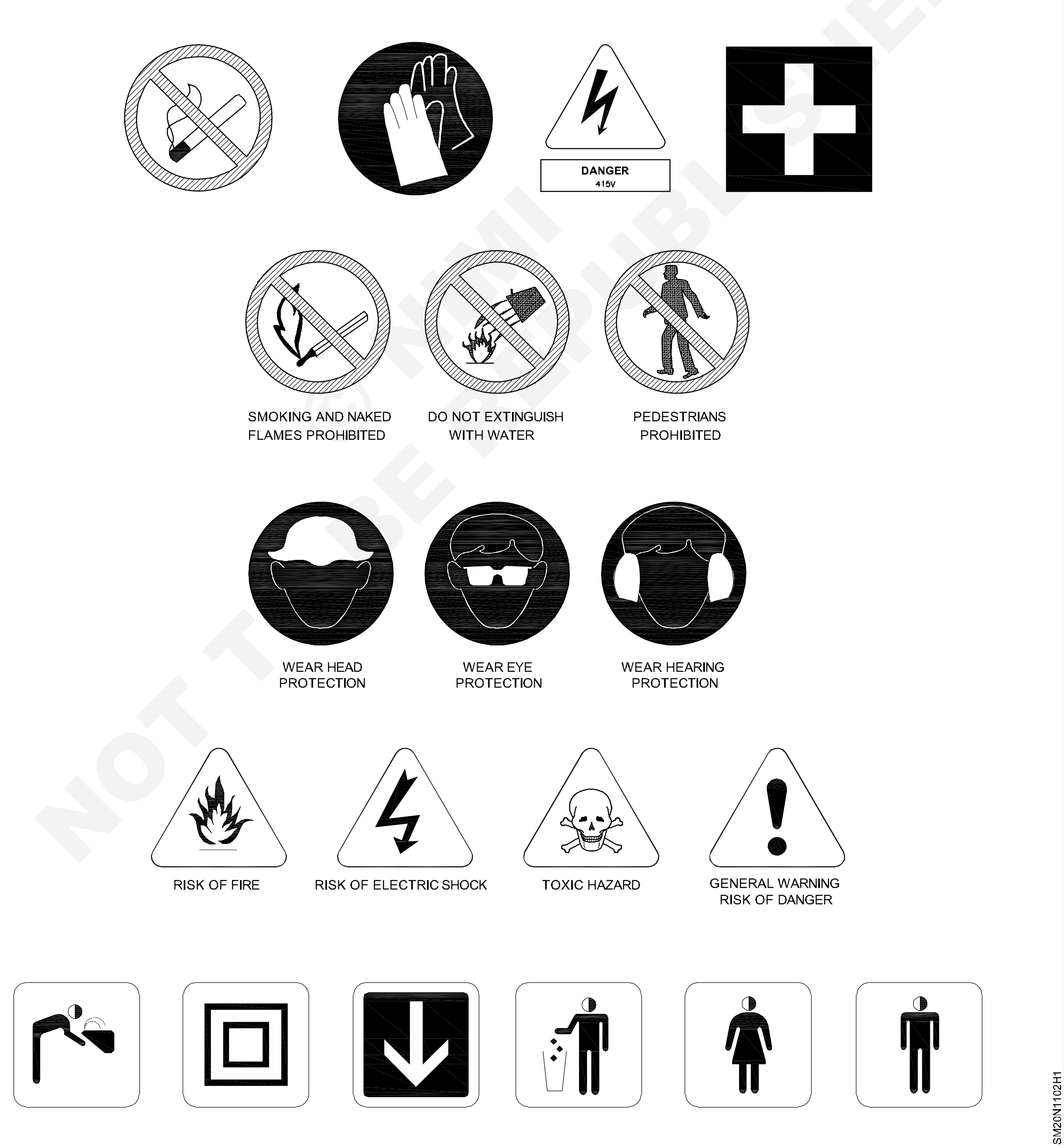


Table 3

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

Get it checked by your instructor

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TASK 2: **Personal Protection Equipment**

Fig 1

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

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

Table 2

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

Get it checked by your instructor.

— — — — — — —

Identification of tools & equipment marking in sheet metal trade

Objectives: At the end of this exercise you shall be able to
- **use measuring tools in sheet metal**
- **identify machinery used in sheet metal trade.**

TASK 1: **Identifying the tools**

The Instructor will explain major marking tools, measuring tools, production tools used in sheet metal trade.

Fig 1

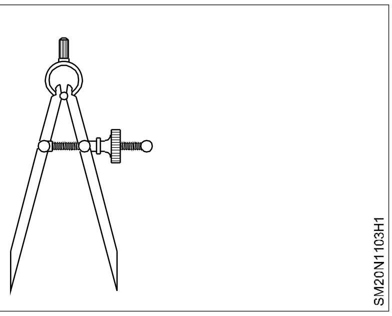


Fig 2

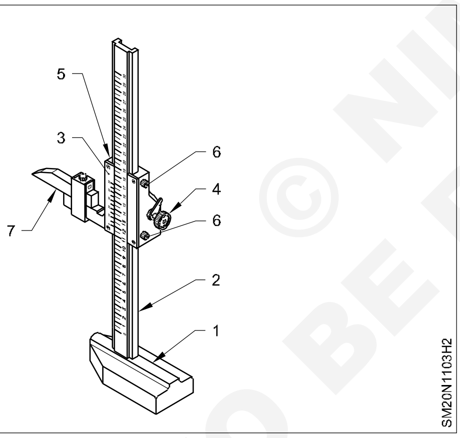
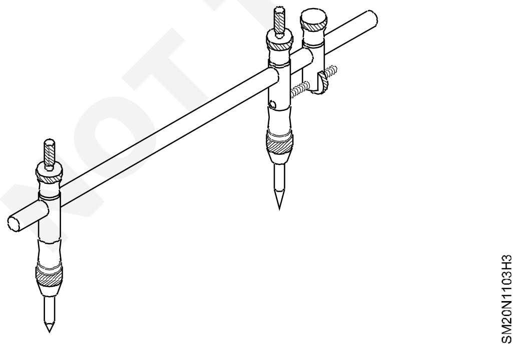


Fig 3



In sheet metal there are some tools used for marking some used for marking & measuring, some tools used for production purposes like hammers, shear, swage etc. Identify from the given figures which category they belong, its name and specific use in table 1.

Fig 4

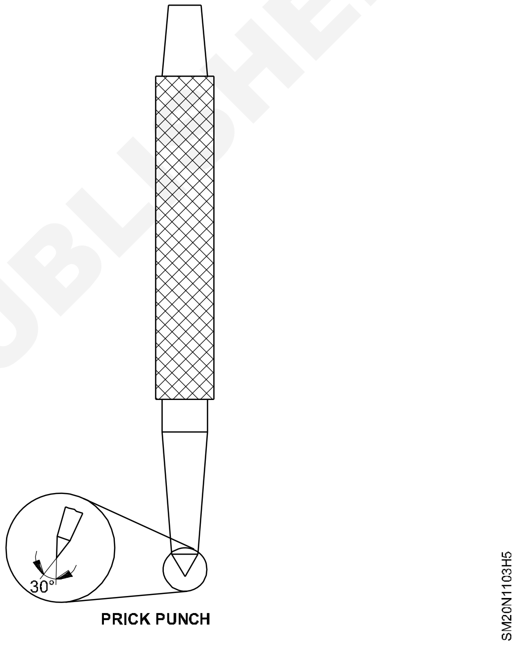


Fig 5

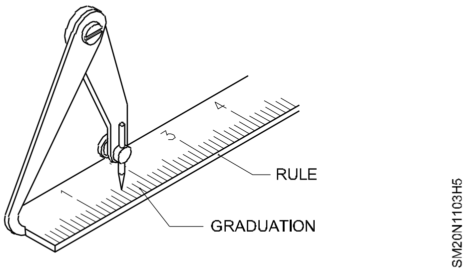
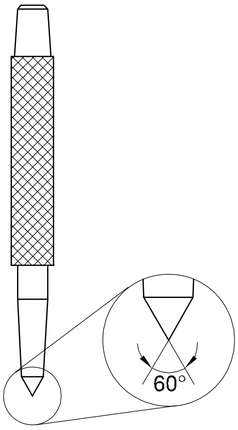
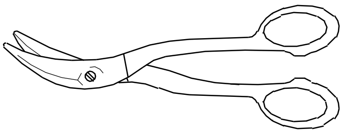


Fig 6



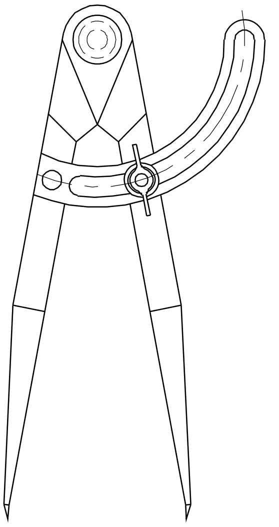
SM20N1103H6

Fig 7



SM20N1103H7

Fig 8



SM20N1103H8

Table 1

Fig No.	Name of the Tool	Category	Remarks
1			
2			
3			
4			
5			
6			
7			
8			
9			

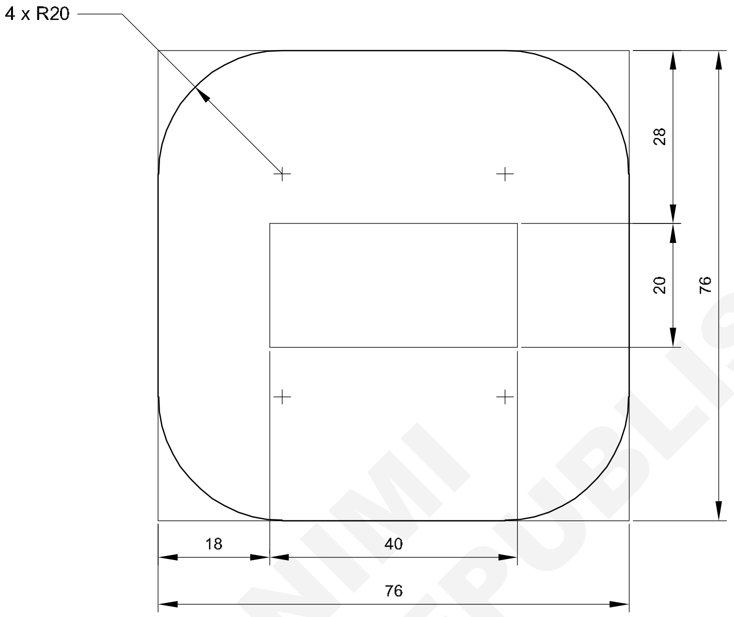
Note: In category column mark M_1 - Marking tools, M_2 - Measuring tools, M_3 - Marking cum Measuring, P - Production tools.

Get it checked by your Instructor.

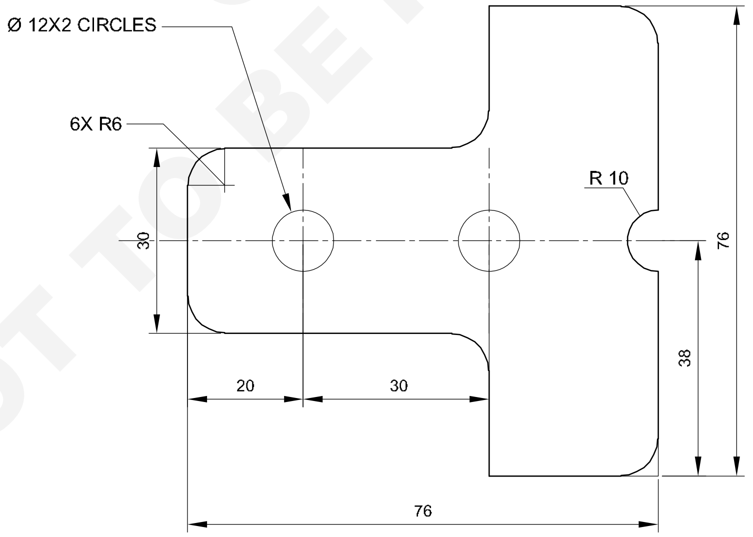
Marking off straight lines and arcs using scribing biecting of straight line

Objectives: At the end of this exercise you shall be able to
- **mark parallel lines using scribing block**
- **mark arcs using dividers.**

TASK 1



TASK 2



1	80 ISF 10-80		Fe 310			1.1.04
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

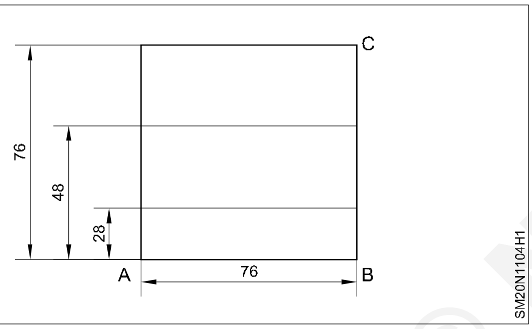
SCALE 1:1	**MARKING STRAIGHT LINES & ARCS USING SCRIBING BLOCK & DIVIDERS**	TOLERANCE ±0.5mm	TIME 5 Hrs
		CODE NO. SM20N1104E1	

Job Sequence

Marking straight lines & arcs

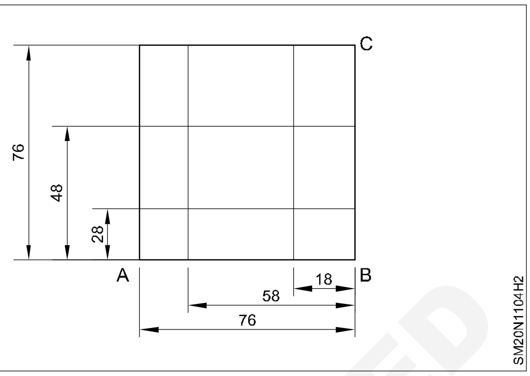
- Check the raw material size using steel rule.
- File three sides mutually perpendicular to each other.
- Mark and file to size of 76 x 76 x 9 mm
- Clean Marking Table, Angle plate, Scribing block and Steel rule with soft cloth.
- Place Scribing block, Angle plate and Steel rule on marking table.
- Support the Steel rule along with Angle plate.
- Set the dimension 28 mm in scribing block using Steel rule.
- Support the Job along with angle plate and scribe dimension line 28 mm in scribing block with reference to side 'AB' Fig 1

Fig 1



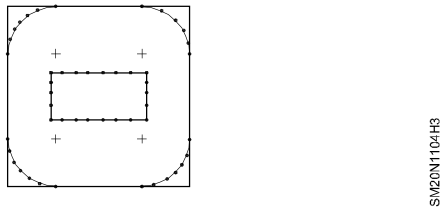
- Similarly, set 48 mm and scribe line with reference to side 'AB.
- Turn and place the Job with reference to side 'BC'.
- Set the size 18 mm and scribe line with reference to side 'BC' Fig 2.

Fig 2



- Similarly, set the size 58 mm and scribe line with reference to side 'BC'
- Set the size 20 mm and scribe line with reference to all over the four sides to draw radius.
- Punch on the four radius point with a 30° prick punch.
- Draw 20 mm radius using divider in four corners.
- Punch on the marked lines with equal intervals. (Fig 3)
- Preserve it for evaluation.

Fig 3



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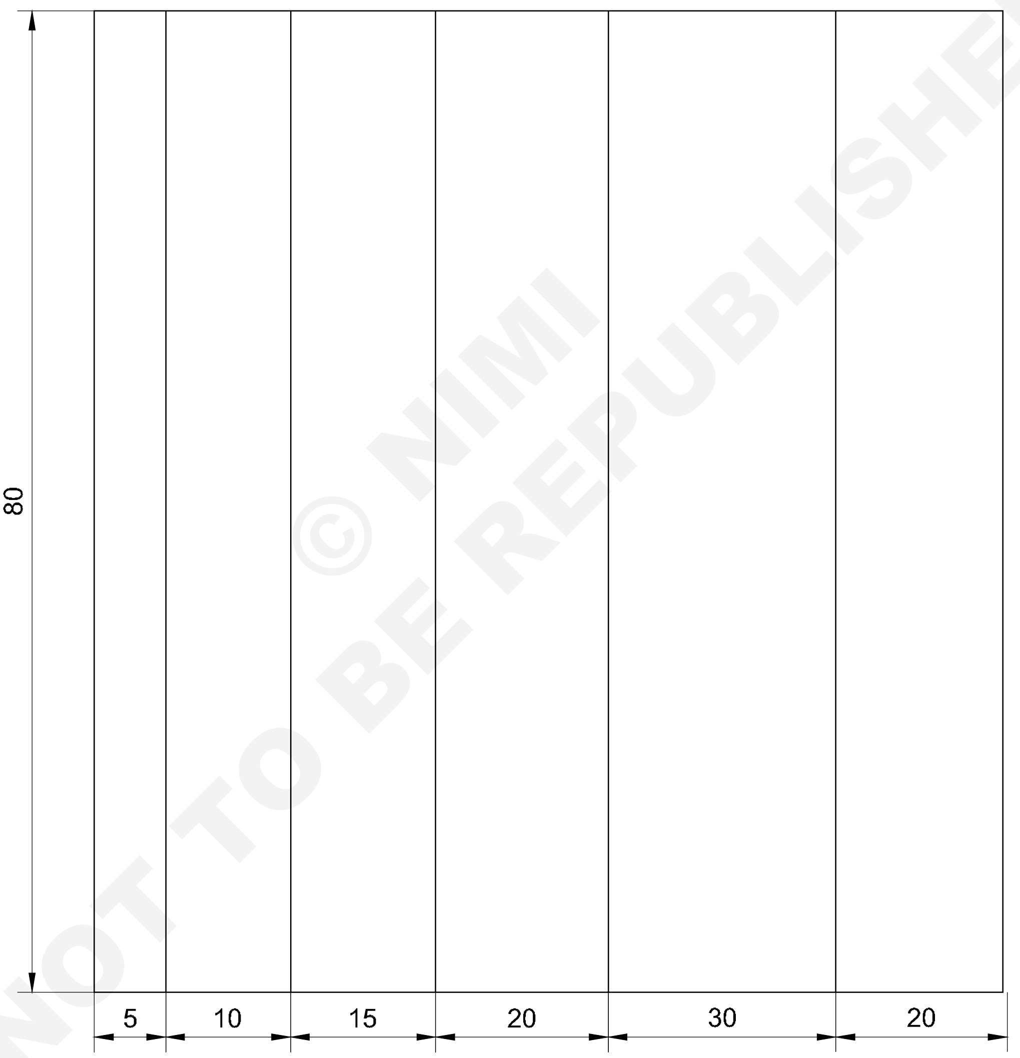
Planishing of sheet metal mark & cut through the straight lines

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

- **planish the sheet metal by a wooden mallet and a tinman's anvil stake to steel rule edge accuracy**
- **mark off parallel lines by using scriber, L square, steel rule and straight edge**
- **cut the sheet metal through straight line as per the marking using straight snips.**



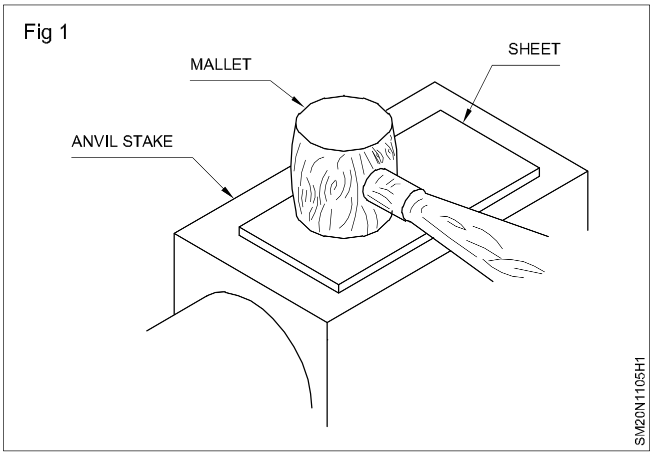
1	ISSH 160 x 160 x 0.508	–	G.I SHEET	–	–	05
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**PLANISHING OF SHEET METAL, MARK & CUT THROUGH THE STRAIGHT LINES**	DEVIATIONS ±1	TIME 10h
		CODE NO. SM20N1105E1	

Job Sequence

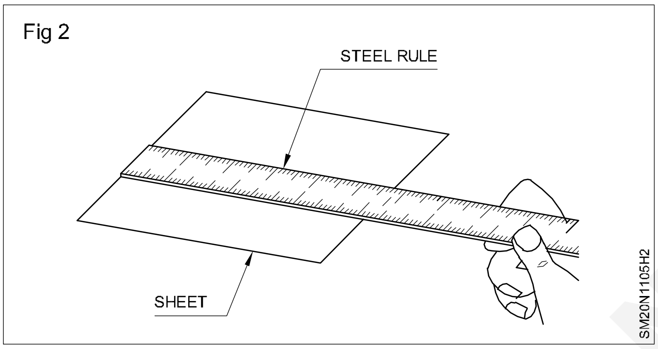
- Planish the job using a wooden mallet and a tinman's anvil stake. (Fig 1)

Fig 1



- Check the size of the sheet using a steel rule. (Fig 2)

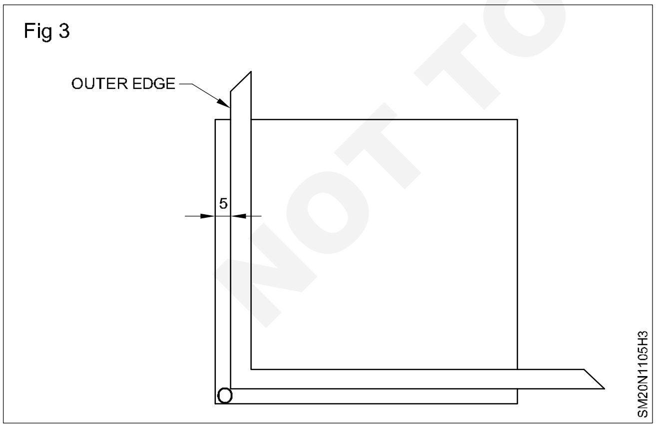
Fig 2



- Place the tinman square as shown in Fig 3. Scribe two straight lines on the outer edges of the tinman's square.

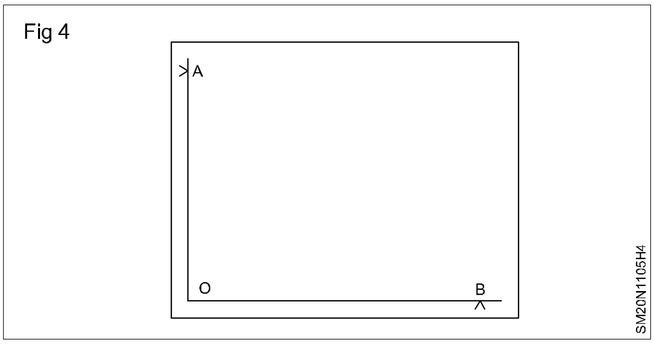
While marking a point on the sheet metal mark a "V" shape from the point for easy identification.

Fig 3



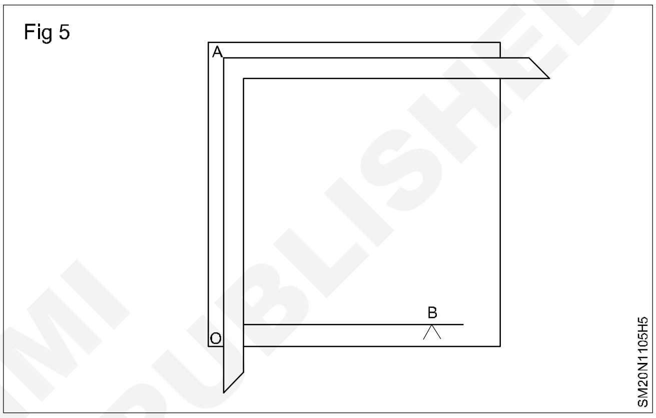
- Mark a point at 150 mm distance from mark "O" on both lines and name them A and B as shown in Fig 4 using a steel rule and a scriber.

Fig 4



- Place the outer corner of the tinman's square on "A" and draw a straight line as shown in Fig 5 using a scriber.

Fig 5



- Place the outer corner of the tinman's square on "B" and draw a straight line using a scriber. Now you get a square of 150 mm side as shown in Fig 6. Inside this square, mark "V" points at a distance of 65 mm from A & C, and join them by a straight line using a straight edge and a scriber as shown in Fig 7.

Fig 6

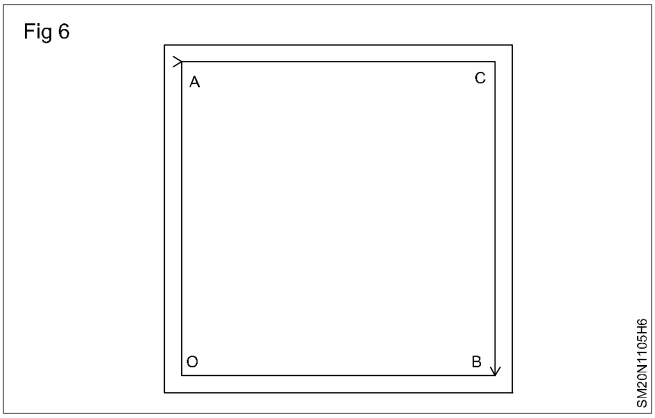
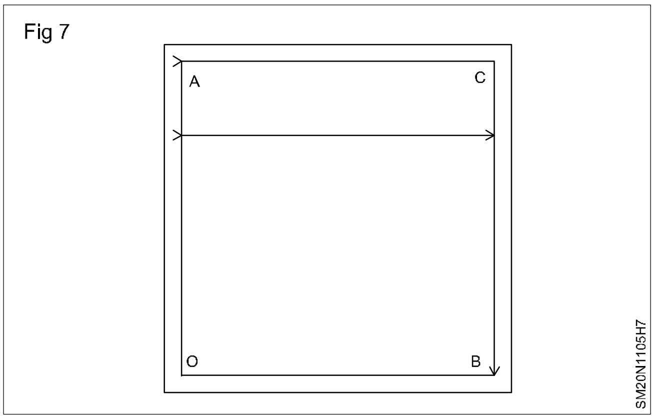
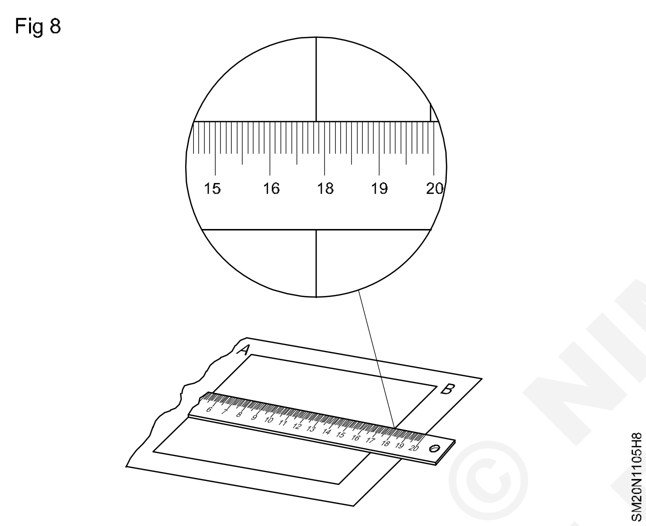


Fig 7



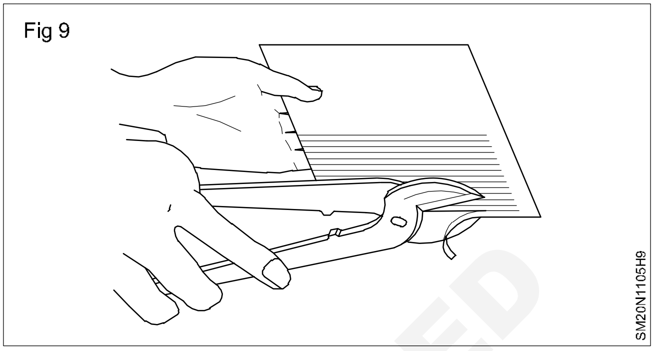
- In the same way, draw other parallel lines according to the job drawing.
- Check the lines marked using a steel rule. (Fig 8)

Fig 8



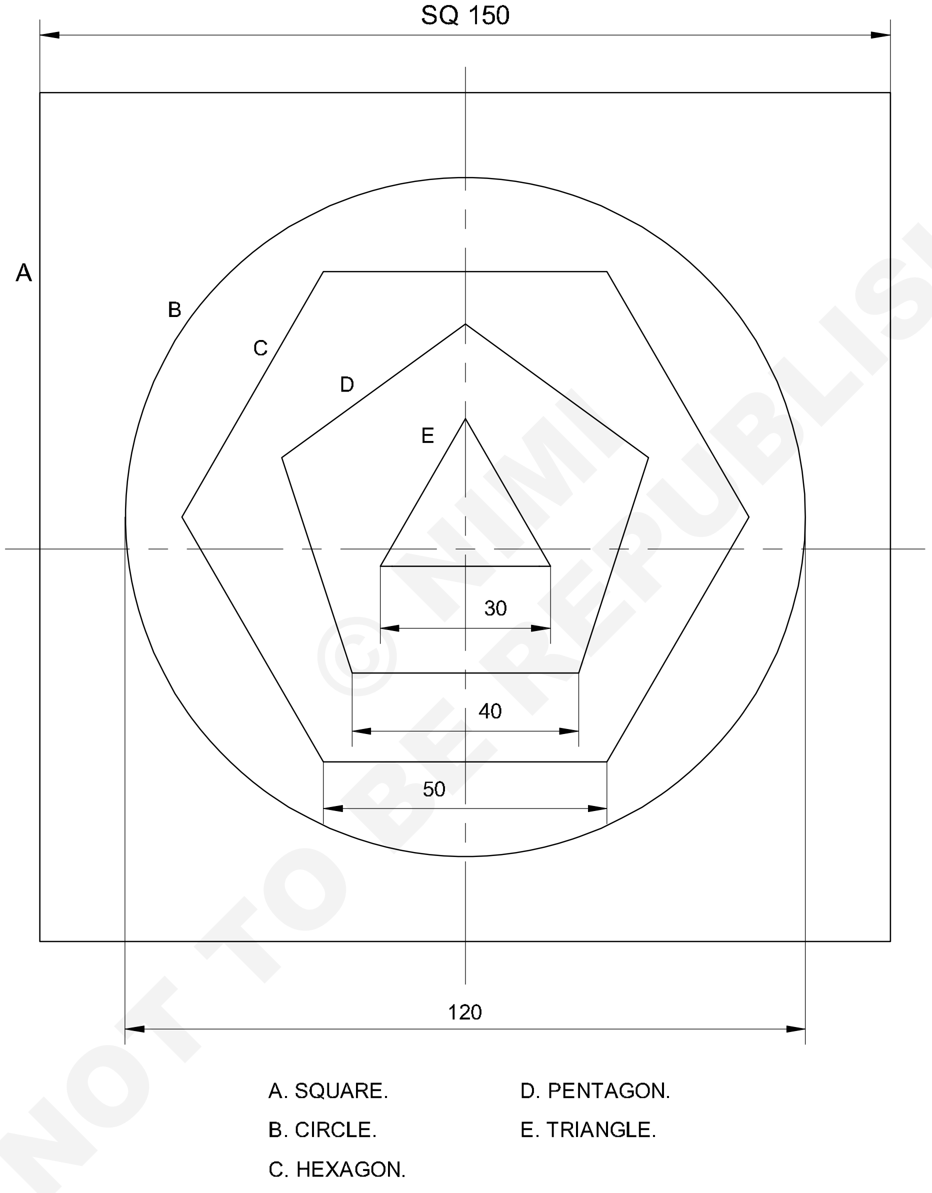
- Cut along the lines marked using straight snips. (Fig 9)
- Planish the cut piece and check the dimensions using a steel rule.
- Accordingly, flatten and check the remaining cut pieces after cutting.

Fig 9



Practice in drawing simple geometrical shapes

Objective: At the end of this exercise you shall be able to
- **draw different types of geometrical shapes.**

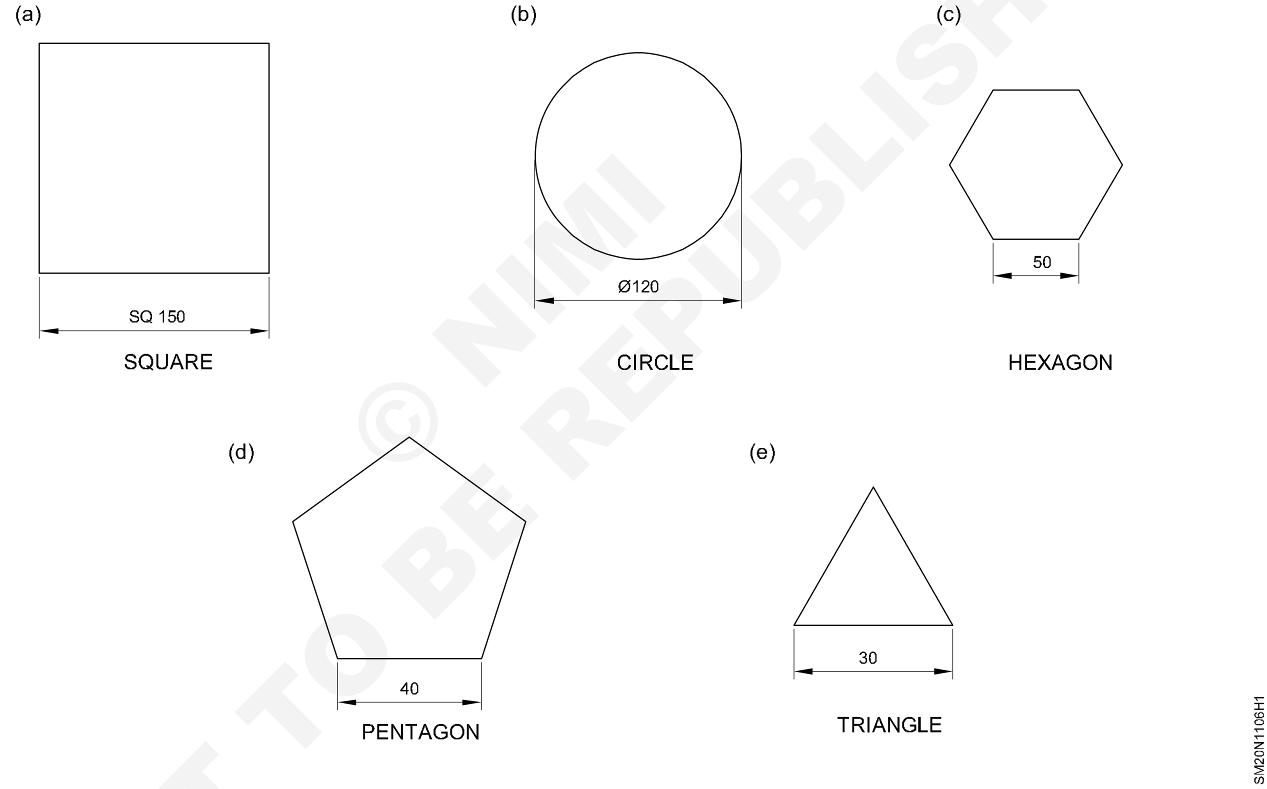


1	ISSH 150 x 150 x 0.61	–	G.I SHEET	–	–	06
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 3:4	MARK AND CUT THE GEOMETRICAL SHAPES				DEVIATIONS ±1	TIME 10h
					CODE NO. SM20N1106E1	

Job Sequence

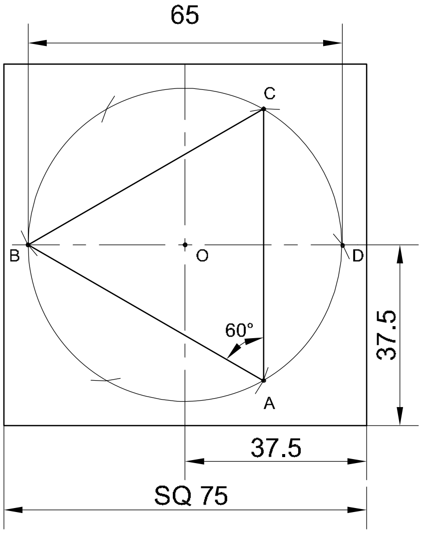
- Planish the sheet metal on a tinman's Anvil using mallet.
- Check the sizes of the sheet 150x150x0.5 mm using a steel rule.
- Mark the centre line as shown in job drawing.
- Punch the centre point using a prick punch 30° and a ball pein hammer.
- Mark a square of 150mm side using a steel rule, straight edge, 'L' square and scriber.
- Draw a circle of ϕ120mm from the same centre point using steel rule and divider.
- Mark a hexagon of 50 mm side in the circle as shown in job drawing
- Mark a pentagon of 40 mm side within the hexagon as shown in job drawing.
- Mark an equilateral triangle of 30 mm side within pentagon as shown in job drawing.
- Place the sheet on Anvil.
- Cut the square 150 mm side using flat chisel and ball pein hammer fig 1.
- Check the different geometrical profiles with steel rule.

Fig 1

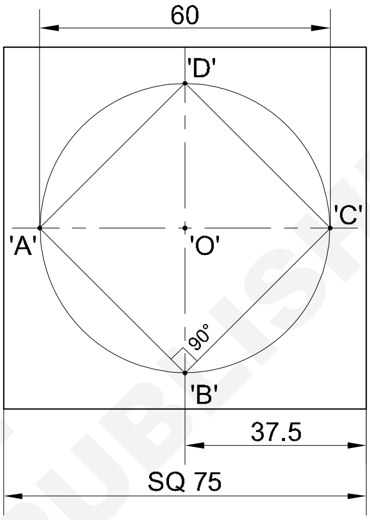


Marking and cutting of sheets various angles

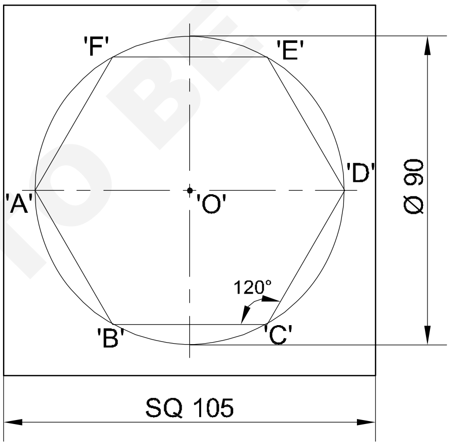
Objectives: At the end of this exercise you shall be able to
- **steel rule and compass used various angles mark and cutting.**



MARKING AND CUTTING TRIANGLE



MARKING AND CUTTING SQUARE



MARKING AND CUTTING HEXAGON

1	-	-	-	-	-	1.1.07
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	TITLE: MARKING AND CUTTING VARIOUS ANGLE IN G.I. SHEET	DEVIATIONS ±1mm	TIME
		CODE NO. SM20N1107E1	

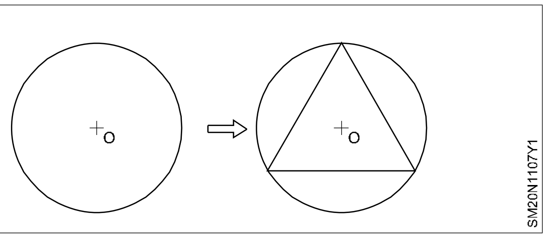
Construct an equilateral triangle inside a circle

Objectives: This shall help you to

- **construct an equilateral triangle inside a circle by using a steel rule and a wing compass.**

Inscribe an equilateral triangle in a circle (Fig 1)

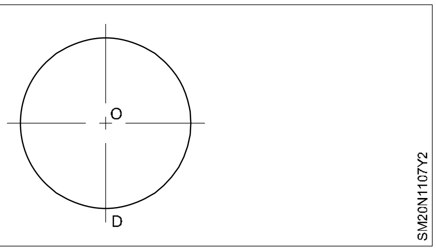
Fig 1



Take the radius of a circle as 0.58 x the side of the equilateral triangle.

Draw the circle with the above radius. (Fig 2)

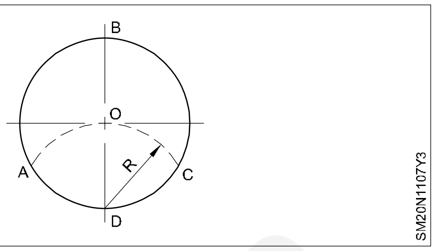
Fig 2



Draw an arc AC from point D, taking DO as radius. (Fig 3)

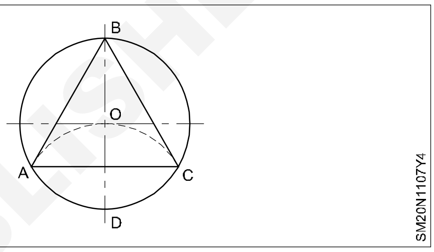
Join AB; BC & AC.

Fig 3



ABC is the equilateral triangle drawn inside the given circle. (Fig 4)

Fig 4



Construct a circle inside a square

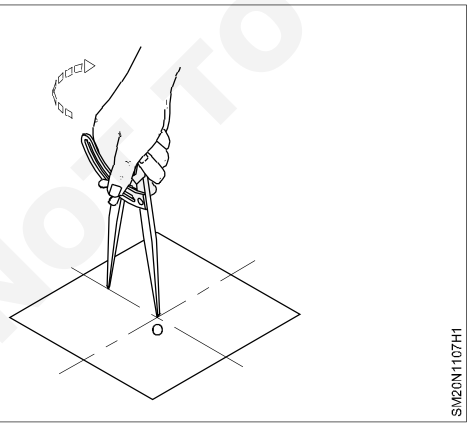
Objective: This shall help you to

- **construct a circle of a given radius by using a wing compass and a steel rule.**

Set the wing compass for a given radius using a steel rule tighten the wing nut and check the dimension again.

Hold the compass head with the palm of your hand to prevent the compass point from slipping from the centre point. (Fig 1)

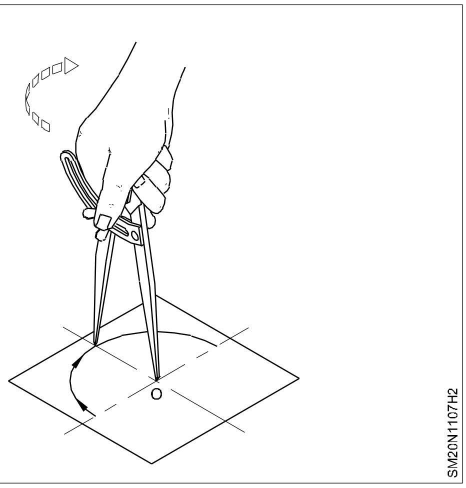
Fig 1



Do not press the wing nut.

Draw a half circle clockwise from left to right, using thumb pressure. (Fig 2) Change the thumb position of the compass and mark the rest of the circle anticlockwise from left to right. (Fig 3)

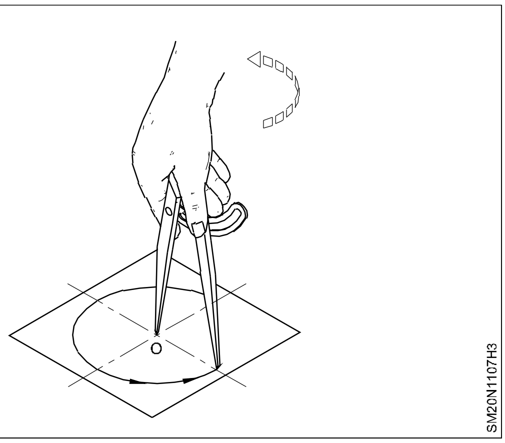
Fig 2



While marking, tilt the compass slightly in the direction of the rotation to avoid chattering of point..

Mark clearly at the first stroke itself.

Fig 3



Construct a hexagon inside a circle

Objectives: This shall help you to

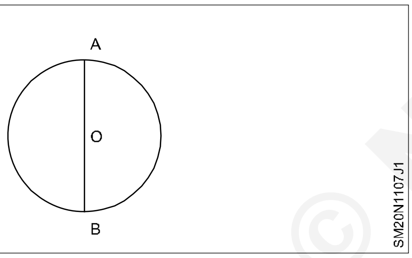
- **construct a hexagon of a given side inside circle by using steel rule, wing compass and a scriber.**

Draw the circle of a given radius using wing compass.

Radius of the circle = side of the hexagon

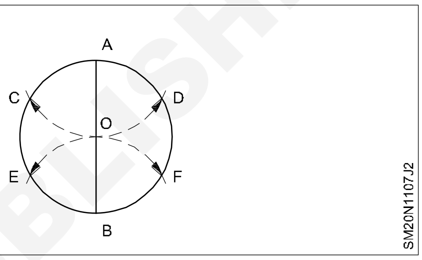
Mark points ‘A’ and ‘B’ on the circumference of the circle on a line passing through the centre point of the circle. (Fig 1)

Fig 1



From points ‘A’ and ‘B’ mark points C,D,E,F on the circle using wing compass taking the radius of the arc as the radius of the circle. (Fig 2)

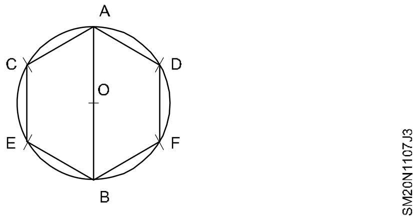
Fig 2



Join points A,D,F,B,E&C as shown in Fig 3.

Now a regular hexagon is inscribed in the circle. (Fig 3)

Fig 3



Cut geometrical shapes

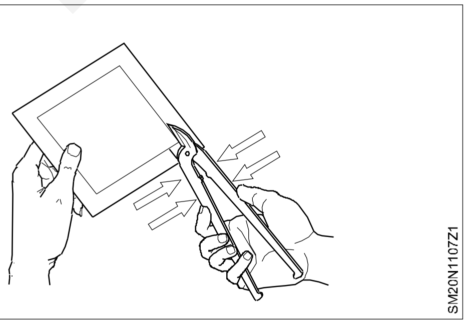
Objectives: This shall help you to

- **cut different geometrical shapes on a sheet metal using straight snips.**

Inspect the snips to make sure that the blades are neither too loose nor too tight.

Hold the snip in one hand and sheet metal in the other hand. (Fig 1)

Fig 1



Open the snips and begin to cut from the edge of the metal.

To obtain a clear cut, keep the blade at right angle to the metal being cut.

Do not use the full length of the blade while cutting. This prevents small burrs and joggle edges.

While cutting always keep the blade on the line, if necessary change the direction gradually according to the shape to be cut.

While cutting, move the snips forward and sheet metal towards you along the line of cut. Synchronise this motion to cut in correct shape. Continue this process till the full length is cut as per the marking.

For the outside circular cut trim off the excess metal by cutting off the corners as shown in Fig 2.

Fig 2

Hold the snips such that the blades do not cover the marking line. Take continuous small cuts, rotate the metal uniformly to get a correct circular/curved shape. (Fig 3 & 4)

Use straight snips for external circular cutting and bend snips for internal circular cutting.

Fig 3

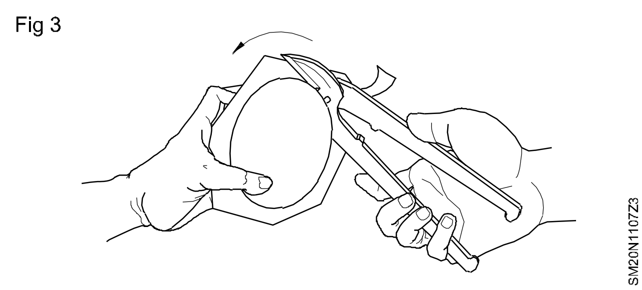
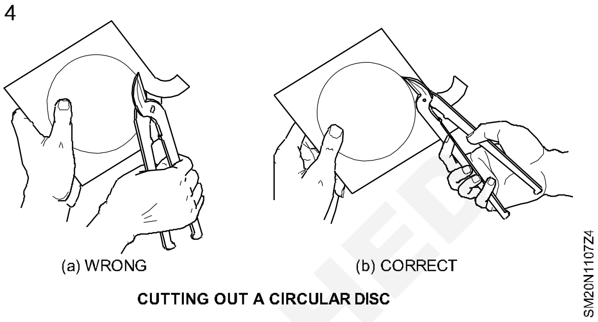


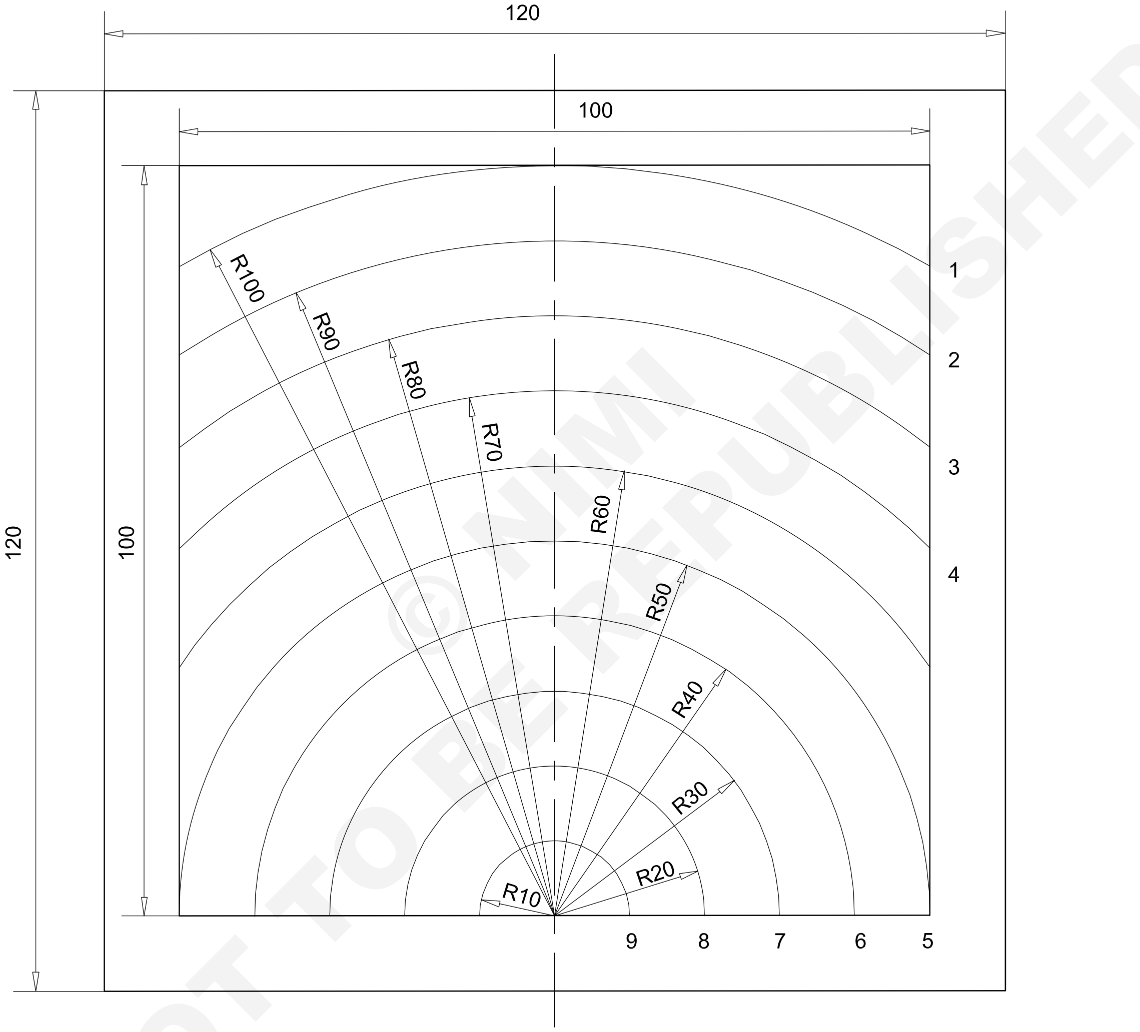
Fig 4



CUTTING OUT A CIRCULAR DISC

Mark and cut through the curved lines used to different types of snips

Objectives: At the end of this exercise you shall be able to
- **transfer the measurements from the steel rule to the wing compass**
- **cut along the marked outside curved lines using straight snips.**



NOTE:- OUTSIDE CURVED LINE FROM 1 TO 4 SHOULD BE CUT BY USING STRAIGHT SNIPS
INSIDE CURVED LINES FROM 5 TO 9 SHOULD BE CUT BY USING BEND SNIPS.

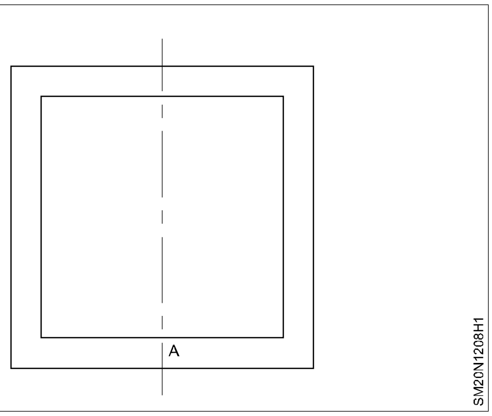
1	ISSH 120 x 120 x 0.508	–	G.I SHEET	–	–	1.1.08
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**MARK AND CUT ALONG THE CURVED LINES**	DEVIATIONS ±1	TIME 10h
		CODE NO. SM20N1208E1	

Job Sequence

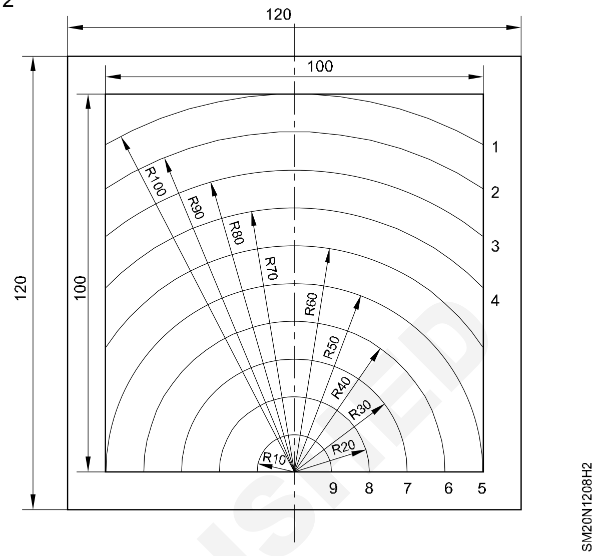
- Flatten the sheet metal using a wooden mallet and a tinman's anvil stake.
- Check the size of the sheet using a steel rule.
- Mark square 100 x 100 using a steel rule, a straight edge and a "L" square.
- Mark the centre line as shown in Fig 1.

Fig 1



- Mark point 'A', a punch using a dot punch and a ball peen hammer.
- Taking point 'A' as the centre, mark curved lines using a wing compass as per job drawing.
- Check the marked curved lines using a steel rule.
- Cut along the marked outside curved lines 1 to 4 using straight snips. (Fig 2)

Fig 2



- Cut along the marked inside curved lines 5 to 9 using bend snips. (Fig 2)
- Check the dimensions of the cut pieces and the surface flatness using a steel rule, a wooden mallet and an anvil stake.

Skill Sequence

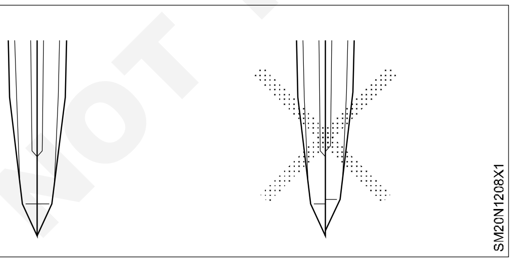
Transfer the measurement from the steel rule to the wing compass

Objectives: This shall help you to

- **set various measurements on a wing compass.**

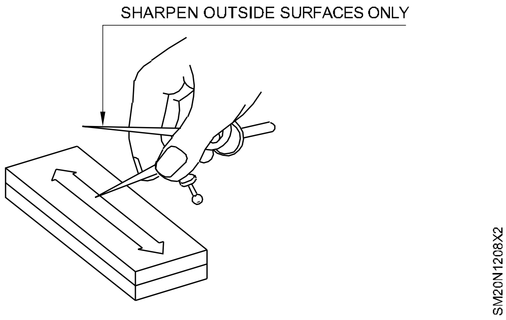
Check whether the legs of the wing compass are of the same length. (Fig 1)

Fig 1



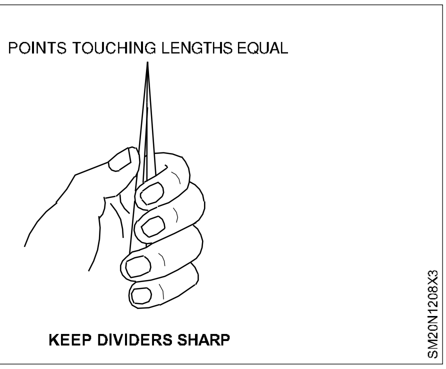
If not, sharpen it with an oil stone. (Fig 2)

Fig 2



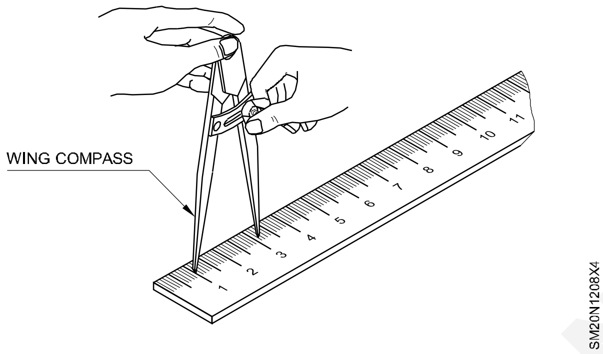
Check that the legs are equal in length and that the points touch each other when closed. (Fig 3)

Fig 3



For smaller lengths, loosen the wing nut and open the compass wider and squeeze with your right hand to adjust and match the required length on the steel rule. (Fig 4)

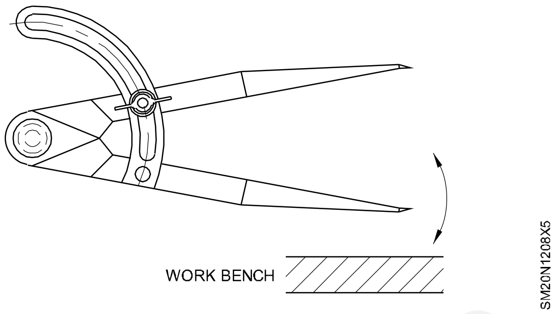
Fig 4



While setting the compass, use the middle portion of the rule and not the edge.

For larger lengths, place the steel rule on the work table, set one tip on the steel rule and adjust the other tip to the required dimension. To close the legs fractionally, tap the outside of the leg lightly. (Fig 5)

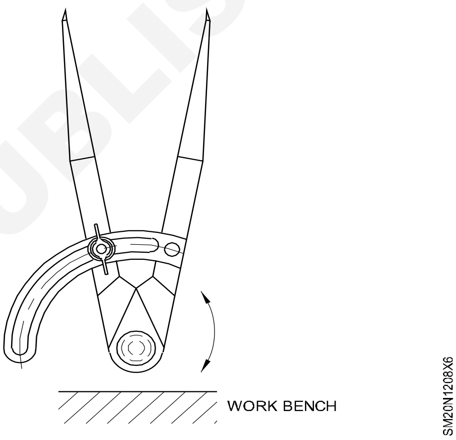
Fig 5



To open them fractionally, turn the compass upside down and tap the head lightly. (Fig 6)

After setting the dimension, lock the legs with the wing nut and check the dimensions again on the steel rule.

Fig 6



Cutting along curved lines

Objectives: This shall help you to

- **cut outside curves on sheet metal by straight snips**
- **cut inside curves on sheet metal by bend snips.**

Cutting outside curves by straight snips

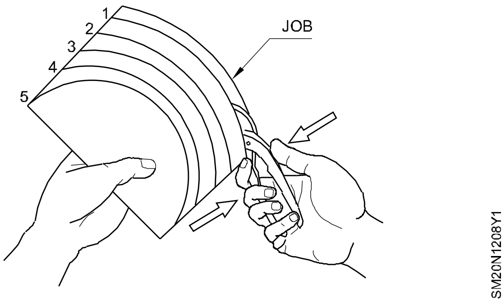
Hold the workpiece in one hand.

Hold the straight snips by the other hand at the handle end.

Keep the straight snips blade on the outside curved line at 90^0 angle and gently press the handle. This produces the shearing force which cuts the material. (Fig 1)

While cutting, move the snips forward along the curved line and the workpiece towards you. This motion should be synchronised to get a correct curved shape.

Fig 1

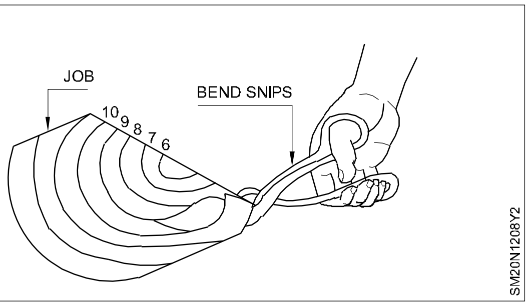


Accordingly, continue the process along the total length of the curved line, point by point, till the curved line ends.

Use small length of blade, while cutting outside curved lines to get correct curved shape.

Cutting inside curves by bend snips: The skill sequence is similar to that of cutting external curves except bend snips are used for cutting along internal curved lines. (Fig 2)

Fig 2

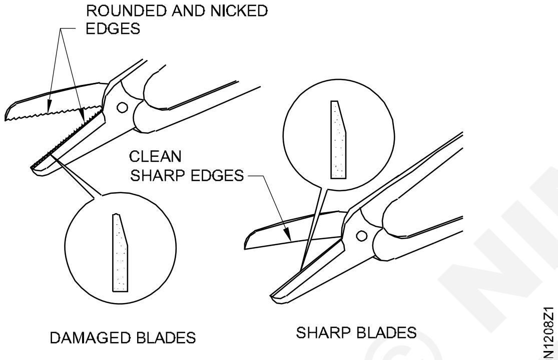


Sharpening of snips

Objectives: This shall help you to
- **sharpen the blunt snips.**

Introduction: After continuous use, the cutting edge of the snips gets worn out and requires resharpening. (Fig 1)

Fig 1



DAMAGED BLADES NEED SHARPENING

Ways of sharpening snips

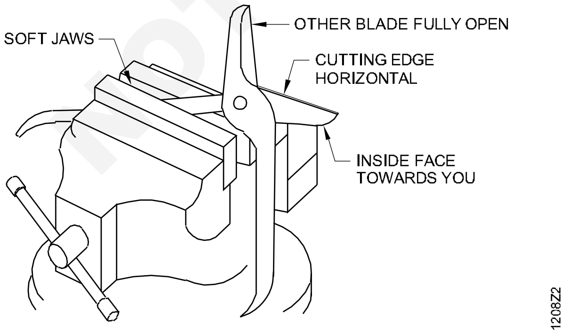
1 Sharpening by files

2 Sharpening by oilstone

3 Sharpening by grinding wheel

Sharpening by files: Clamp the handle of the blade to be sharpened as shown in Fig 2.

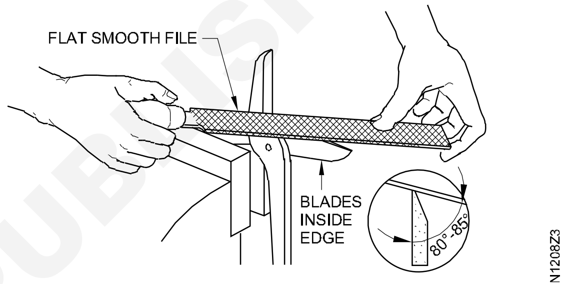
Fig 2



CLAMP THE HANDLE IN A VICE

File the cutting face of the blade using a flat smooth file as shown in Fig 3.

Fig 3



FILE THE CUTTING EDGE & FINISH WITH OILSTONE

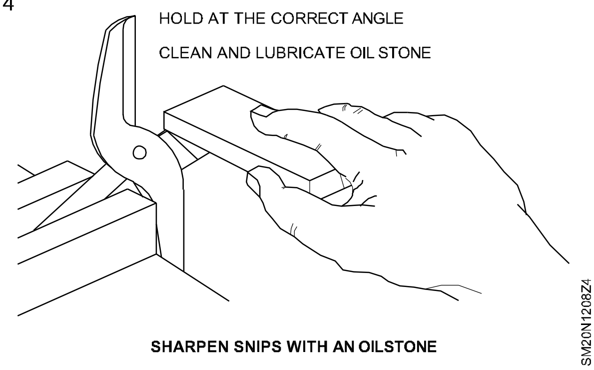
Remove the snips from the vice, clamp the other handle in the vice as done before.

Sharpen the second blade by file.

Sharpening by oilstone: Clamp one handle of the snips in a benchvice.

Use the oil stone the same way as you use a file. (Fig 4)

Fig 4



SHARPEN SNIPS WITH AN OILSTONE

Use the coarse side of the oil stone first. Use the fine side of the oil stone for finishing.

Remove the snips from the vice and repeat the same for the other blade.

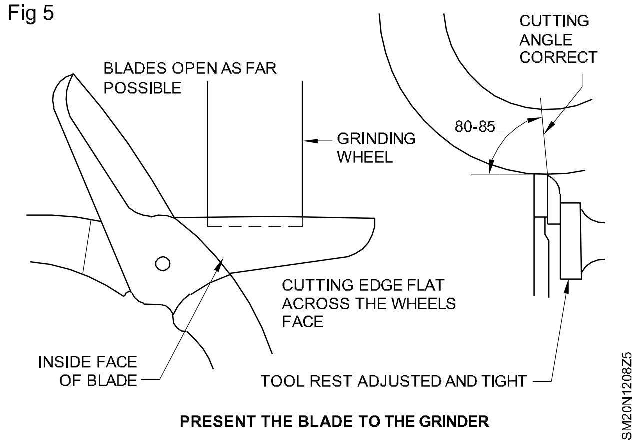
Sharpening by grinding wheel

Switch on the off hand grinder.

Open the blades of the snips as far as possible.

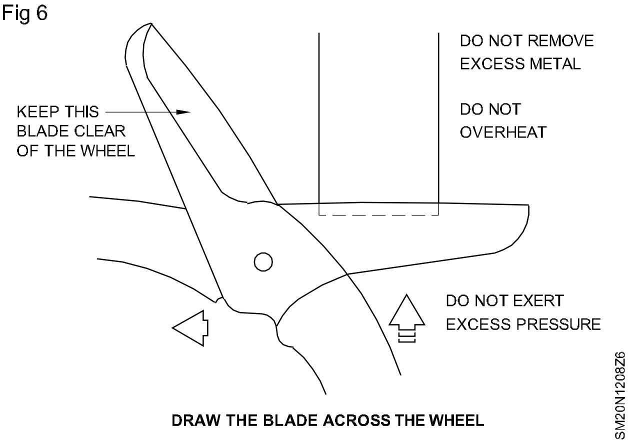
Lay each blade to the grinding wheel as shown in Fig 5. Start grinding from the pivot joint and draw the blade across the grinding wheel. (Fig 6)

Fig 5



PRESENT THE BLADE TO THE GRINDER

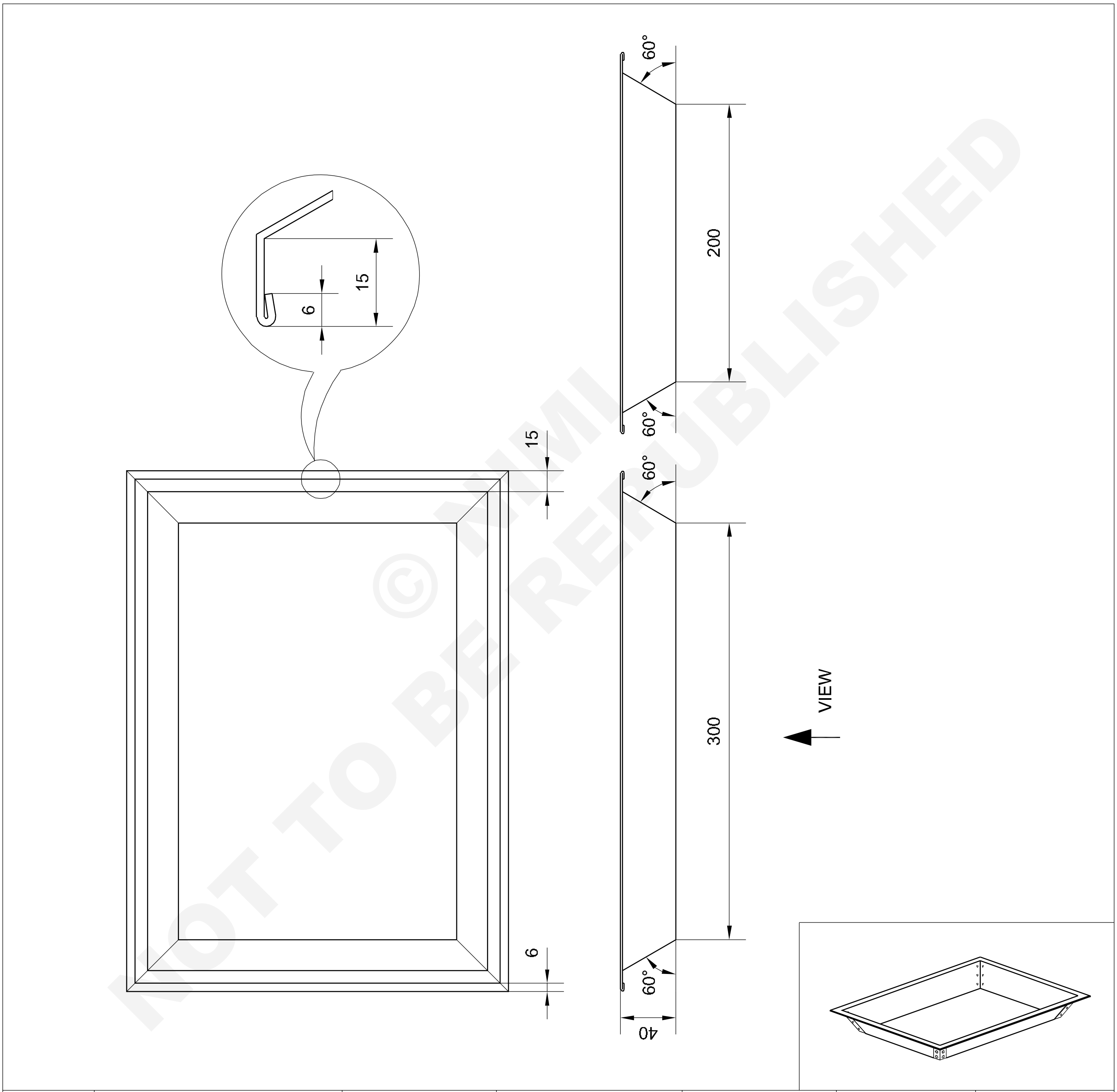
Fig 6



DRAW THE BLADE ACROSS THE WHEEL

Marking and cutting of 'V' notches use to taper tray

Objectives: At the end of this exercise you shall be able to
- **develop and layout the pattern for a taper tray by geometrical construction method**
- **joint area used to 'V' notch**
- **fold sides of the taper tray at 60⁰ using a pair of angle iron.**



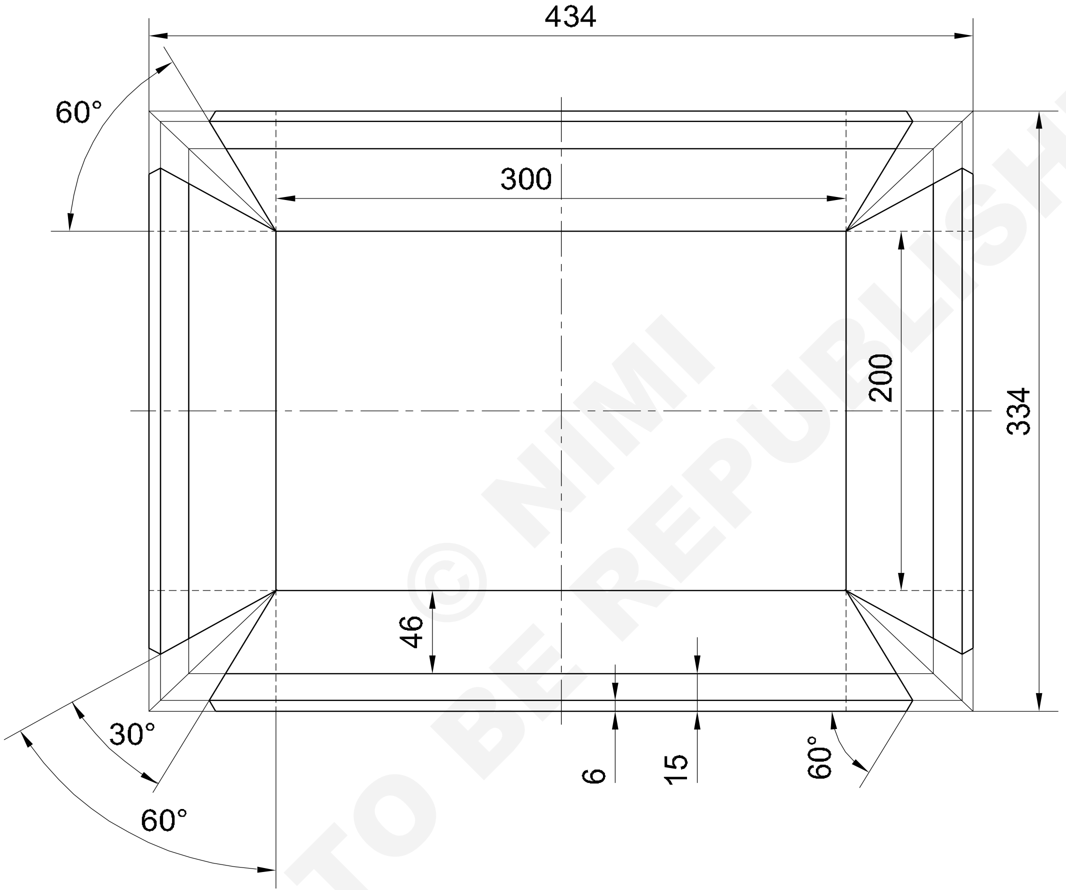
1	ISSH 450 X 350 X 0.61		STEEL SHEET			09
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:4	MARKING AND CUTTING OF 'V' NOTCHES & PROFILES	DEVIATIONS ±1	TIME 10h
		CODE NO. SM20N1209E1	

Job Sequence

- Check the size of the sheet metal workpiece as per drawing using a steel rule.
- Flatten the sheet metal piece on the dressing plate using a wooden mallet.
- Develop a pattern layout for the tray, considering allowance for the flanges and single hem, on sheet metal by geometrical construction method using a scriber, steel rule, protractor and divider. (Fig 1)
- Cut the sheet metal as per the pattern layout on the sheet metal using a straight snip.
- Fold 6 mm edges to make single hems on the four sides on the barfolder.
- Fold 15 mm sides at 60^0 to make flanges on the four sides of the taper tray on the barfolder.
- Fold 46 mm four sides, at 60^0 as shown in the drawing, using a pair of angle iron, a benchvice, a 'C' clamp and a wooden mallet.
- Check the angle of the tapered sides using a bevel protractor and rectify, if necessary.

Fig 1



PATTERN LAYOUT FOR TAPER TRAY

Skill Sequence

Preparing the pattern layout

Objectives: This shall help you to
- **calculate the developed length and width**
- **develop the pattern layout**

Let us take the same job for better illustration.

Calculate the developed length and the width of a rectangular taper tray.

Given

Base length = 300 mm

Base width = 200 mm

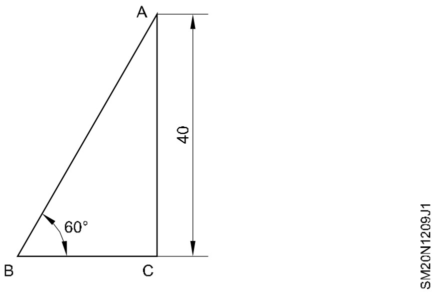
Flange length = 15 mm

Let us take the single hem as 6 mm and calculate the slant height

AB is the slant length.

Given AC = 40 mm (Fig 1)

Fig 1



Sin 60^0 = AC/AB

0.866 = AC/AB

AB = 40/0.866

AB = 46.1 mm

Let us take the slant length as 46 mm

Developed length = Base length + 2 (Slant height + flange length + Single hem allowance)

300 + 2 (46 + 15 + 6) = 300 + (2 x 67)

= 300 + 134

= 434 mm

Developed width = Base Width + 2 (Slant height + Flange length + Single Hem allowance)

= 200 + 2 (46 + 15 + 6)

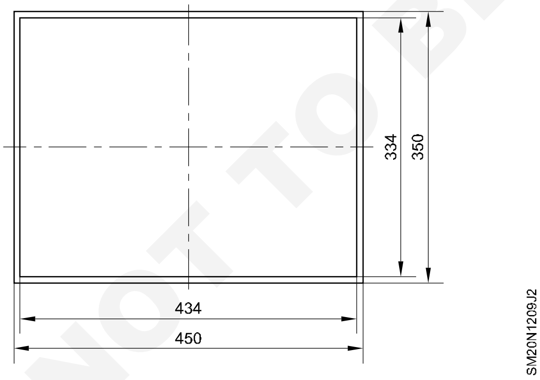
= 200 + 2(67)

= 200+ 134

= 334 mm.

Mark and cut the sheet metal to the size 434 x 334 mm. (Fig 2)

Fig 2



Draw the centre line of length and width XX and YY respectively. (Fig 3)

Draw the base length and width at the centre of the sheet metal workpiece, marking lines at 150 mm on both sides of YY and 100 mm on both sides of XX. (Fig 3)

Draw lines for 46 mm slant height of the four sides of the rectangular taper tray parallel to AB, BC, CD and DA as shown in the Fig 4.

Fig 3

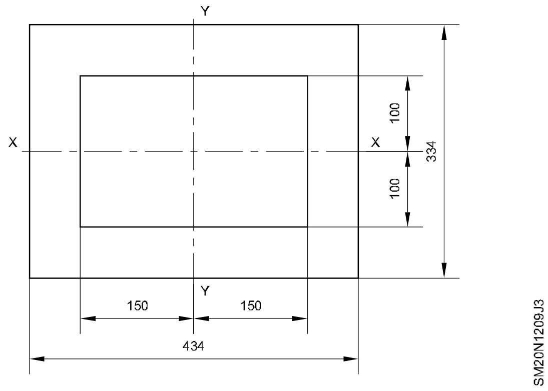
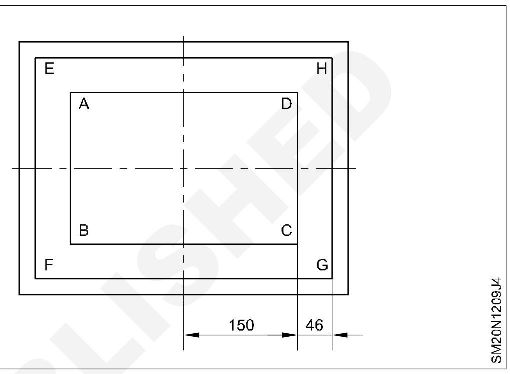
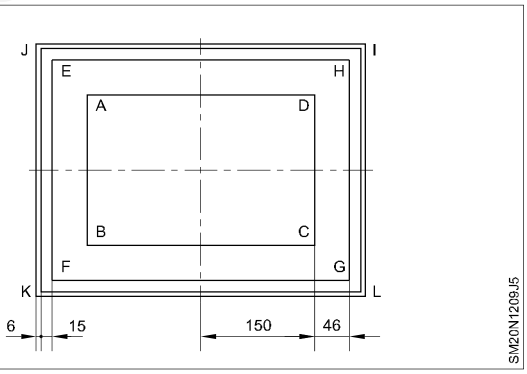


Fig 4



Draw lines for 15 mm flange and 6 mm single hem allowance on the four sides parallel to EF, FG, GH and HE as shown in the Fig 5.

Fig 5

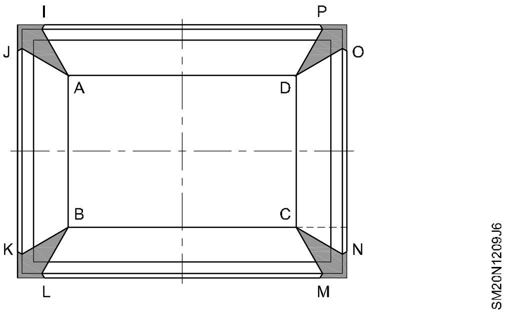


Draw lines at an angle of 30° at points A,B,C,D at both ends of lines AB, BC, CD and DA as shown in Fig 6.

Draw lines at an angle of 60^0 at points I,J,K,L,M,N,O,P as shown in Fig 6.

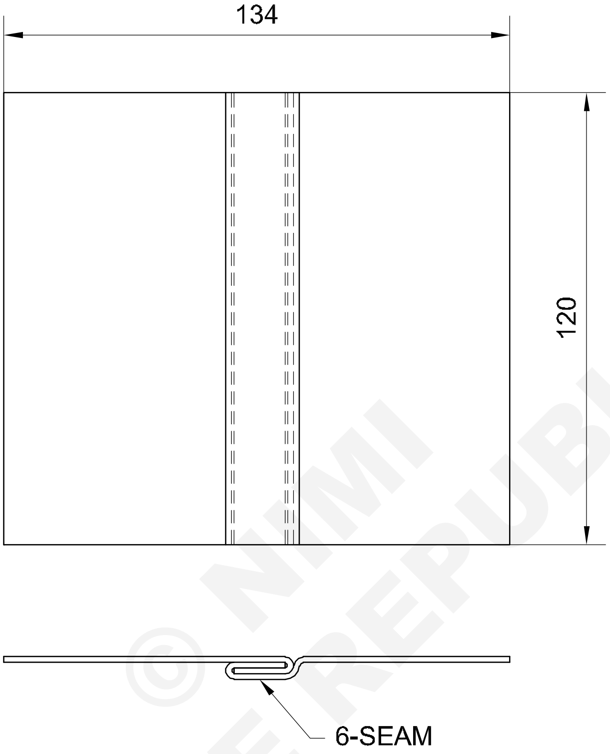
Cut the unwanted portion of the pattern shown by shadow in Fig 6.

Fig 6



Practice on locked grooved joint

Objectives: At the end of this exercise you shall be able to
- **determine and mark the joining drawing allowances for locked grooved joint**
- **make the locked grooved joint using a hand groover.**



Job sequence

Locked grooved joint (seam)

- Mark and cut the raw material into two pieces of size 100 mm x 75 mm each.
- Flatten the workpieces.
- Determine the fold size of the given seam.
- Mark the straight lines for folding on the two sheets using a steel rule and a scriber.
- Fold the two pieces to an acute angle on the marked line using a hatchet stake steel plate and a mallet to form the hooks.
- Make the folded widths flat by filling with a scrap band sheet of approximately 1.5 times thickness of sheet and pressing with a mallet to get the pocket for lock.
- Interlock the folds and press the joint.
- Using a hand groover lock the joint and finish

1	ISSH 125 x 160 x 0.508	--	G.I SHEET	--	--	1.1.10
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	**PRACTICE ON GROOVED LOCKED GROOVED JOINT**	DEVIATIONS ±1	TIME 5h
		CODE NO. SM20N1310E1	

Skill sequence

Marking and Forming

Objectives: At the end of this exercise you shall be able to
- **mark the allowance for double hemming**
- **make double hemming at the edges of a sheet metal using a hatchet stake.**

First determine the fold size for the given width of the seam.

Fold size = Width of the lock - 3 times the material thickness.

New from the fold size determine the total allowance for the locked grooved joint.

Total allowance = (3 x the fold size) + (6 x the thickness of the sheet)

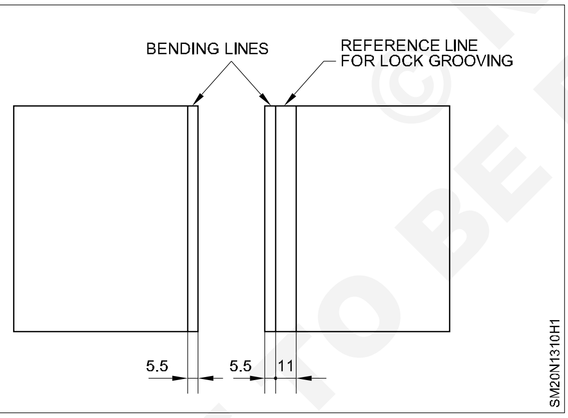
For example, if the width of the lock is 6mm and the thickness is 0.5 mm then, the fold size = 6 - (3 x 0.5) = 4.5mm

The total allowance = (3 x 4.5) + (6 x 0.5) = 13.5+3=16.5mm.

Mark the line at a distance of $1/3^{rd}$ of the total allowance on one sheet and two lines at a distance of $1/3^{rd}$ and $2/3^{rd}$ of the total allowance on another sheet.

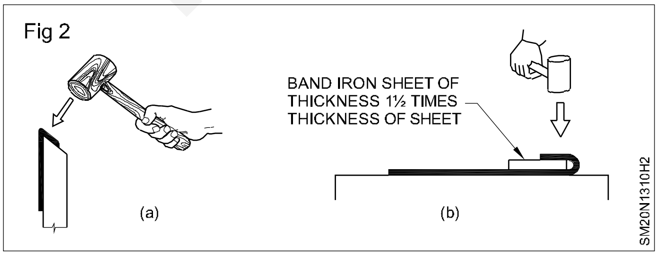
For example, if the total allowance is 16.5 mm then, mark the line at a distance of 5.5mm from the edge on one sheet and two lines at a distance of 5.5mm and 11.00mm from the edge on another sheet (Fig 1)

Fig 1



Fold the workpiece to more than 90^0 on the hatchet stake using a wooden mallet (Fig 2a) and then place the band sheet of 1.5 times the thickness as shown in (Fig 2b) and flatten the edge using the wooden mallet. This looks like a hook.

Fig 2



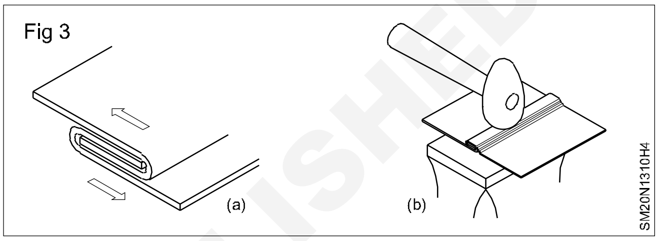
Make a similar hook on the other workpiece also.

Interlock and place the workpiece on the dressing plate. (Fig 3a)

While interlocking, ensure that the interlock is parallel and tight at both ends visually.

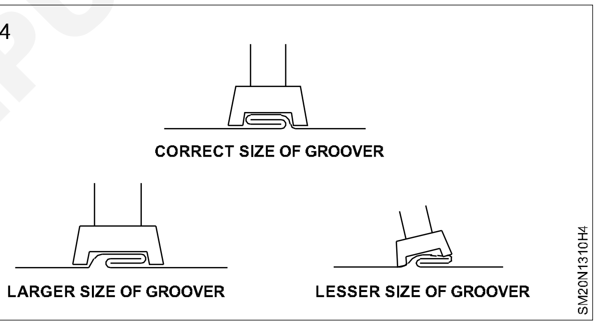
Press the joint to close down using the wooden mallet, to get the grooved joint (seam). (Fig 3b)

Fig 3



Select the hand groover of a given width of the lock (seam). If proper size groover is not used, it may cause improper locking of the grooved joint (Fig 4)

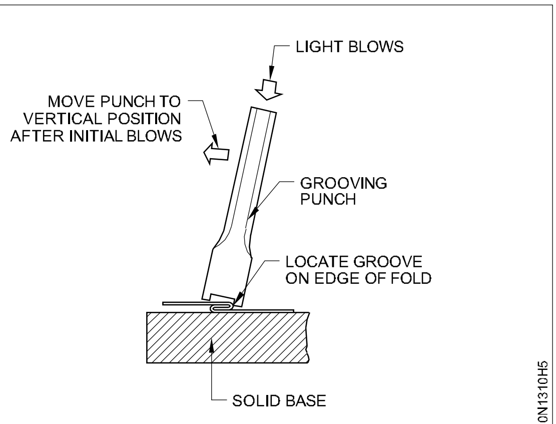
Fig 4



Place the groover over the fold at one end as shown in Fig 5.

Hold the hand groover in one hand and strike the top of the groover with ball pen hammer by the other hand and clinch the groove. Similarly clinch the groove at the other end.

Fig 5

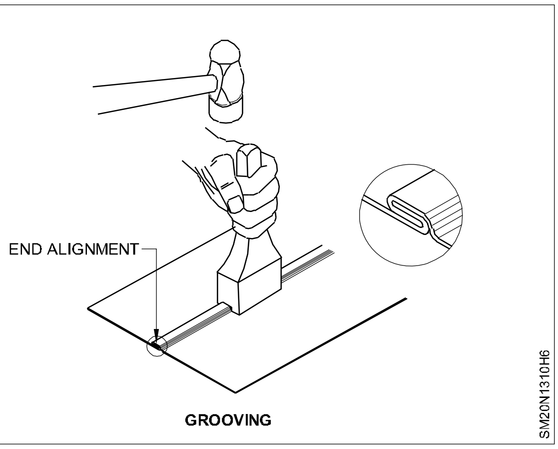


CLINCHING THE GROOVE

Advance this work every 1/3 of the groover length, until the entire groove is clinched down (fig 6)

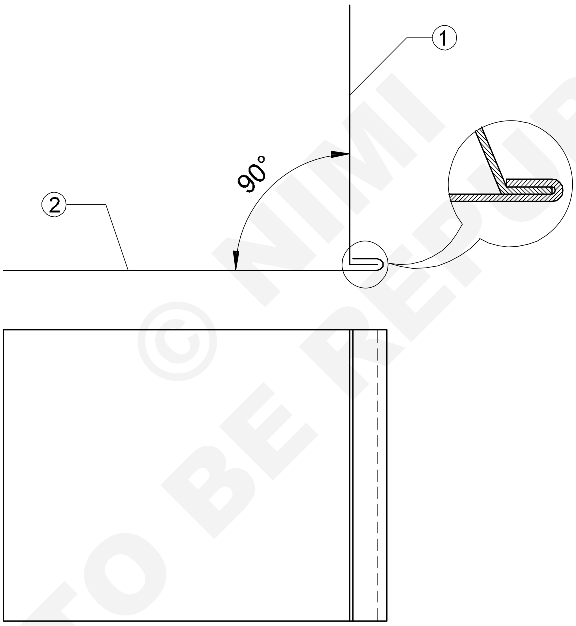
Finish the locked grooved joint (seam) with the hand groover and the hammer.

Fig 6



Practice on pane down seam

Objectives: At the end of this exercise you shall be able to
- **make flange for pane down seam**
- **make singe seam for pane down seam**
- **make pane down seam**



Job sequence.

- Make and cut raw material to size 75 x 75 for -part 1 and Part 2
- Flatten the sheets
- For in flange in part 1 for pane down seam
- For in single seam in part 2 for pane down seam
- Join part 1 and 2 by pane down seam as shown

1	ISSH 75 x 75 x 0.6	--	--	--	2	-
1	ISSH 75 x 75 x 0.6		--		1	1.3.10
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	**PRACTICE ON PANE DOWN SEAM**	DEVIATIONS	TIME 5h
		CODE NO. SM20N1310E2	

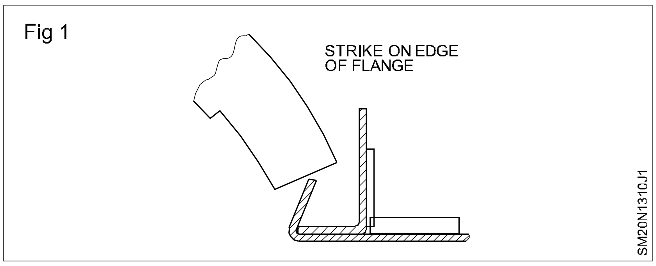
Skill sequence

Practice on pane down seam

Objectives: At the end of this exercise you shall be able to
- **set the parts and finish the pane down seam**

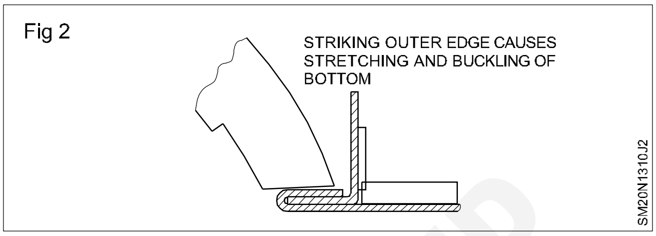
Strike on the edge of the flange

Fig 1



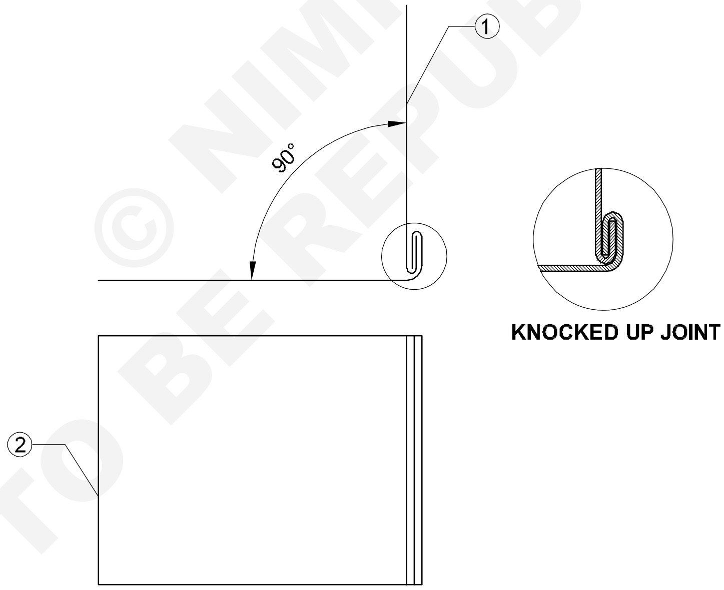
Striking the outder edge causes stretching and bucking of the bootton.

Fig 2



Practice on knocked up seam (Single & Double Seam)

Objectives: At the end of this exercise you shall be able to
- **Make single seam (paned down joint) using hand tools**
- **Make double seam (knocked up joint) using hand tools.**



Job Sequence

- Cut raw material to size 75 x 75 for part 1 & 2
- Flatten sheets
- Form single seam in part 2 for Pane down seam
- Form flange in part 1 for pane down seam
- Joint part 1 & 2 by pane down seam
- Form knocked up seam as shown

1	ISSH 75 x 75 x 0.6		--		2	10
1	ISSH 75 x 75 x 0.6		--		1	10
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS

PRACTICE ON KNOCKED UP SEAM
(SINGLE & DOUBLE SEAM)

PROJECT:

PART: **1.**

DEVIATIONS ±1

TIME 5h

CODE NO. SM20N1310E3

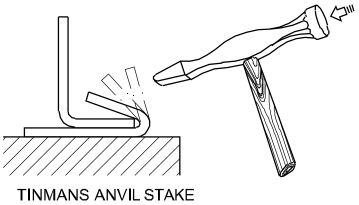
Skill Sequence

Objectives: This shall help you to us

- **Set the part and finish the paned down joint (single seam)**
- **Set the part and finish the knocked by joint (Double seam)**

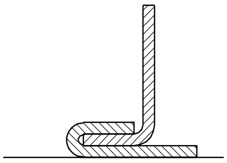
The setting down operation for the single seam (paned down joint) should be carried out stage by stage as shown in (Fig 1)

Fig 1



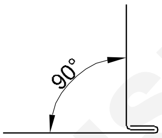
While striking, stretching and buckling of the metal is occured at the bottom edge (Fig 2)

Fig 2



The finished single seam (paned down joint) is shown in (Fig 3)

Fig 3



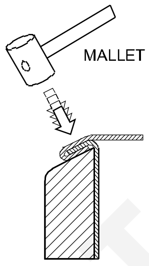
Setting and double seaming

Objectives: This shall help you to us

- **place the joint on halfmoon stake and square stake**
- **finish the knocked upjoint**

For knocked up seam, the paned down joint is turned up. Place the pane down joint on a half moon stake and join by a mallet as shown in Fig 1.

Fig 1



Support the job hand and strike with the mallet all around to an angle as shown in Fig 2.

Increae the angle of the bend gradully, while striking with the mallet all around the seam as shown in Fig 3.

Fig 2

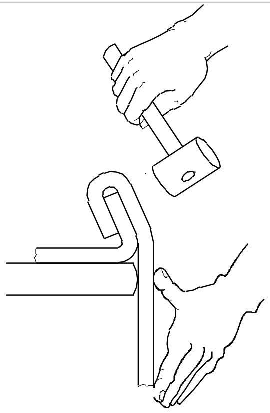
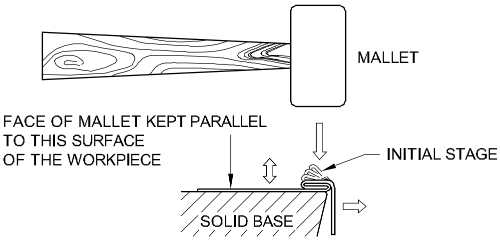
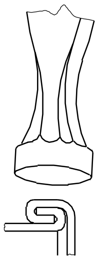


Fig 3



Tighten the double seam (knocked up joint) using the planishing hammer s shown in Fig 4.

Fig 4



Place the edge of the joint on the square stake and lightly dress the bottom with the planishing hammer as shown in Fig 5.

The Finished double seam (knocked up joint) is shown in Fig 6.

Fig 5

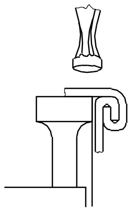
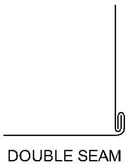
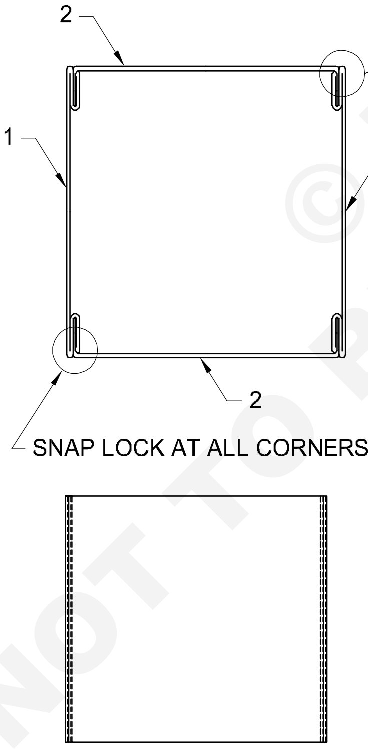


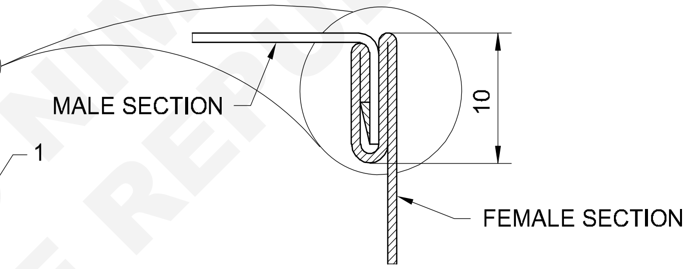
Fig 6



Practice on snap locked seam

Objectives: At the end of this exercise you shall be able to
- **cut sheets as per drawing**
- **For in lock seam**
- **For in snap locked seam**





Job sequence

- cut four pieces to the required sizes
- Layout the pattern for check (2 Nos.) heel and throat of the square elbow, including allowance for snap lock
- Make a square duct with snap lock using portable shear for cutting, slip roll forming machine for rolling bar folder for bending, chisel for wedge shaped projection, dolly copper smith stake and setting hammer for lock seam.
- Check the square duct for size and squareness.

2	ISSH 100 x 50 x 0.6	–	G.I. SHEET	–	2	-
2	ISSH 150 x 50 x 0.6	–	G.I. SHEET	–	1	1.3.10
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PRACTICE ON SNAP LOCKED SEAM	DEVIATIONS ±1	TIME 10h
		CODE NO. SM20N1310E4	

Skill Sequence

Make a square duct elbow with snap lock

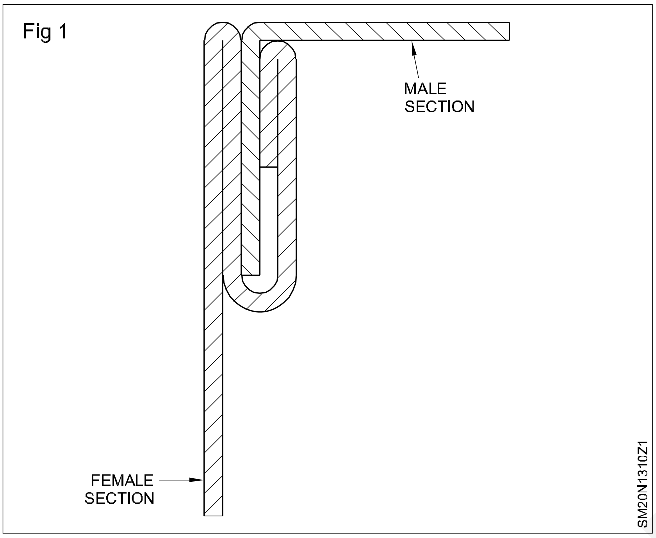
Objectives: This shall help you to

- **make a with snap lock using portable shear, slip roll forming machine, bar folder, copper smith stake, dolly, setting hammer and chisel.**

Fig 1 shows parts of the square duct elbow, wedge shaped projections on check and section of lock seam.

Layout the pattern for check, considering allowance for lock seam (Fig 1)

Fig 1



Layout the pattern for considering allowance for lock seam.

X_1 = allowance for lock seam.

= Width of the lock - 2 x thickness of sheet

(width of the lock = 10 mm, thickness of sheet = 1mm)

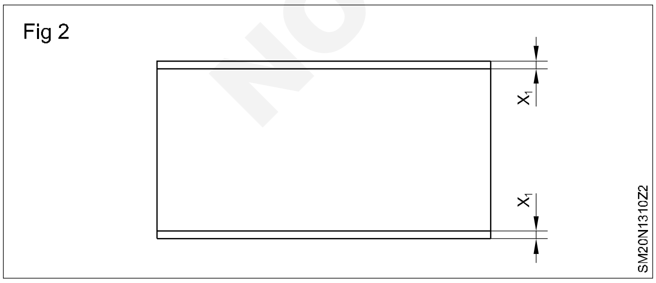
Therefore Allowance X_1 = 10 mm - 2mm = 8mm

The pattern for throat is similar to that of heel except the length. Here the length of the pattern is 267.

First flange the 8mm edges of check (2Nos.) to 90^0 on the burning machine.

For making the edges of heel and throat for lock seam as per section shown in Fig 2 fold the edges to make pocket for lock seam as shown in Fig 3 in sequence on bar folder.

Fig 2



a = w/2-t = 4 mm

b = w = 10mm

c = w + t = 11mm

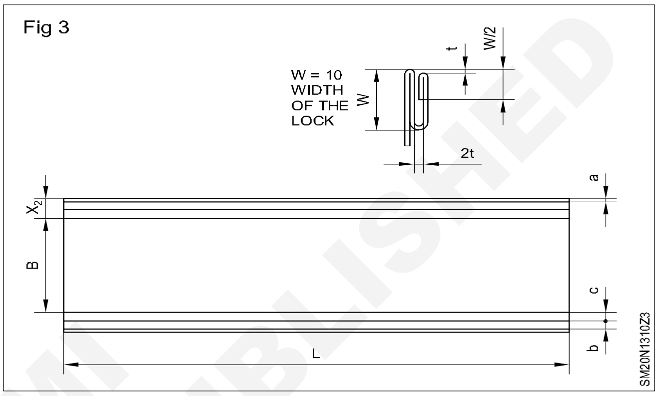
X_2 = a+b+c = 25mm

B = 170- 2t =168mm

L = 1/4 x 2 R= 534mm

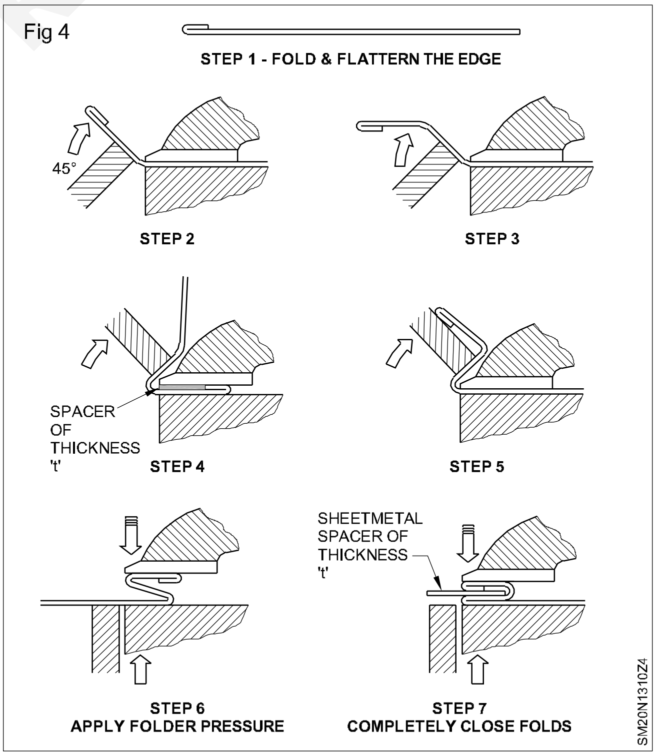
Form the curved shape on the slip roll forming machine using 4mm spacer sheet between two folded edges.

Fig 3



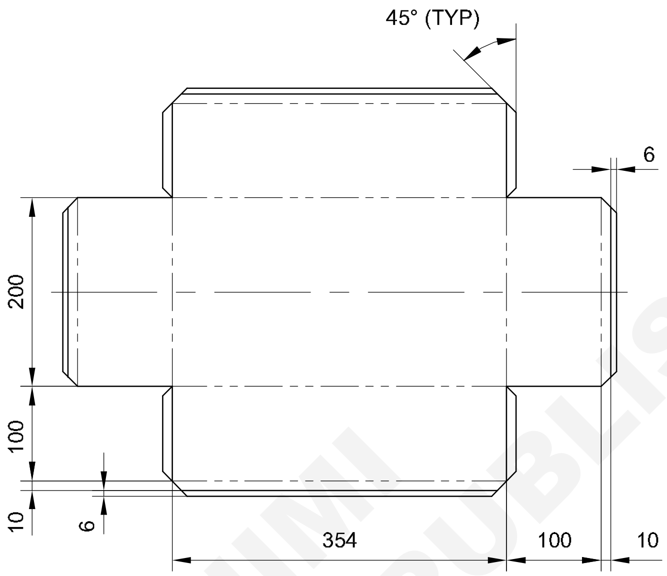
Make wedge shaped cuts like tabs on flanges of both checks approximately at a distance of 40mm. See that the section should lie above half the length of the edge towards the edge using chisel and ball pane hammer. (Fig 4)

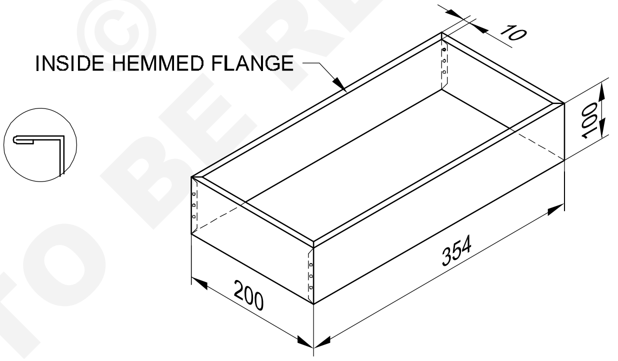
Fig 4



Forming rectangular shape using stake

Objectives: At the end of this exercise you shall be able to
- **develop and layout the pattern for rectangular box by parallel line method.**





Job Sequence

- Check the size of the raw material as per drawing using a steel rule
- Flatten the sheet metal Tinman's anvil using a wooden mallet
- Develop and layout the pattern for rectangular box by parallel line method on sheet metal.
- Cut the sheet metal pattern using a straight ship notch and clip corners

1	ISSH 600 x 450 x 0.61		G.I SHEET			1.3.11
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:8	FORMING RECTANGULAR SHAPE USING STAKE	DEVIATIONS ±2	TIME 10h
		CODE NO. SM20N1311E1	

Skill sequence

Developing and cutting

Objectives: This shall help you to
- **calculate the developed length and width.**

Calculate developed length and width of a rectangular box.

Developed length = Base length + 2 (Side height + flange length + Single hem allowance)

354 + 2 (100+10+6) = 586 mm.

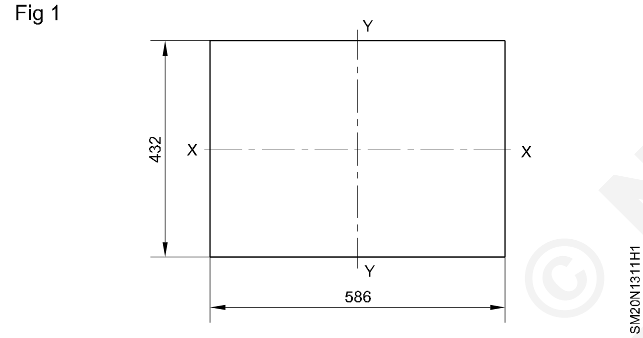
Developed width = Base width + 2 (Side height + flange length + single hem allowance)

= 200 + 2 (100+10+6) = 432 mm

Mark and cut the sheet metal workpiece to the size of 586 x 432 mm maintaining squareness.

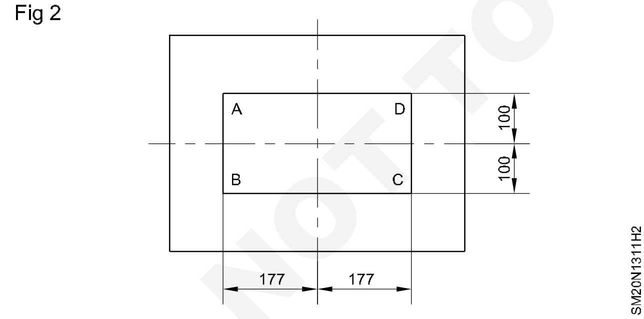
Draw the centre lines of the length and width XX and YY. (Fig 1)

Fig 1



Draw the base length and width at the centre of the workpiece. Mark lines at 177 mm on both sides of YY and 100 mm on both sides of XX. (Fig 2)

Fig 2



Draw lines for 100 mm height of the four sides of the rectangular box parallel to AB, BC, CD and DA as shown in the Fig 3.

Draw lines for 10 mm flange and 6 mm single hemming allowance on the four sides parallel to FG, HI, JK and LE as shown in Fig 4.

Fig 3

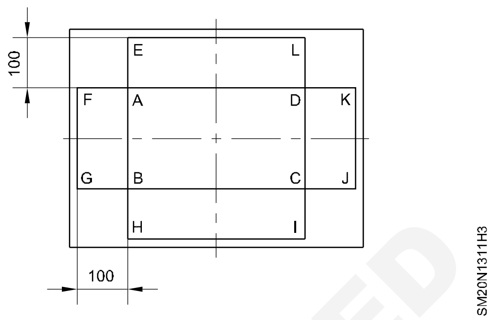
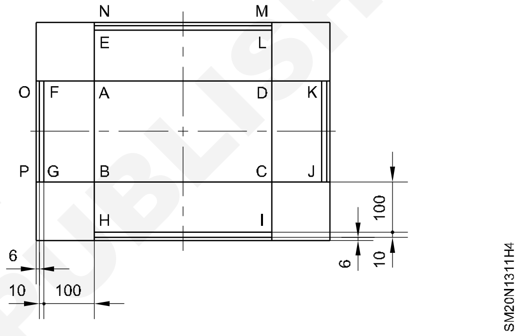


Fig 4



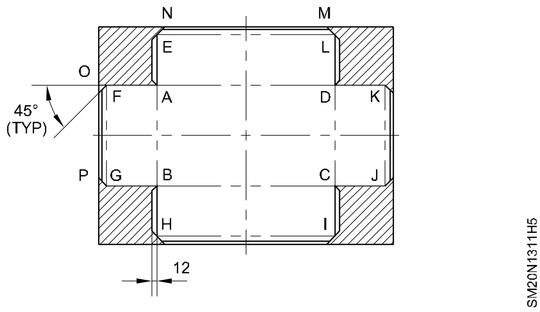
Draw lines for 12 mm lap for the rivetted joint at the corners of the rectangular box parallel to BH, CI, DL and AE as shown in Fig 5.

Draw lines for 45^0 slant notches at points H,I,J,K,L,E,F and G, A,B,C and D. (Fig 5)

Cut the unwanted area shown in shadow using a straight snip. (Fig 5)

Deburr the edges of the sheet metal pattern using a smooth flat file.

Fig 5



Capital Goods & Manufacturing **Exercise 1.3.12**
Sheet Metal Worker- Folding & Locking

Forming cylindrical job using various stakes

Objectives: At the end of this exercise you shall be able to
- **locked grooved joint use to hand tools.**
- **job edes pending of hemming.**

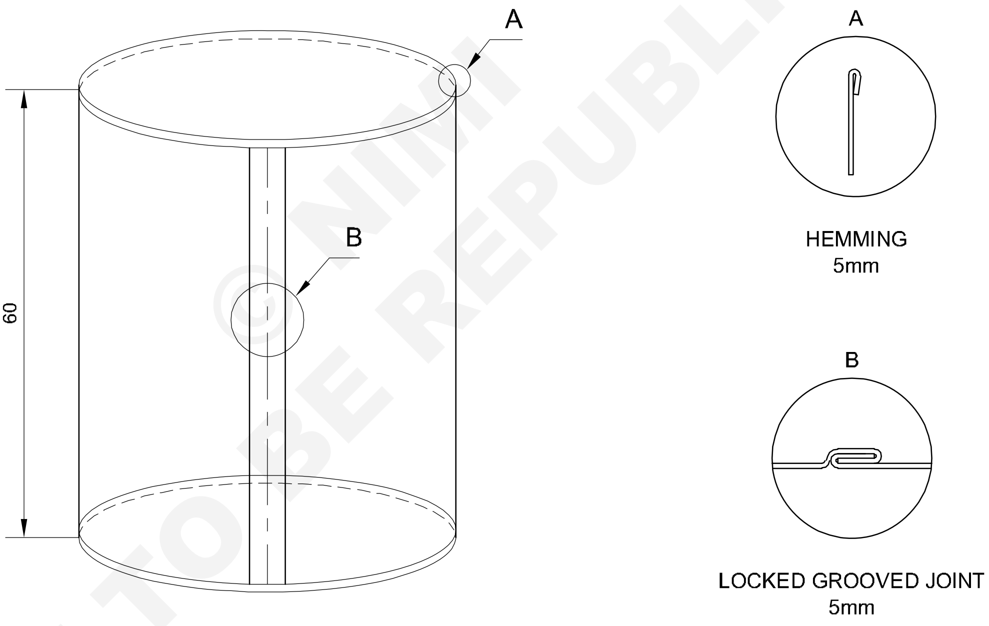
REQUIREMENTS

Tools/Instruments

- Steel rule, Try square
- Scriber, Millet
- Snips straight
- Grammar
- Hammer
- Hatchet state
- Tinman's state

Equipments/Materials

- Rooling machine
- G.I sheet 24 SWG. 8' x 4'



1	ISSH 350 x 125 x 0.6		G.I SHEET	1	2	1.3.12
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	**FORMING CYLINDRICAL JOB USING VARIOUS STAKES**	DEVIATIONS ±1	TIME
		CODE NO. SM20N1312E1	

JOB SEQUENCE

- Forming cylindrical job using various states
- Check the pattern for its correctness
- Ensure the correct size of the material
- Make single hemming an of the cylinder using a hatchet stake and Tinman's anvil
- Dress the cylinder to regular round shape using a round mandrel stake and a mallet.

Skill Sequence

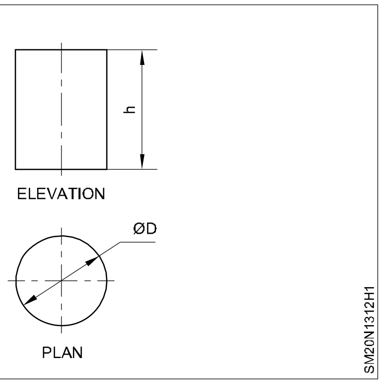
Parallel line development

Objectives: This shall help you to

- **develop and layout a pattern for a cylinder by parallel line development method .**

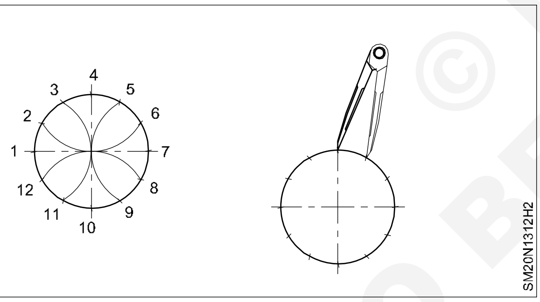
Draw the front elevation and the plan of the cylinder on a paper. (Fig 1)

Fig 1



Divide the periphery of the circle into 12 equal parts and check each division. (Fig 2)

Fig 2

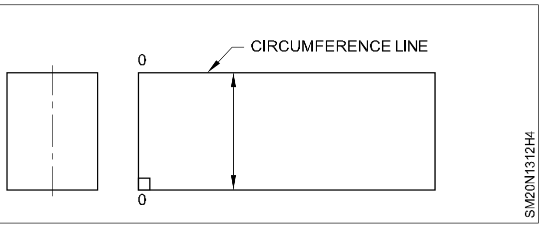


Extend the lines to a length slightly more than the circumference of the circle (pd) plus the allowances for the locked grooved joint. (Fig 3)

Fig 3

Draw a line 00' perpendicular to the parallel line through the left end. (Fig 4)

Fig 4

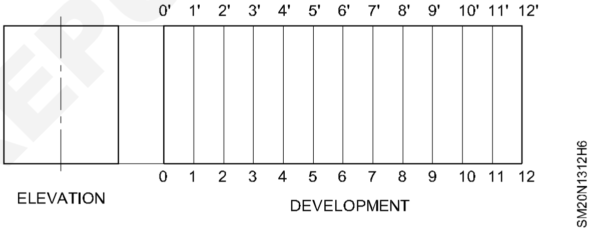


Transfer equal distances 0,1,2,3,4 upto 12 of the plan on the circumferential line without disturbing the equal lengths with compass. (Fig 5)

Fig 5

Draw a perpendicular at the end of the twelth point of layout to the base line. (Fig 6)

Fig 6

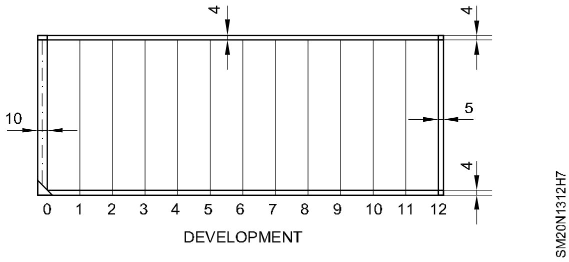


Draw parallel lines to line 00' at points 1,2,3,4 upto 12. (Fig 6)

Mark the lines at 4 mm distance on the top and bottom of the pattern for hemming at the top edge and joining at the bottom edge. (Fig 7)

Draw the lines parallel to 00' and 12 12' at a distance of 4 mm and 8 mm on both sides respectively for seaming. (Fig 7) Now the pattern is completed.

Fig 7



Forming cylindrical shape by hand process

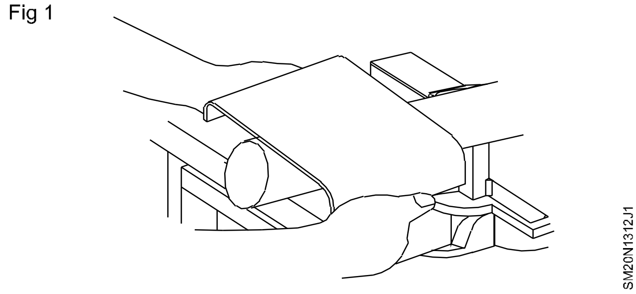
Objectives: This shall help you to
- **form a plain sheet to a cylindrical shape by hand process.**

Ensure for the correct size and shape of the pattern. (Workpiece)

Fix the mandrel stake on to the bench plate.

Set and bend the workpiece ends parallel to the axial line of the mandrel. (Fig 1)

Fig 1



Gradually rotate and form the entire workpiece to cylindrical shape by hand. (Fig 2 & 2A)

Check the formed cylinder for the roundness of the external diameter using an external gauge. See Fig 2 of skill sequence of checking the roundness.

Set the workpiece parallel to the axial line of the stake. If not the edges will not match with each other as shown in Fig 3.

Fig 2

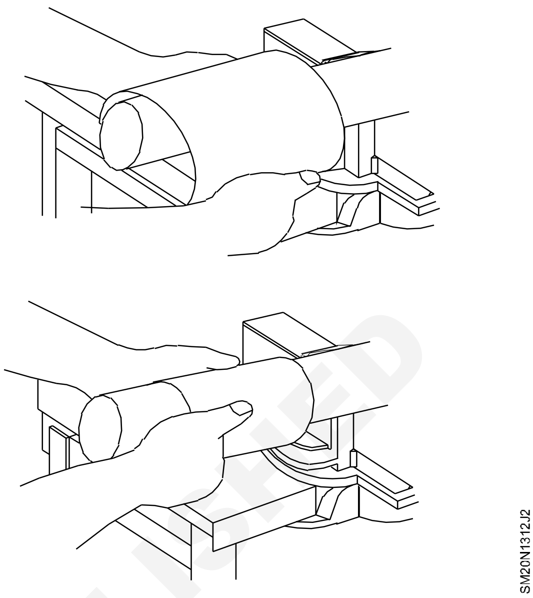
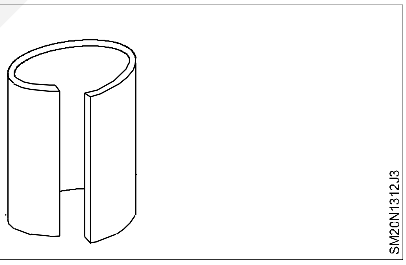


Fig 3



Making lock grooved joint on a cylinder by hand process

Objective: This shall help you to
- **make a locked grooved joint on a cylindrical object using hand groover.**

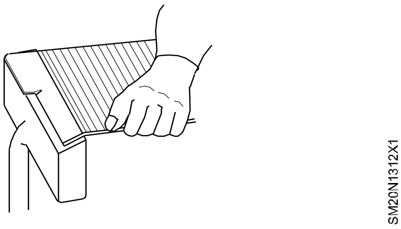
Ensure for correct marking on the pattern, for allowances for making the locked grooved joint.

Fix the hatchet stake in the vice or the bench plate.

Place and set the bending line along the bevelled edge of the hatchet stake. (Fig 1)

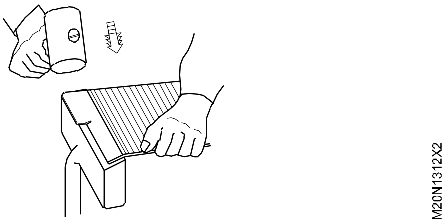
Set the bending line correctly on the bevelled edge of the hatchet stake, to avoid unequal folding.

Fig 1



Form the hooks at both ends in opposite direction using a hatchet stake and a mallet. (Refer Skill sequence Ex.No.12) (Fig 2)

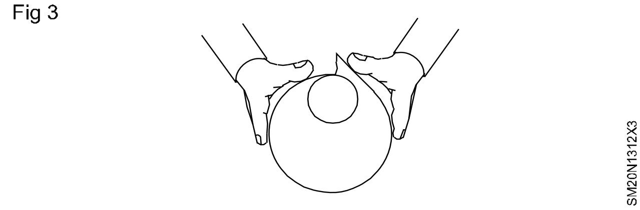
Fig 2



Form the sheet to cylindrical shape using a round mandrel stake. (Refer previous skill sequence).

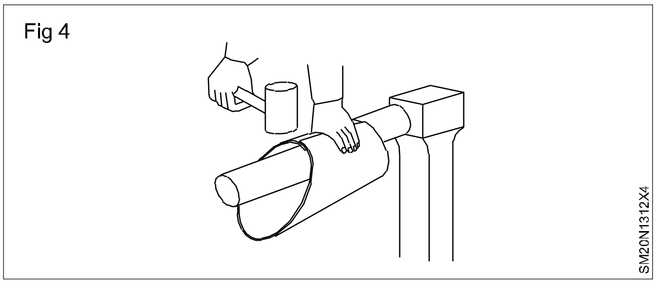
Interlock the hooks at the ends as shown in Fig 3.

Fig 3



Close down the hooks by light blows using a mallet. This is the grooved seam. (Fig 4)

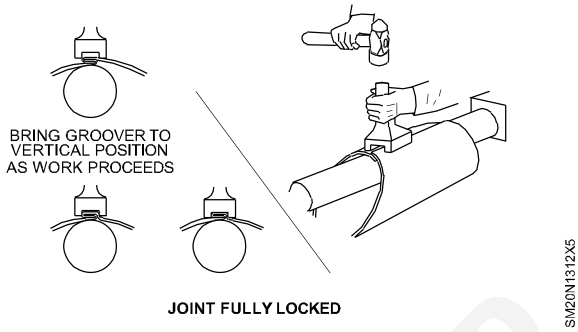
Fig 4



Lock the grooved seam with a hand groover and a hammer as shown in Fig 5.

Dress the formed cylinder to a regular round shape using a round mandrel stake and a wooden mallet.

Fig 5



Make a single hemming on a curved edge

Objectives: This shall help you to

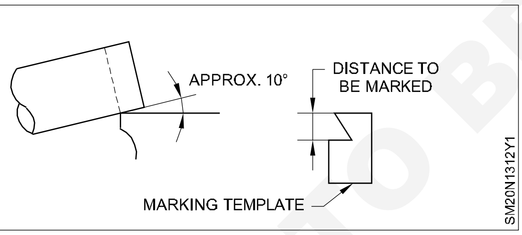
- **make a single hemming on a curved edge using anvil stake and setting hammer.**

Mark the hemming allowance on the formed body using a marking template.

Fix the anvil stake on to the vice or bench plate.

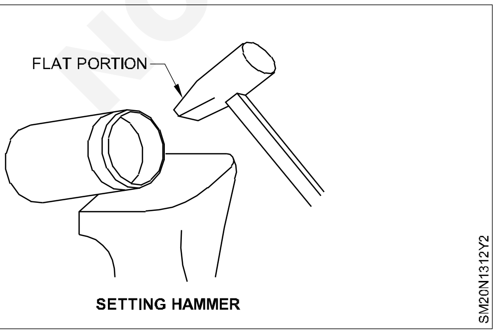
Hold the workpiece such that the marked line coincides with the edge of the stake approximately inclined an angle of 10^0 as shown in Fig 1.

Fig 1



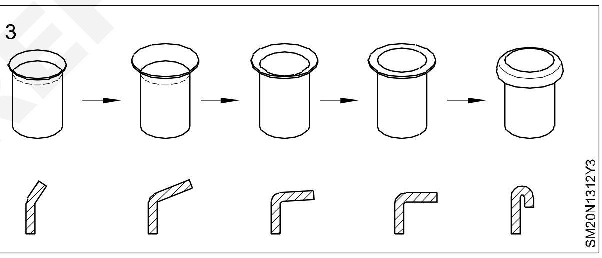
Strike and rotate the workpiece gradually along the marked line to form a small flange using a setting hammer. (Fig 2)

Fig 2



Gradually increase the angle of inclination while forming the flange as shown in Fig 3.

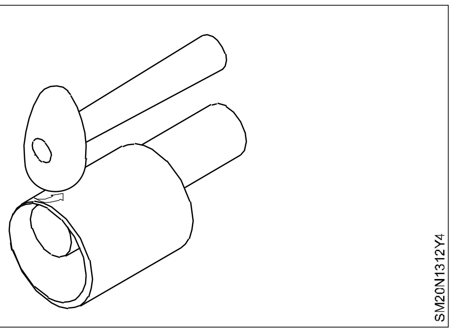
Fig 3



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



Checking the roundness of a cylindrical body internally and externally

Objectives: This shall help you to

- **check the roundness of a cylindrical body internally and externally using gauges.**

Checking the roundness of a cylindrical body internally

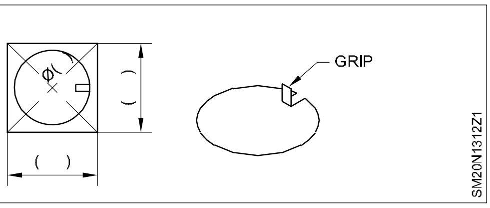
Scribe the circle having the inner diameter of the cylinder to be checked using a divider.

Cut the workpiece by straight snips 300 mm.

Finish the gauge profile it with a smooth file.

Cut two slots and bend it at 90^0 as shown in Fig 1. Use this as a grip for holding while checking.

Fig 1



Use this as a gauge for checking the roundness of the inside diameter of a cylinder.

Place the cylinder on the surface plate vertically.

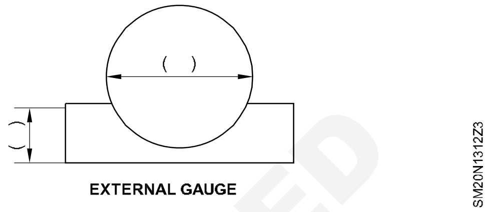
Now insert the gauge by holding the grip and check the roundness of the inside diameter of the cylinder.

If any ovality is observed, rectify it with the round mandrel stake using a mallet.

Checking the roundness of the cylindrical body externally

Scribe the circle having the external diameter of the cylinder to be checked using a divider. Cut the gauge using bent snips. (Fig 2)

Fig 2



Finish the gauge profile with half round smooth file 200 mm.

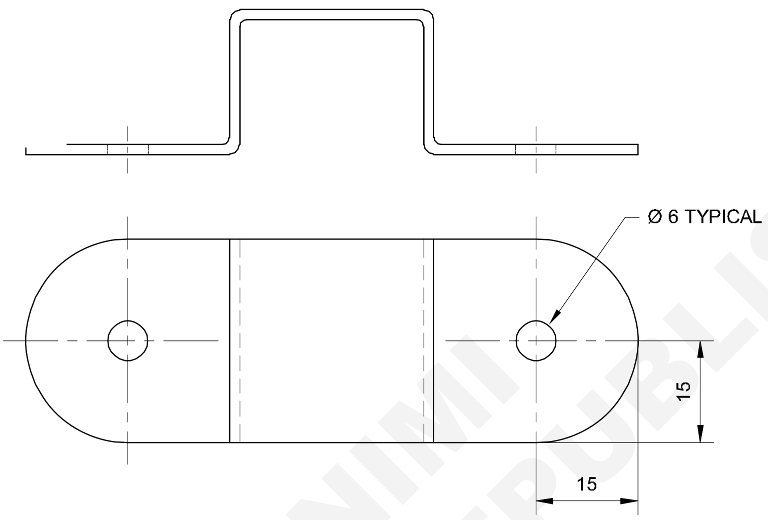
Place the cylinder to be checked horizontally on the plain surface or if the size of the cylinder is smaller, hold it in one hand horizontally.Place the gauge vertically on the outside diameter of the cylinder. Check visually whether it is touching the completed circumference.

If not, rectify the roundness on the round mandrel stake using a wooden mallet.

Folding and bending sheet metal to 90 degree use of 'C' clamp

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

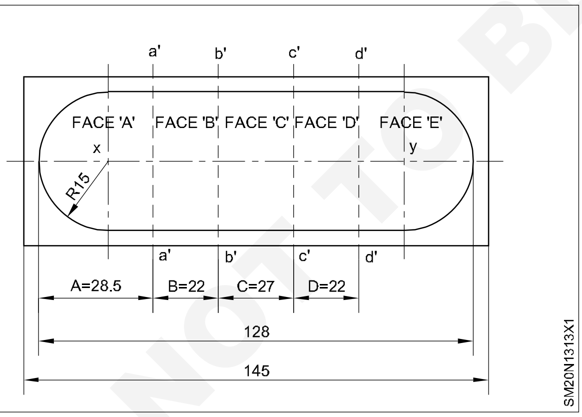
- **check the flatness of the sheet metal workpiece using a trysquare**
- **mark profile as per job drawing**
- **fold the sheet metal at right angle using a folding bar**
- **fold the sheet metal at right angle using an angle iron**
- **check the perpendicularity using try square.**

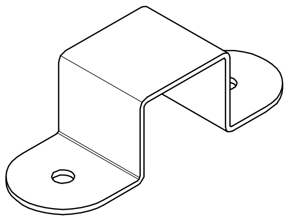


Job Sequence

- Check the size of the raw material using a steel rule.
- File the burrs on the cut edges of the sheet metal workpiece by a flat file smooth 250 mm.
- Flatten the job material on a Tinman's anvil using a wooden mallet ϕ75.
- Check the flatness of the job material by a trysquare (Fig 1 in skill sequence).
- Mark straight lines with a scriber using a steel rule.
- Mark bend lines a'a', b'b', c'c', d'd' on both sides of the workpiece, reducing for face A and E one time thickness of sheet and face B, C and D 2 time thickness of sheet from the clamp dimensions as shown in Fig 1.

Fig 1





1	ISSH 145 x 40 x 0.6		–			1.3.13
NO.OFF	STOCK SIZE	SEMI-F		PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**FOLDING AND BENDING SHEET METAL TO 90 DEGREE USE OF 'C' CLAMP**	DEVIATIONS ±1	TIME 10h
		CODE NO. SM201313E1	

- Mark points ‘X’ and ‘Y’ and indent with center punch and ball peen hammer. Mark curved lines using wing divider. (Fig 1)
- Cut along straight and curved lines by straight snips.
- File the burrs on the cut edges of the job by flat file smooth 250 mm.
- Clamp the face B of the job the folding line just above 1/2 time thickness of sheet in folding bars, hold in benchvice and fold the face A at right angles using the wooden mallet ø 75. (Fig 2&3)

Fig 2

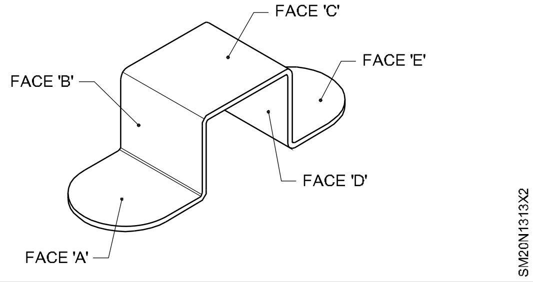
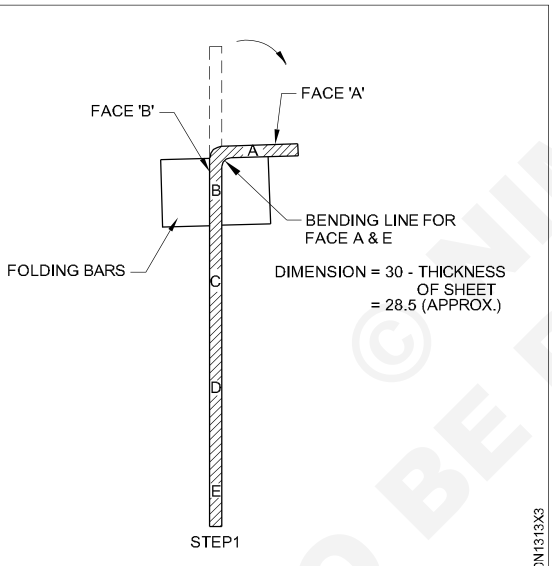


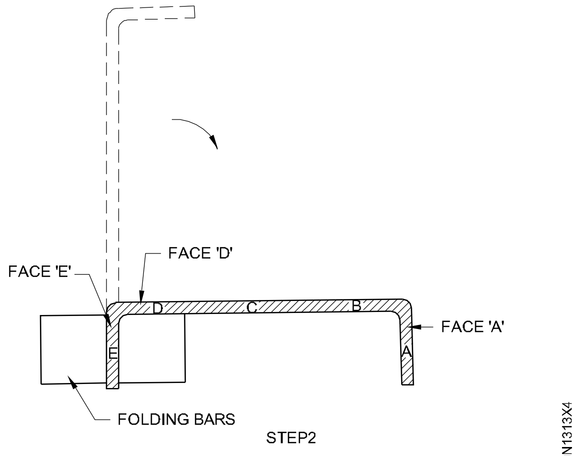
Fig 3



FOLDING FACE 'A' USING FOLDING BARS

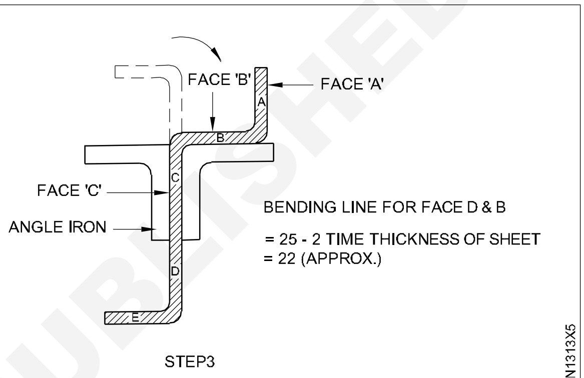
- Remove the job, by loosening the jaws of the vice. Similarly, clamp face D of the job in folding bars held in benchvice and fold face E at right angle using the wooden mallet ø 75. (Fig 4)
- Remove the job, by loosening the jaws of the vice.
- Clamp face C of the job in a pair of angle irons, held in benchvice and fold face B at right angle using the wooden mallet ø 75. (Fig 5)
- Remove the job, by loosening the jaws of the benchvice.
- Similarly, clamp face ‘C’ of the job in angle irons held in benchvice and fold face D at right angle using the wooden mallet ø 75. (Fig 6)

Fig 4



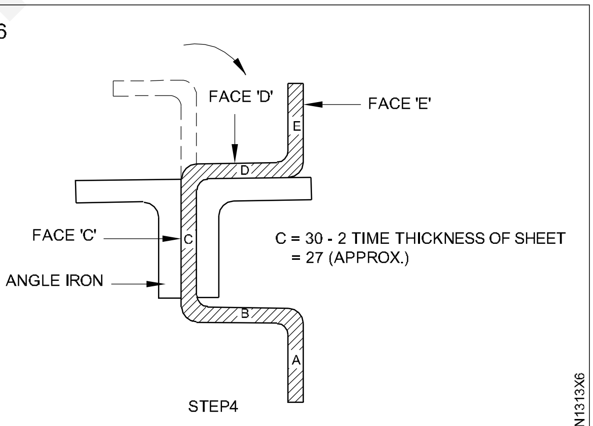
FOLDING FACE 'D' USING FOLDING BARS

Fig 5



FOLDING FACE 'B' USING ANGLE IRONS

Fig 6



FOLDING FACE 'D' USING ANGLE IRONS

- Check the perpendicularity of all the bends using a trysquare. (Fig 1 in Skill sequence - checking perpendicularity)
- Rectify the perpendicularity, using a wooden mallet and a suitable wooden support, if folds are not perpendicular.

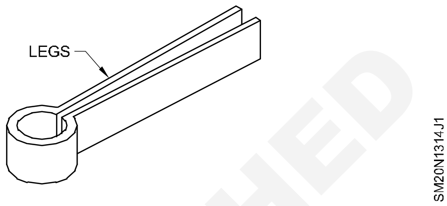
Make hairpin folder using a radius wooden blocks.

Objectives: At the end of this exercise you shall be able to
- **set the bar folder folding beam angle gauge (stopper) with spring back allowance**
- **set and clamp the workpiece on the bed with the clamping beam of the bar folder**
- **fold the workpiece at right angle with the folding beam of a bar folder**
- **remove the workpiece from a bar folder and check the angle of bend.**

Job Sequence

- Mark the job material with a scriber using a steel square. (Fig 1)
- Set the bar folder folding beam angle gauge (stopper) with spring back allowance.
- using a wooden metal suporting the job
- Check the perpendicularity of the job by a trysquare.

Fig 1



Skill sequence

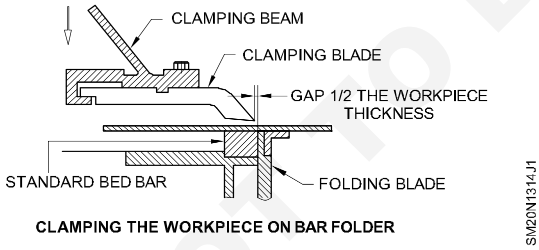
Setting & folding make a hairpin folder

Objectives: This shall help you to
- **clamp and fold the workpiece on the bed**
- **check the angle of fold.**

Bar folder is a hand operated machine used for folding sheet metal to different angles with spring beak allowance

- Set the angle of fold with spring back allowance on bar folder.
- Place the workpiece on the bed of the machine.
- Set the marked bending line forward by about half of the workpiece thickness from the front edge of the clamping blade fixed on the clamping beam. (Fig 1)

Fig 1



CLAMPING THE WORKPIECE ON BAR FOLDER

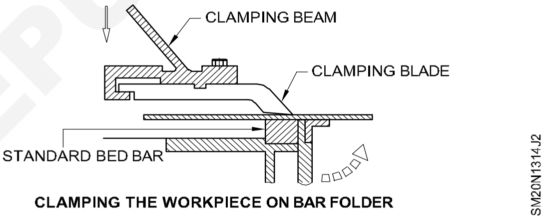
Ensure that the marked line is set correctly at both ends of the workpiece.

- Clamp the workpiece between the clamping blade fixed on the clamping beam and the bed, moving the clamping beam downwards by turning the beam operating lever downwards. (Fig 2)

While clamping, keep your fingers or part of your body, away from the bed.

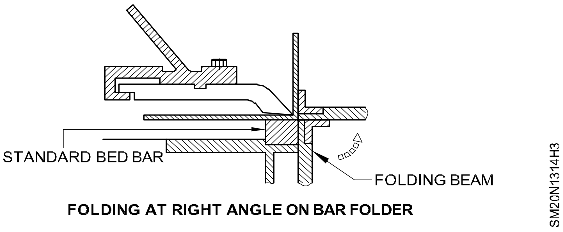
- Fold the workpiece by the folding blade, which is fixed on the folding beam, gradually by the moving folding beam upwards, with the folding handle. (Fig 3)

Fig 2



CLAMPING THE WORKPIECE ON BAR FOLDER

Fig 3



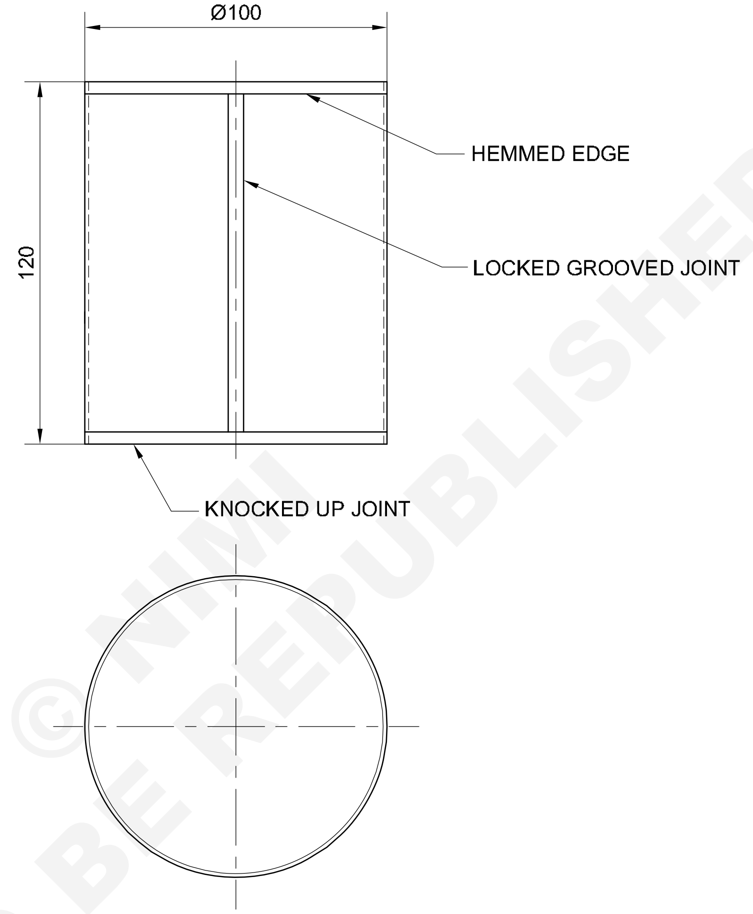
FOLDING AT RIGHT ANGLE ON BAR FOLDER

Turn the folding beam slightly more than 90° to compensate for the spring back action of the sheet metal. For soft steel, brass, aluminium or Copper Spring back 0 to 1^0, for 1/4 hard 1/2 hard materials 1 to 5^0, for hard material 12 to 15^0 or more. These values are approximate and the correct values can be found out only by experiment.

- Bring back the folding beam to its original position with the help of the folding handle.
- Take the clamping beam to its original position with the help of the beam operating lever and remove the workpiece from the bed of the bar folder.
- Check the angle of fold with a protractor. If the angle is not attained, adjust the bar folder angle adjustment and repeat the operation.

Making a clinder container

Objectives: At the end of this exercise you shall be able to
- **make a patter development**
- **make double seam (knocked up joint) using hand tools.**



BOTTOM FIXING WITH BODY BY KNOCKED UP JOINT.

Job Sequence

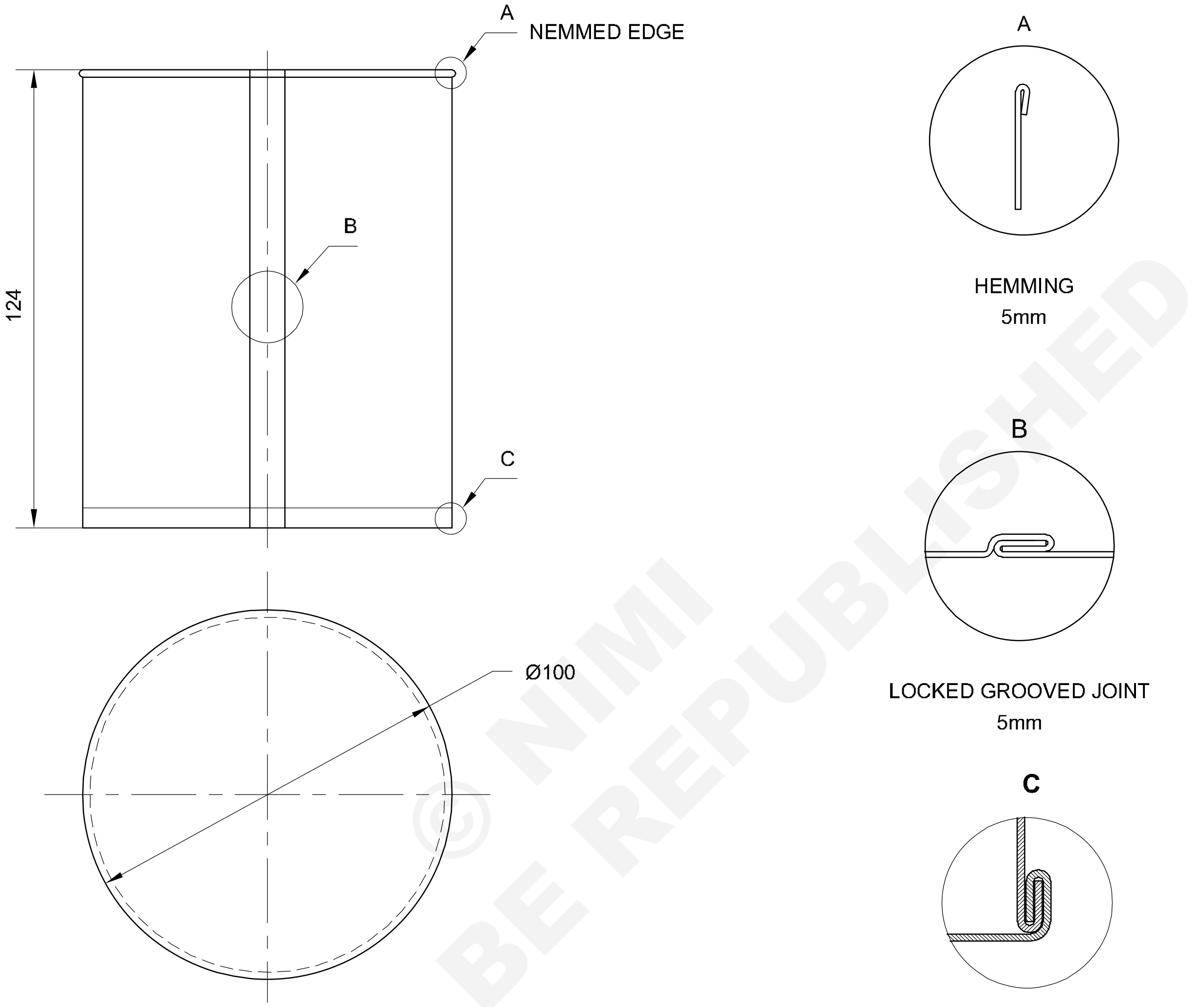
- Check the dia of the base of the cylinder and the dia of the turned disc by using a steel rule as per drawing.
- Make single seam (Paned down joint) by placing the cylindrical body over the bottom disc, using a levelling plate, a square edge a stake, a setting hammer and a wooden mallet.
- Make double seam (knocked up joint) using a square edge stake, a setting hammer and a wooden mallet.

NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
1	--	BS-2-43 BS-2-20	--	4	2	15
1	--	BS-2-43 BS-2-17	--	4	1	15

SCALE 1:2	**SINGLE SEAM AND DOUBLE SEAM (KNOCKED UP JOINT) BY HAND PROCESS**	DEVIATIONS ±1	TIME 3h
	PROJECT: MUG PART: **1. BODY 2. BASE**	CODE NO. SM20N1315E1	

Planishing the turned edge of the circular disk by hand process

Objective: This shall help you to
- **make single seam (paned down joint) using hand tools**
- **make double seam (paned down joint) using hand tools.**



Job sequence

- Develop and layout the pattern for the cylinder (Fig 1) with all allowances for joining and hemming on plain paper by parallel line method.
- Check the pattern for its correctness.
- Ensure the correct size of the material.
- Cut the pattern and paste it on the given sheet metal with gum.
- Cut the pattern with notches using 12" straight snips.
- Deburr the edges using a smooth flat file 150 mm long.

1	ISSH 350 x 125 x 0.6		G.I SHEET	1	2	1.3.15
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2

FORM THE CYLINDRICAL SHAPE AND LOCK GROOVED JOINT FOR THE BODY

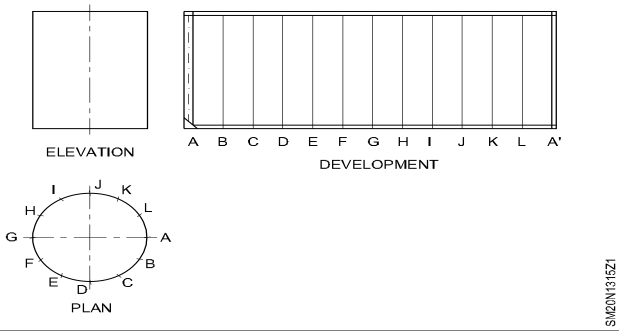
PART: **1.BODY**

DEVIATIONS ±1

TIME

CODE NO. SM20N1315E2

Fig 1



- Fold the edges of the sheet metal pattern using a hatchet stake and a mallet in the form of hooks for making the lock grooved joint. (Fig 2) (Ref. Skill Sequence)

Fig 2

- Form the sheet metal pattern to cylindrical shape using a round mandrel stake and a mallet. (Fig 3) (Ref. Skill Sequence)
- Hook the folded edges and make the lock grooved joint using a hand groover. (Fig 4) (Ref. Skill Sequence)

Fig 3

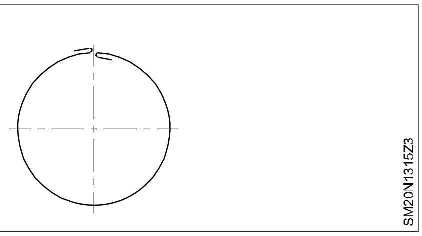
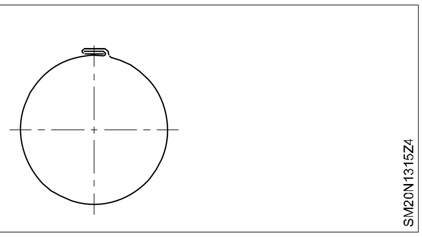
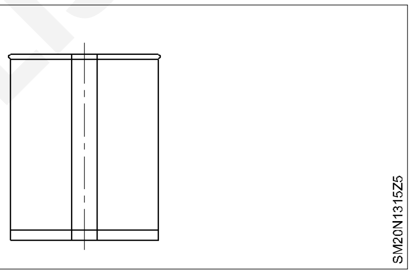


Fig 4



- Make single hemming on one end of the cylinder using a hatchet stake and Tinman's anvil. (Ref. Skill Sequence)
- Dress the cylinder to regular round shape using a round mandrel stake and a mallet. (Fig 5)
- Check the roundness of the inside diameter of the cylinder using a gauge.

Fig 5



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Job sequence

- Level the workpiece by using a Tinman's anvil and a mallet.
- Check the dia of the workpiece as per drawing.
- Turn the edge of the circular disc to 90° by using a setting hammer, a wooden mallet and a half moon stake.
- Planish the turned edge of a circular disc using square edge stake.

Skill Sequence

Turn the edge of the circular disc to 90° by hand process

Objectives: This shall help you to

- **turn the edge of the circular disc to 90^0 using a half moon stake**
- **turn the edge of the circular disc to 90° using a half moon stake, a round steel bar, a wooden mallet and a setting hammer**
- **planish the turned edge of the circular disc using a planishing hammer, a square edge stake and a tinman's anvil stake.**

Clean the surface of the half moon stake and the circular steel bar.

Flatten the circular disc using a wooden mallet and a tinman's anvil stake.

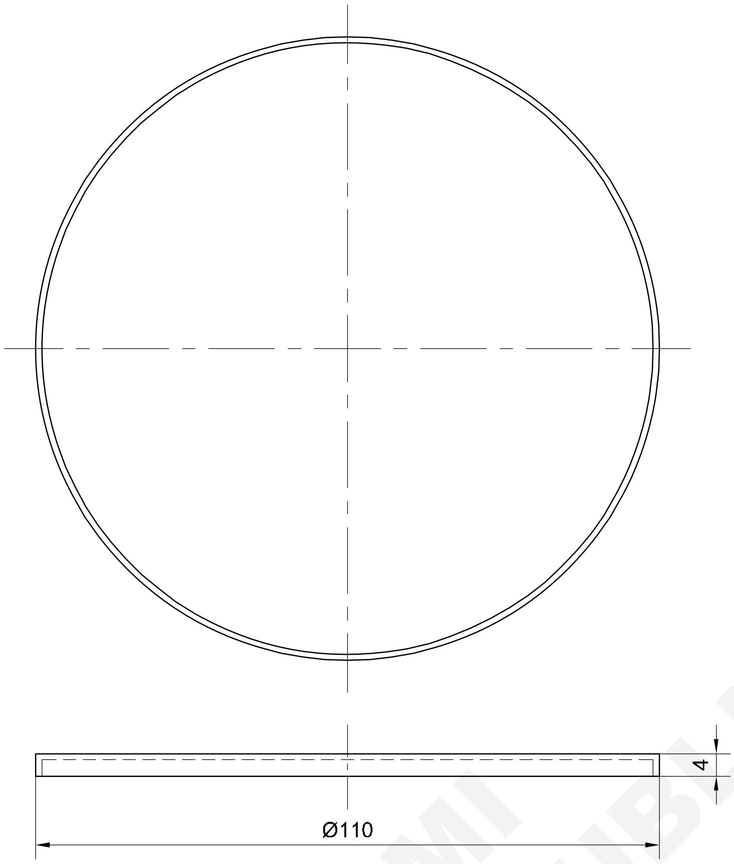
Check the flatness on the surface plate.

Check the size of the workpiece using a steel rule.

Mark the allowance of turning on the edge of circular disc.

Hold the half moon stake in a bench vice as shown in Fig 1.

Hold the workpiece by one hand in flat position and rest the blank guide line on the half moon stake edge as shown in (Fig 2).



1	--		--	1	1	1.3.15
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**CIRCULAR DISC TURNING**	DEVIATIONS ±1	TIME
		CODE NO. SM20N1315E3	

Fig 1

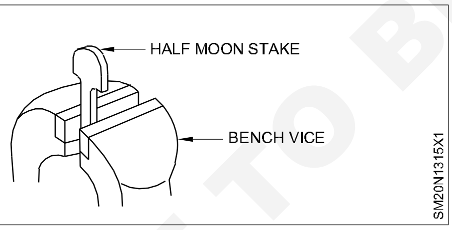
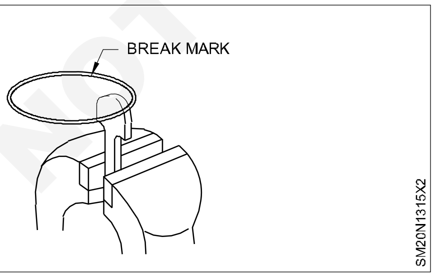


Fig 2



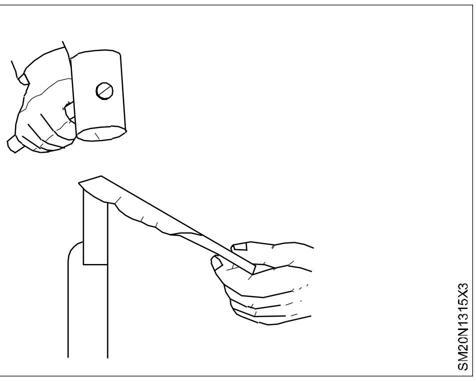
It is difficult to align the working point in the line of the stake with the guide line. In order to position the guideline on the working point strike with the mallet. Observe the location of the first impression.

If the impression is on the guide line, continue the process. Otherwise readjust the workpiece according to the position mark with respect to the guide line.

Strike the edge with the mallet to form the first break mark as shown in Fig 3.

Turn the disc slowly in one direction and strike on the edge to continue to make the break mark on guide line. This is the first stage of turning.

Fig 3



Continue the turning process in four stages as shown in Fig 4.

After the completion of the first break mark, lower the angle of the disc by hand and repeat striking and turning the disc closer to 90°. (Fig 5)

Fig 4

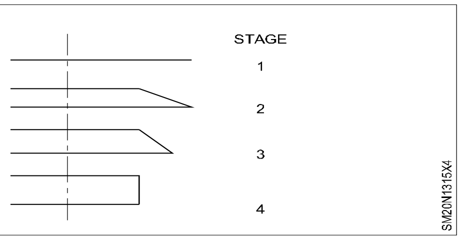
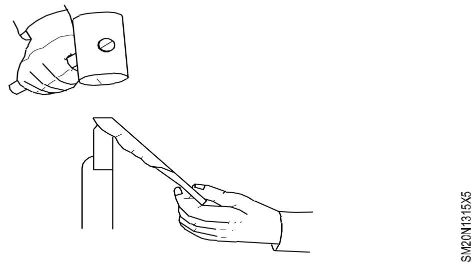
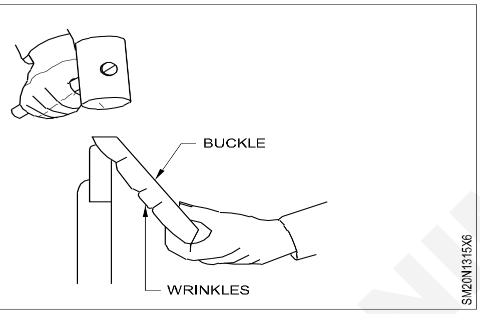


Fig 5



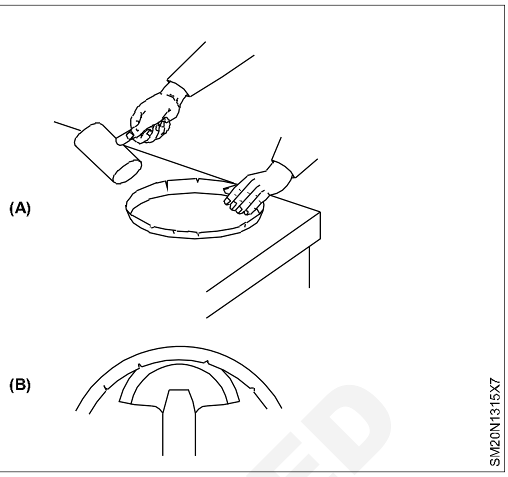
During turning, wrinkles will be formed on the edge and buckling will be formed on the bottom surface of the disc. (Fig 6)

Fig 6



Remove the wrinkles and bucklings by tapping the edge and the base of the disc using the mallet and the tinman's anvil and the half moon stake. (Fig 7A & 7B)

Fig 7



Repeat the same process for 3 times and complete the turning process. Also remove the wrinkles and bucklings at the end of each stage itself.

At every stage of turning process, formation of wrinkles and bucklings are possible. The same must be removed during the end of that stage itself.

Planishing the turned edge of the circular disk by hand process

Objective: This shall help you to

- **planish the turned edge of a circular disc using a planishing hammer, a square edge stake and a levelling plate.**

Hold the square edge stake on benchvice. (Fig 1) Place the disk blank as shown in the Fig 2 and planish the turned edge to 90^0 accurately.

Fig 1

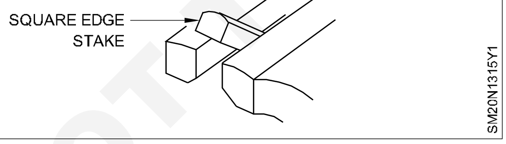
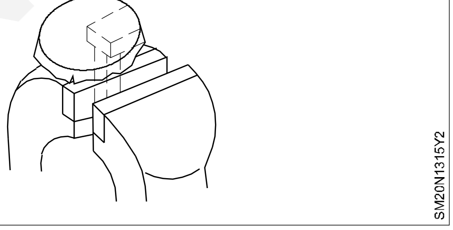


Fig 2



Flatten the surface of the disc on a levelling plate as shown in Fig 3, until the wrinkles are eliminated.

After flattening the surface, the turned edge will get deformed slightly more than 90°. So rectify as shown in Fig 4.

Fig 3

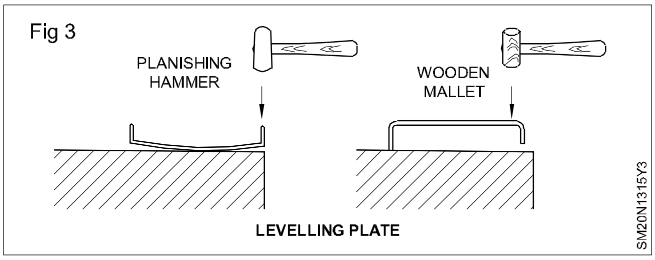
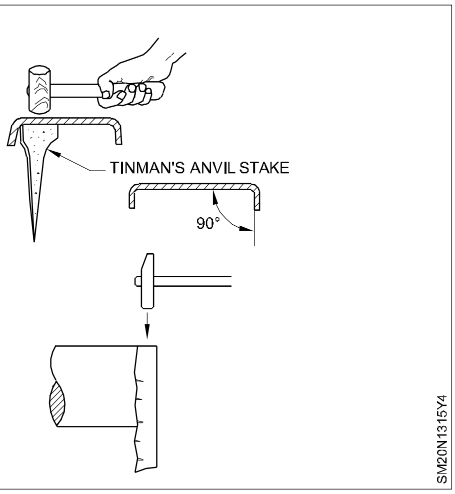
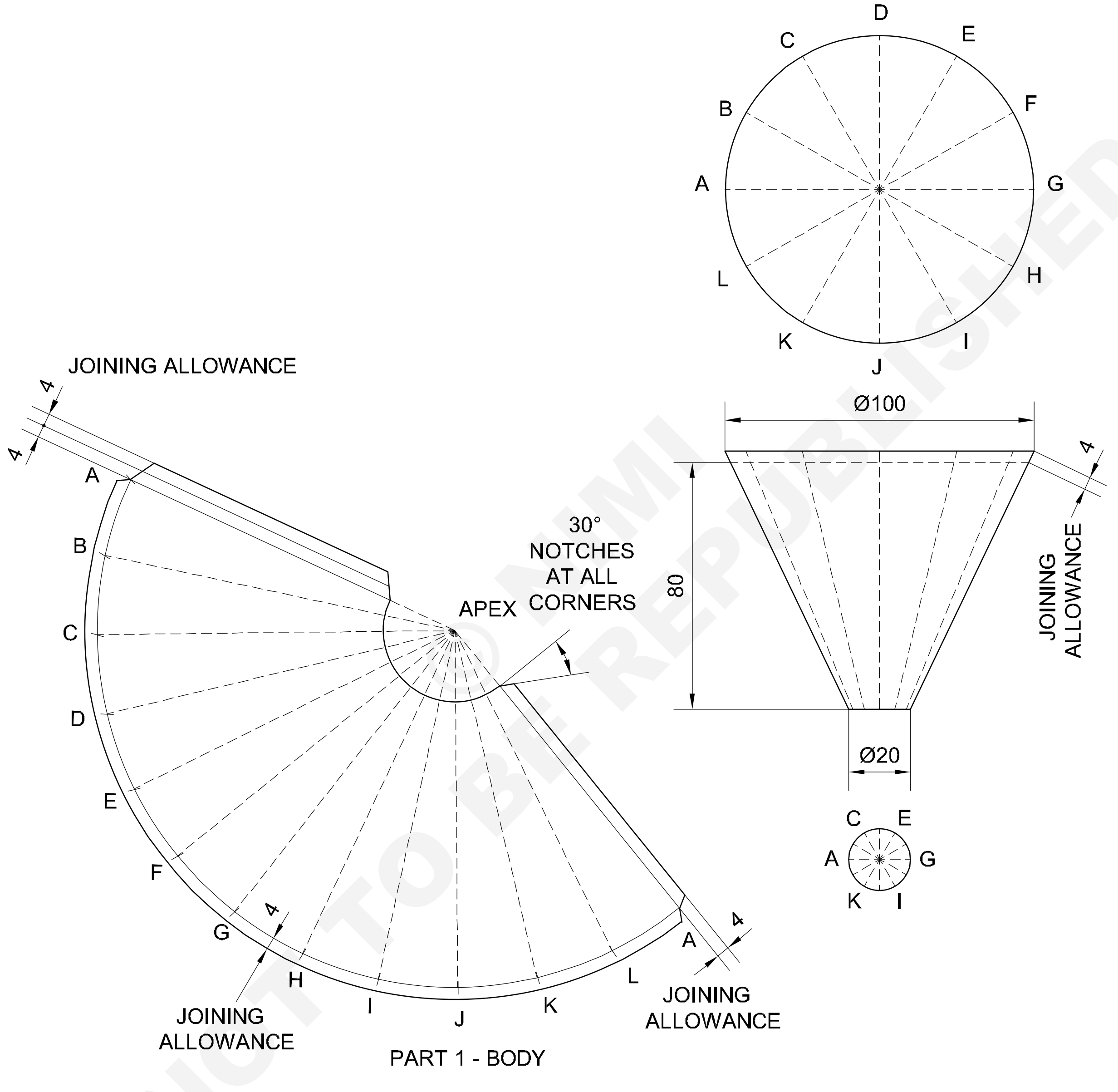


Fig 4



Forming frustum of cone

Objectives: At the end of this exercise you shall be able to
- **develop and layout the pattern for the frustum of a cone by radial line method**
- **to make a frustum of cone by locked grooved joint using hand tools.**



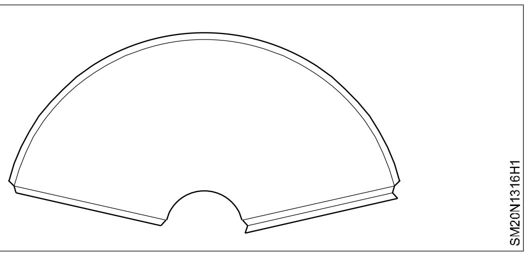
1	ISSH 250 x 140 x 0.5		TINNED - SHEET		1	1.3.16
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	**FORMING FRUSTUM OF CONE**	DEVIATIONS ±1	TIME 5h
		CODE NO. SM20N1316E1	

Job sequence

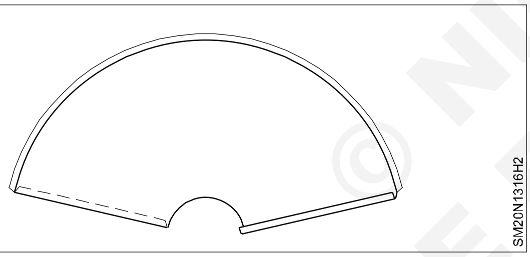
- Cut the material to the size
- Develop and layout the pattern for the body of the measuring can by the radial line development method on a drawing paper.
- Paste the drawing paper on the sheetmetal by fevicol or gum
- Cut the pattern using of a straight ship.
- Flatten the workpiece using a wooden mallet and a Tinmans anvil stake. (Fig 1)

Fig 1



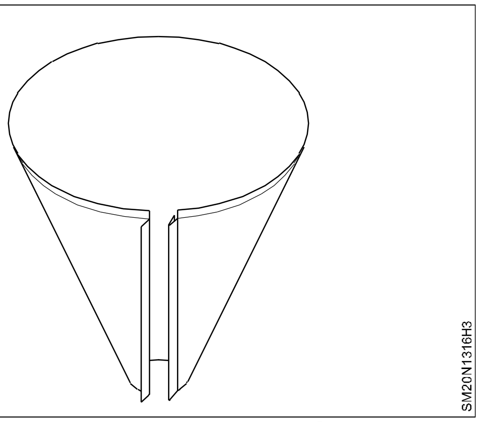
- Check the allowances for the locked grooved joint using a steel rule.
- Form hooks on both the ends in opposite directions by using a hatchet stake, a wooden mallet and a 1/2 lb ball pane hammer. (Fig 2)

Fig 2



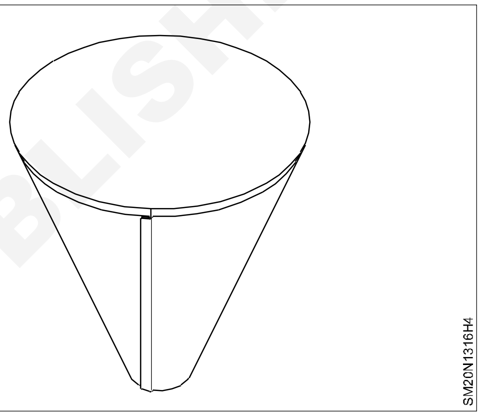
- Form the workpiece to the frustum of cone by using a funnel stake. (Fig 3)

Fig 3



- Make a locked grooved joint by using a funnel stake, a hand groover and a 1 1/2 lbs Ball pane hammer. (Fig 4)

Fig 4



- Finish the job using a wooden mallet.
- Check the dimensions of the job by using a steel rule.

Skill Sequence

Development for a circular cone

Objectives: This shall help you to
- **develop a cicular cone by the radial line development**

develop a cicular cone by the radial line development (Fig 1)

Circular cone: Draw the front elevation and the plan. (Fig 2)

While drawing the plan, the neutral plane (outer diameter plate thickness) of the base circle is taken as the diameter.

The neutral plane size is negligible, if the plate thickness is less than 0.5 mm.

Fig 1

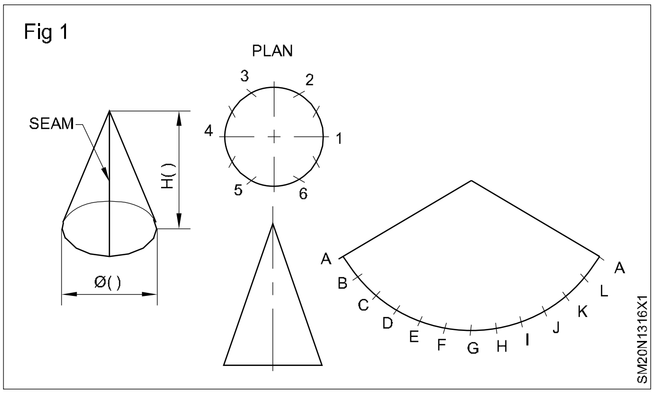
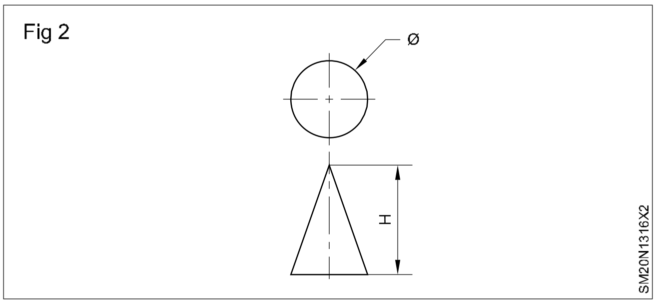


Fig 2

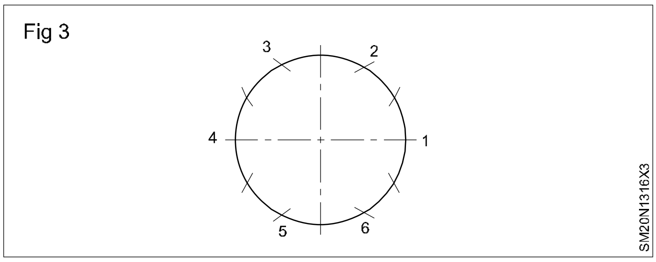


Divide accurately the circumference of the plan into 12 equal parts. (Fig 3)

With the radius of the circle, first divide the circumference into 6 equal parts.

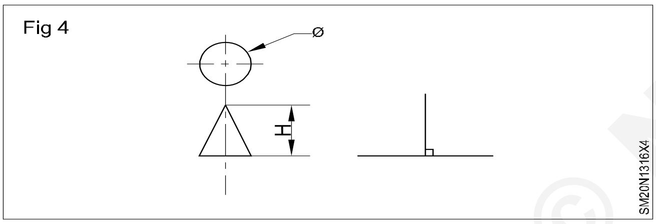
Then divide each part into two.

Fig 3



Draw a perpendicular line on the material. (Fig 4)

Fig 4

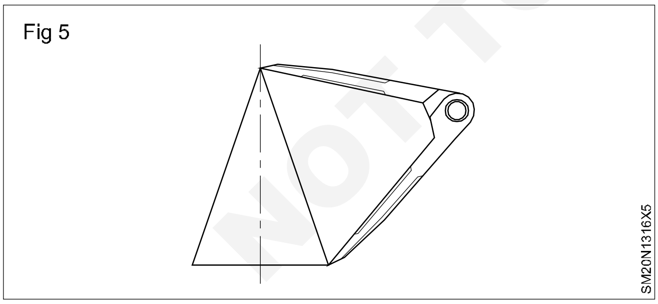


Draw the base line at about 5 mm from the end of the material.

Draw a perpendicular line to the centre of the material blank space.

Transfer the length of the edge line (slant height) to the compass. (Fig 5)

Fig 5



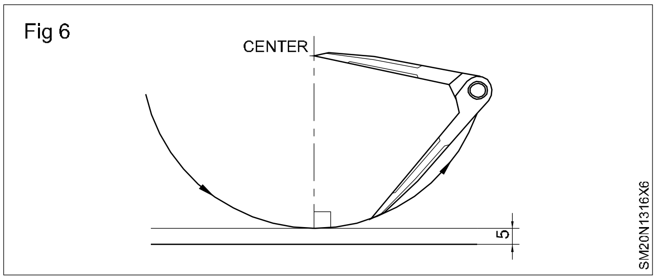
Transfer it accurately.

Draw an arc with the centre at a point on the perpendicular line (Fig 6) and the slant height as the radius.

Check the opening of the compass with each equally divided points, to minimise errors.

Open the compass points to one of the 12 equally divided parts of the circumferential length.

Fig 6

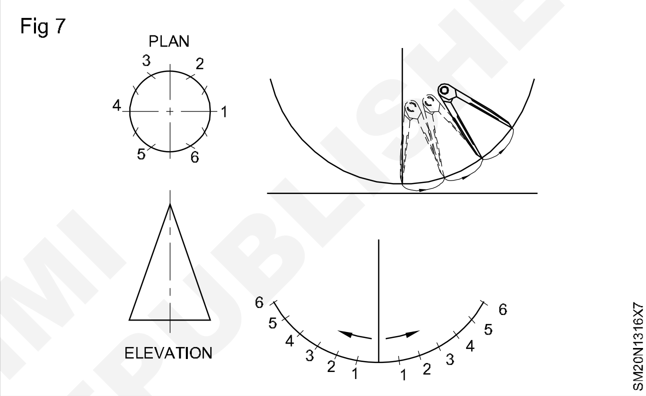


Open the compass by checking each equally divided point to minimise errors.

Scribe 12 opening points of the compass on the arc.

Scribe six points on both the right and left sides of the perpendicular respectively. (Fig 7)

Fig 7

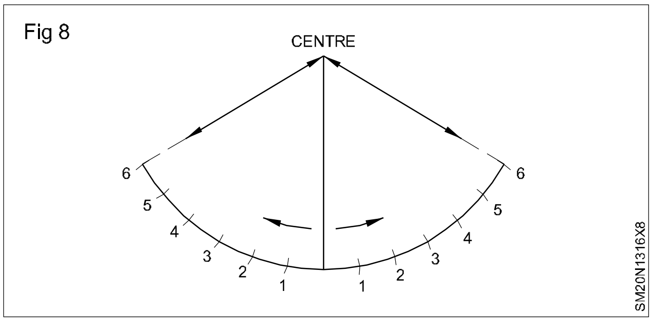


Use the compass points alternately while scribing points, without removing the compass from the arc at a time.

Connect the right and left ends of the arc to the centre. (Fig 8)

Fig 8 shows the development for the given cone.

Fig 8



Job sequence

Develop and layout the pattern for the frustum of a cone by radial line method

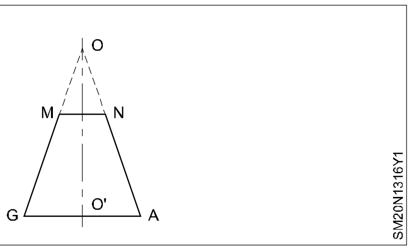
Objective: This shall help you to

- **develop and layout the pattern for the frustum of a cone by radial line method**

Get a plain drawing paper large enough to make the flat pattern layout.

Draw the elevation of the frustrum of a cone in full size 'AGMN' in Fig 1.

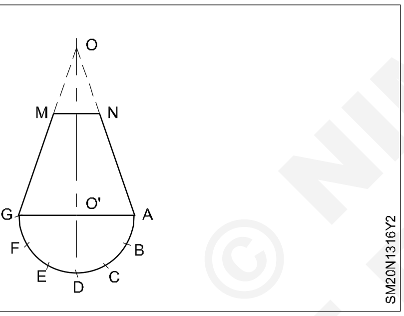
Fig 1



Continue the lines showing taper sides of the body till they intersect at a point 'O'. 'O' is called as an 'Apex'. (Fig 1)

Taking O' as the centre and O'A as radius, draw an arc AG and divide it into six equal parts A-B-C-D-E-F-G. (Fig 2)

Fig 2



With centre 'O' draw arcs AX and NY. X&Y are the points on the centre line of the frustum of a cone. (Fig 3)

Take distance 'X' and mark off twelve lines along the arc AX to obtain A^1-B^1-C^1-D^1.... to D^2-C^2-B^2....A^2. (Fig 3)

Join the points A^1,B^1,C^1......C^2,B^2,A^2 to the point 'O'.

The development required is then A^1 A^2 N^1 N^2.

This is the development of a frustum of a cone without a joining allowance.

Now add joining allowances 'a' & 'b' by drawing lines parallel to A^{1}N^1 & A^2 N^2. (Fig 4)

Add hemming or wiring or joining allowance 'c' & 'd' by drawing arc inside the arc N^1 N^2 and outside the arc A^1 A^2. (Fig 4)

Fig 3

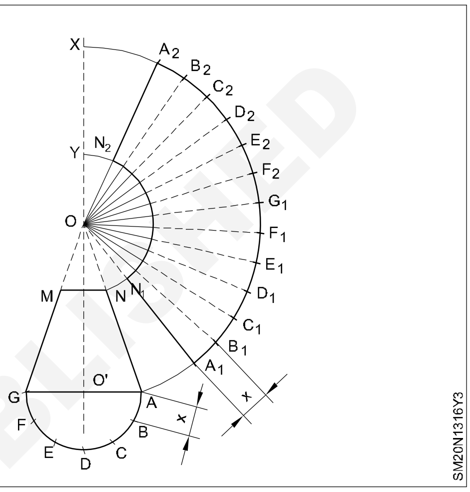
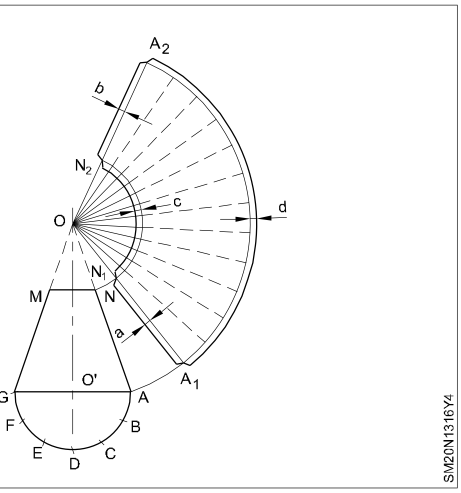


Fig 4



Skill Sequence

Forming a frustum of a cone with locked grooved joint

Objectives: This shall help you to

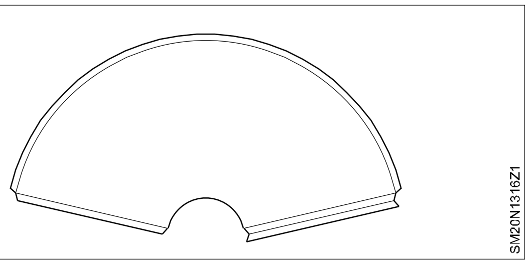
- **form a frustum of cone using a funnel stake and a wooden mallet**
- **make locked grooved joint on tapered curved surface using a funnel stake, hand groover and a ball pane hammer.**

Check the pattern and ensure that all the required allowances are provided by using a steel rule as per the job drawing. (Fig 1)

Remove burrs by using a flat file. Mount the hatchet stake on the bench plate.

Place the sheet horizontally on the hatchet stake edge at the line marked previously for folding.

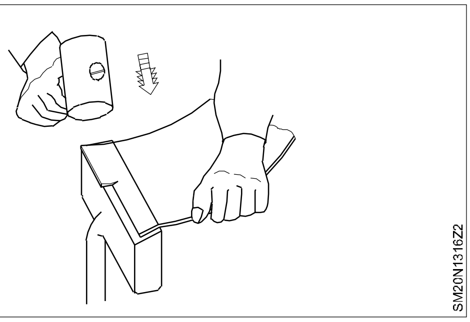
Fig 1



With a wooden mallet strike the edge of the job on both ends. (Fig 2) Observe break or fold mark formed.

Lower the end of the work slightly using the same angle of striking, increasing the angle of turning.

Fig 2



Repeat the above operation till the edge is turned to the required angle.(Fig 3)

Fig 3

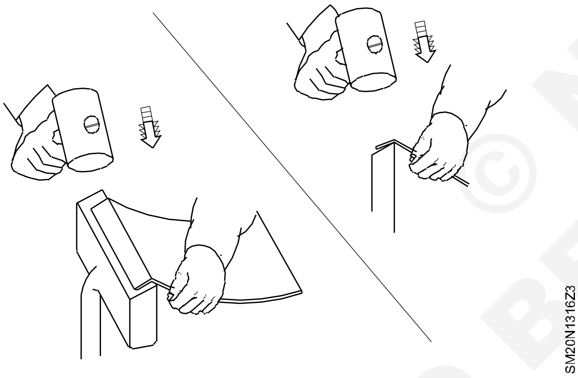
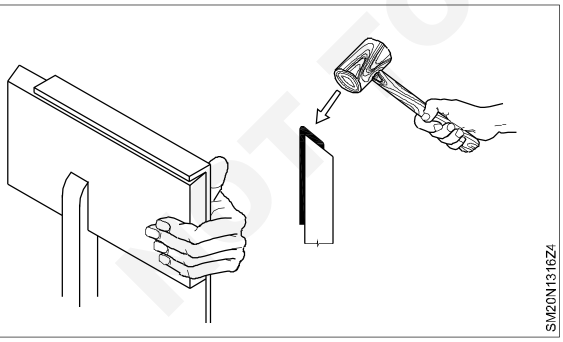


Fig 4



Mallet the edge over a piece of waste tin plate. (Fig 5)

Repeat the same operation on the other edge of the sheet and form hooks.(Fig 6)

Fig 5

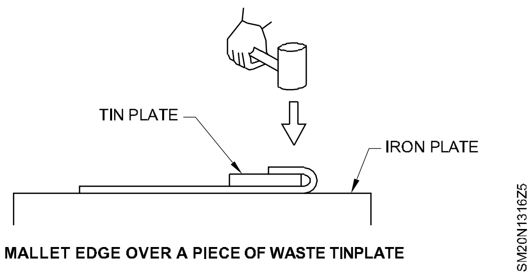
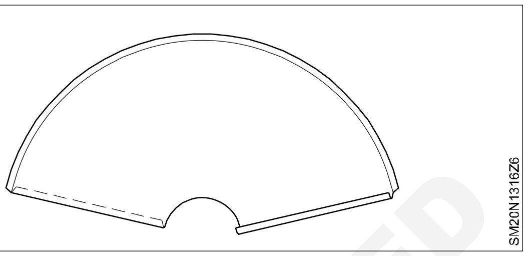
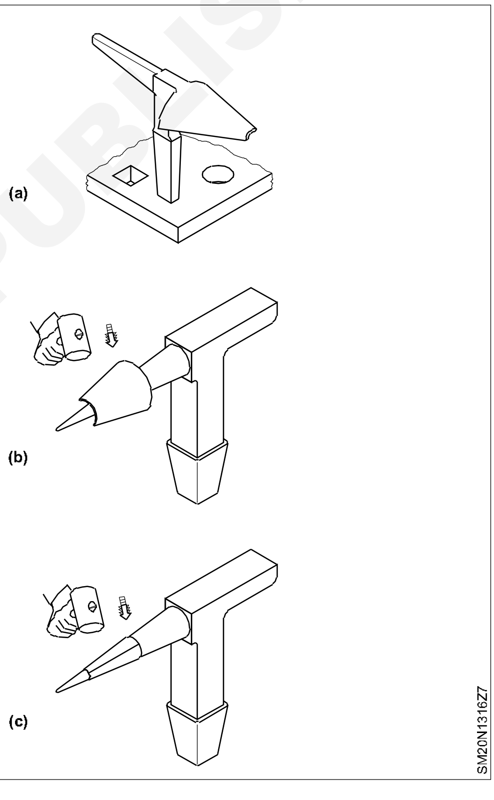


Fig 6



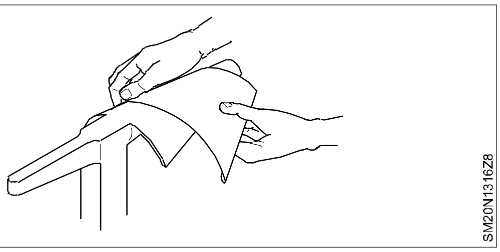
Mount the funnel stake on a bench plate. (Fig 7a) Use "long tapered beak horned iron stake" for the cones having small radius, plate. (Fig 7b & 7c)

Fig 7



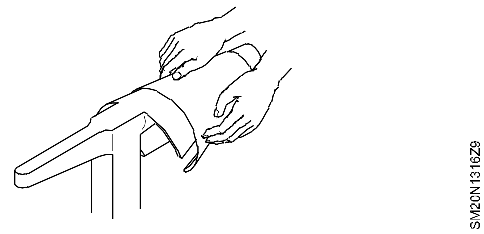
Place one end of the work piece on the funnel stake parallel to the axial line of the stake and bend as shown in Fig 8.

Fig 8



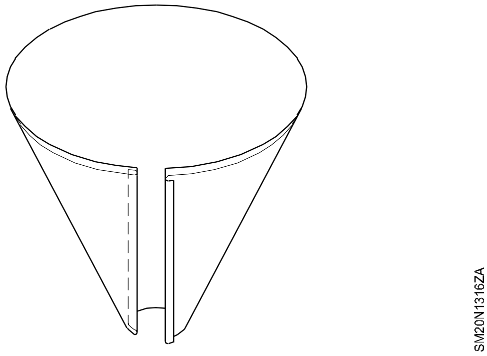
Repeat the same operation on the other end of the workpiece. Bend the workpiece evenly as shown in (Fig 9).

Fig 9



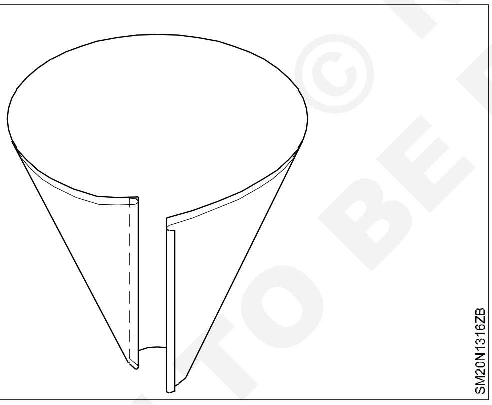
Check the turned up edge of the circular disc and curve it gradually and make both ends to meet together. (Fig 10)

Fig 10



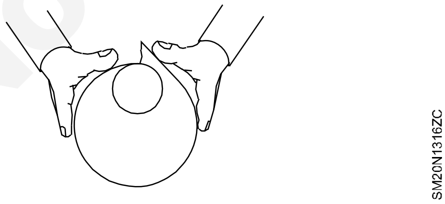
Ensure that the folded edges of the workpiece are parallel, if not the edges will not match as shown in (Fig 11)

Fig 11



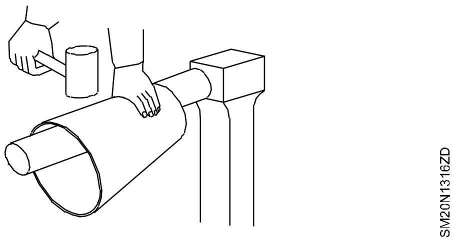
Hook the folded edges as shown in Fig 12.

Fig 12



Slowly lock the edges by light blows using a mallet as shown in (Fig 13) Start blows from one end of the joint to the other end to tighten the joint. (Now grooved seam is formed)

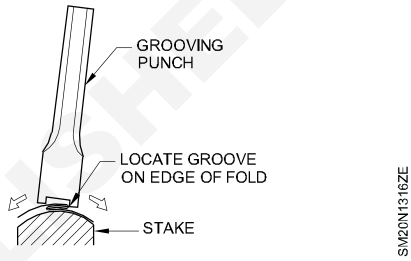
Fig 13



Select the correct size of the groover.

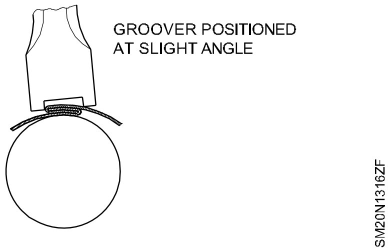
Place the groover over the grooved joint as shown in (Fig 14)

Fig 14



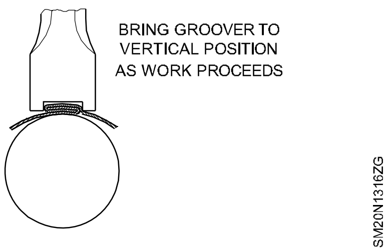
Position the groover at a very slight angle. The edge of joint acts as a guide to the groover. (Fig 15)

Fig 15



Bring the groover to vertical position. (Fig 16)

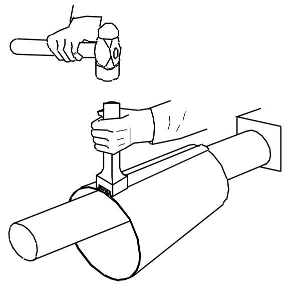
Fig 16



Strike the top of the groover firmly with Ball pane hammer and lock same on the other end. (Fig 17)

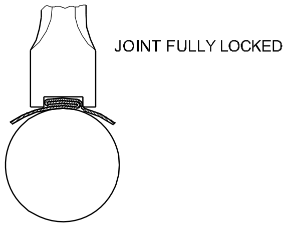
Check the ends again to ensure that they are in line. Continue to lock the seam along the line with the hand groover.

Fig 17



Now the joint is fully locked. (Fig 18)

Fig 18



Finally smoothen with a mallet all over the body and check the dimensions as per the job drawing by using a steel rule.

In order to get proper setting of seam of the required size, it is necessary to use the correct size of a groover. If not, the seam is set too wide or too narrow. See Fig 19, 20,21.

Fig 19

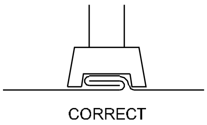


Fig 20

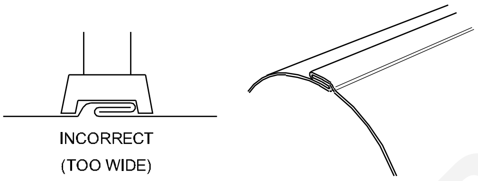
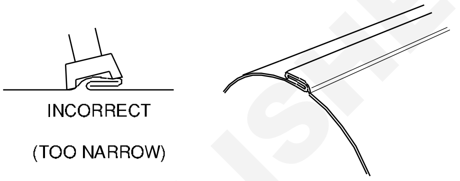
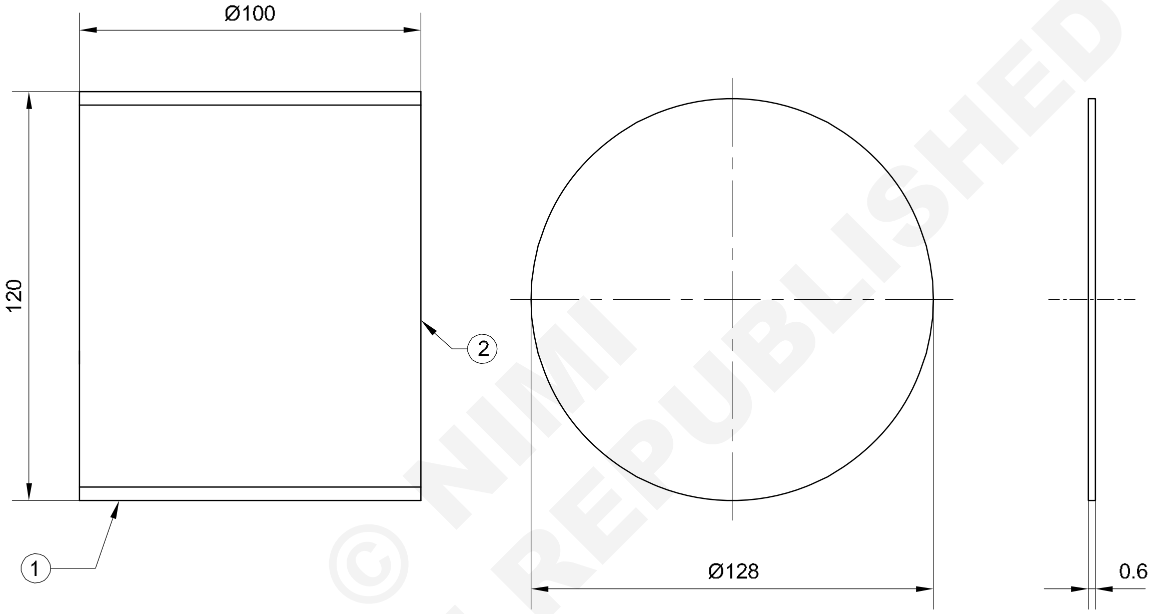


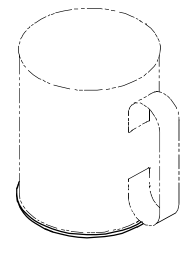
Fig 21



Making a mug

Objectives: At the end of this exercise you shall be able to
- **pattern development layout of parallel line methord**
- **half moon state used to 90° edge joint**
- **pan down joint hand.**




MUG

1	ISSH 350 x 125 x 0.61	--	GI SHEET	1	2	-
1	ISSH 145 x 145 x 0.61	--	GI SHEET	1	1	1.3.17
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	**MAKING A MUG**	DEVIATIONS ±1	TIME 3h
		CODE NO. SM20N1317E1	

Job Sequence

- Planish the sheet on a tinman's anvil using a mallet.
- Check the size of the sheet as per job drawing using steel rule.
- Identify the centre point by drawing diagonal lines on sheet.
- Make a punch mark at the centre point using dot punch and 1/2 lb Ball pane hammer.
- Make circles of ϕ 128, ϕ 120, ϕ 110 using a steel rule and a compass
- Cut circle ϕ 128

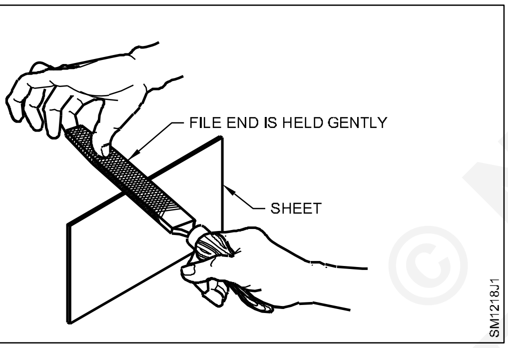
Skill Sequence

Checking the thickness of the sheet metal and the diameter of the wire using standard wire gauge (SWG)

Objectives: This shall help you to
- **check the thickness of the given sheet metal using a standard wire gauge**
- **check the diameter of the given wire using a standard wire gauge.**

Checking with standard wire gauge: Deburr the edges of the sheet on both sides by filing using a flat smooth file. (Fig 1)

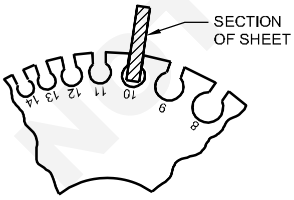
Fig 1



Insert the appropriate slot of standard wire guage which make a snug fit at the edges of the sheet by trial and error method and note the gauge number. (Fig 2)

Then remove the SWG and insert one slot below the test slot and one slot above the test slot. You will find one slot of SWG which enters not very loose or tight.

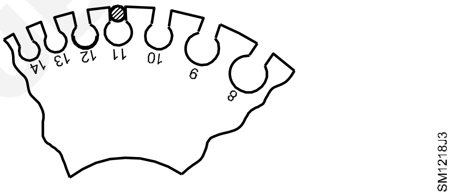
Fig 2



ENLARGED VIEW OF S.W.G SHOWING HOW TO FIND THE GAUGE OF SHEET OR WIRE.

If the SWG enters the sheet edge in the slot not very tight or loose, then the standard wire guage number of the test slot is the correct thickness of the sheet. (Fig 3)

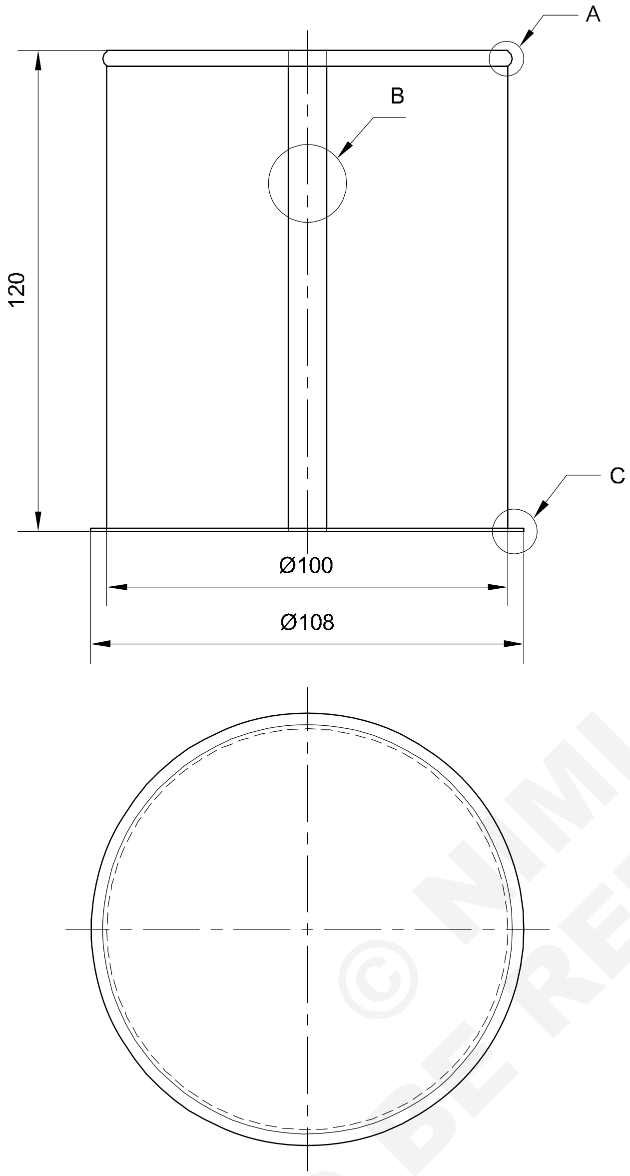
Fig 3

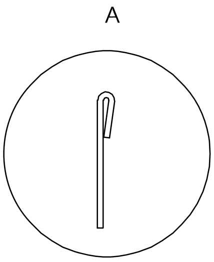


Your judgement on tightness or looseness is very important. Correct selection of the slot will give the correct thickness of the sheet.

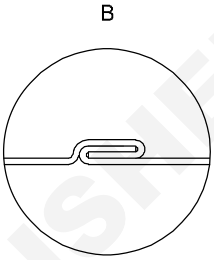
Larger the SWG number, lesser the thickness of the sheet.

In the similar manner, check the dia of the wire. Use only slot and not the hole on SWG when checking the dia of the wire.

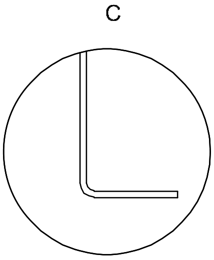




HEMMING
4mm.



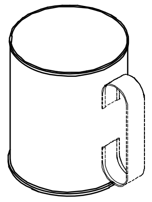
LOCKED GROOVED
SEAM 5mm.



FLANGE 4mm.

Job sequence

- Check for flanging allowance.
- Turn the edge of a cylinder to form a flange using a copper smith stake and a setting hammer.
- Check for the correctness of the flange using a jenny caliper.
- If not, rectify by filing with a 150 mm smooth file.



1	–		–	1	2	1.3.17
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	MAKING A MUG (FLANGING THE BODY)	DEVIATIONS ±1	TIME
		CODE NO. SM20N1317E4	

Skill Sequence

Turning the edge of the cylinder to form the flange using copper smithstake

Objectives: This shall help you to
- **form the flange using copper smith stake.**

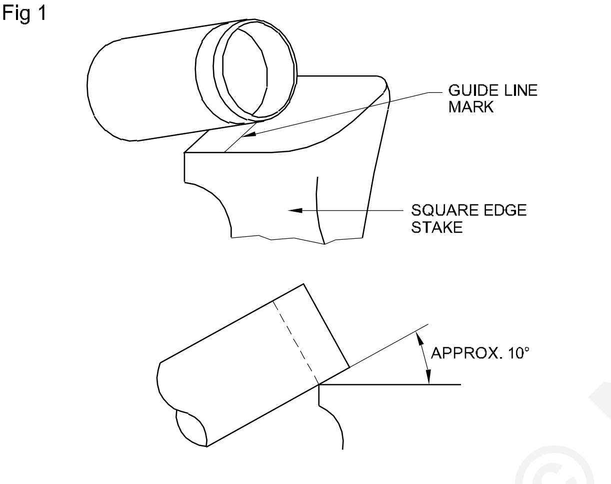
Check the cylindrical body for roundness and the marking allowance for flanging.

Fix the copper smith stake in the benchvice or bench plate firmly.

Mark the flanging allowance as guideline on the stake as in Fig 1.

Hold the cylinder such that the marked line on the cylinder for flanging, coincides with the straight edge of the stake. (Fig 1)

Fig 1



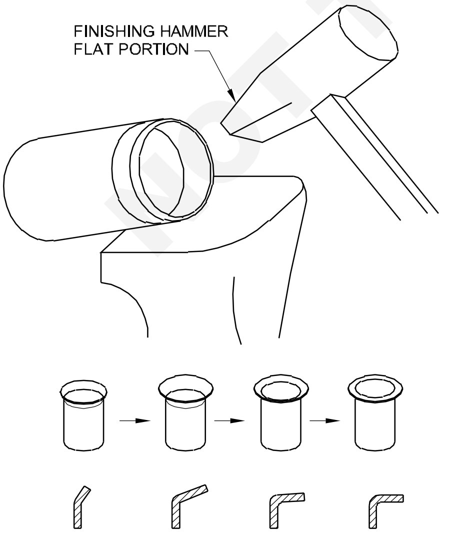
SQUARE EDGE STAKE

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 2) till the flange is bent to 90^0.

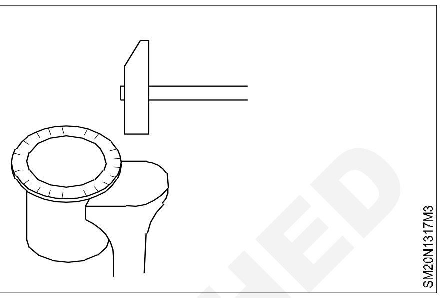
Fig 2



FLANGING

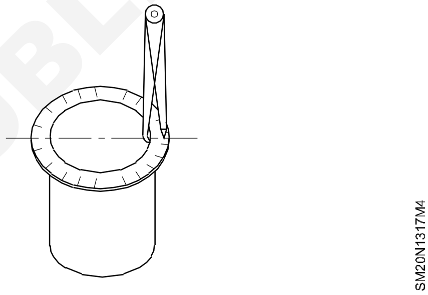
Now place the flange on the face of the copper smith stake and stretch the flange by striking with the finishing hammer. (Fig 3)

Fig 3



Scribe the flanged part to the specified size by using a jenny caliper. (Fig 4)

Fig 4

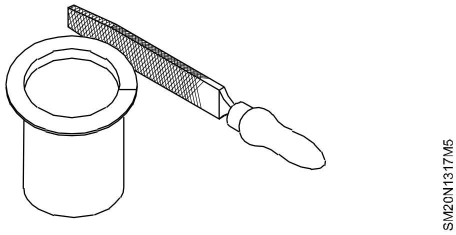


Finish the flange to size using a smooth file. (Fig 5)

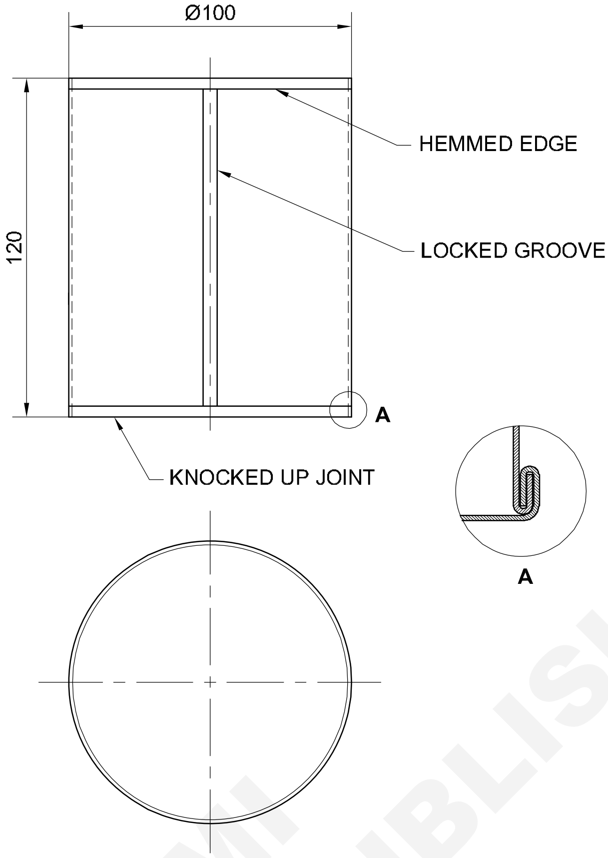
Check for roundness of the job with a template and correctness of the flange with a jenny caliper.

Check the flatness of the flange on a surface plate.

Fig 5



Smoothen the edges of the cylinder by a smooth file and an emery paper to avoid tearing of the sheet while flanging.



BOTTOM FIXING WITH BODY BY KNOCKED UP JOINT.

Job Sequence

- Check the dia of the base of the cylinder and the dia of the turned disc by using a steel rule as per drawing.
- Make single seam (Paned down joint) by placing the cylindrical body over the bottom disc, using a levelling plate, a square edge a stake, a setting hammer and a wooden mallet. (Fig 1)
- Make double seam (knocked up joint) using a square edge stake, a setting hammer and a wooden mallet. (Fig 2)

Fig 1

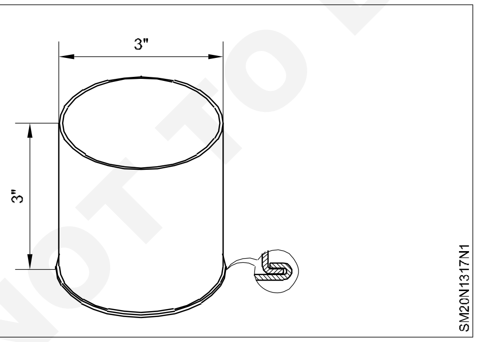
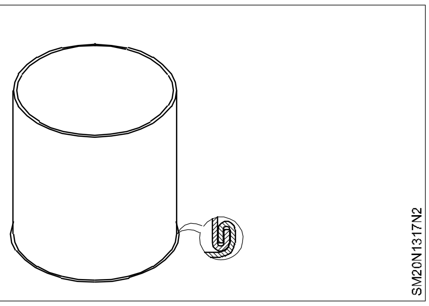


Fig 2



1	--		--	1	2	1.3.17
1	--		--	1	1	1.3.17
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2

MAKING A MUG
(SINGLE SEAM AND DOUBLE SEAM
(KNOCKED UP JOINT) BY HAND PROCESS)

DEVIATIONS ±1

TIME

CODE NO. SM20N1317E3

Skill Sequence

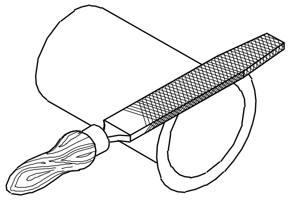
Setting and single seaming

Objectives: This shall help you to
- **set the parts and finish the paned down joint (single seam)**

Check the turned up edge of the circular disc and the flange of the cylindrical body as per the job drawing using a steel rule.

Ensure that the width of the flangand the burred edge of the disc is uniform. If not, rectify by filing with a flat smooth file. (Fig 1)

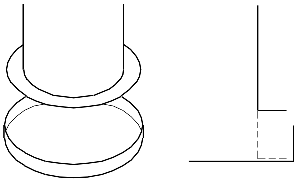
Fig 1



Place the turned disc on the levelling plate.

Place the cylindrical body on the turned disc as shown in Fig 2.

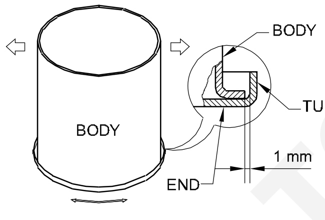
Fig 2



Ensure that the clearance between the cylindrical body and the bottom disc is about 1 mm all around. (Fig 3)

Place the job on the tinman's anvil stake.

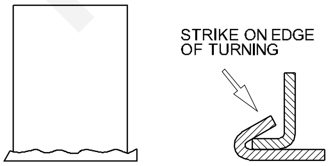
Fig 3



FITTING END TO BODY

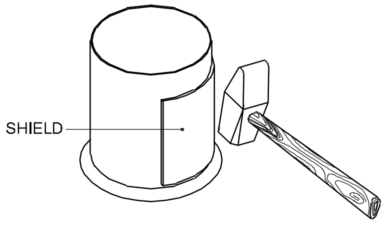
Tap over the bottom edge slightly at several points as shown in Fig 4, to retain the bottom in its position using the setting hammer.

Fig 4



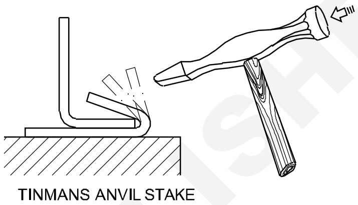
Fold the turned edge gradually using a setting hammer until the single folded seam is obtained. while hammering, use a shield of bent metal piece, to protect the cylindrical body from hammer marks. (Fig 5)

Fig 5



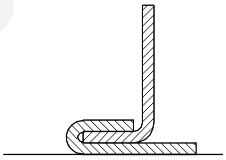
The setting down operation for the single seam (Paned down joint) should be carried out stage by stage as shown in Fig 6.

Fig 6



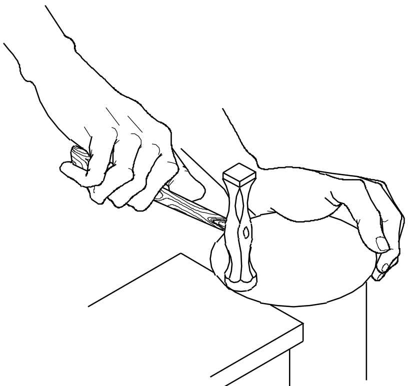
While striking, stretching and buckling of the metal is occured at the bottom edge. (Fig 7)

Fig 7



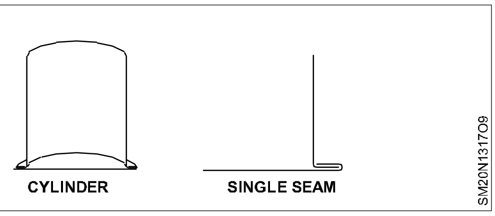
To remove stretching and buckling at the bottom, place the seam over the edge of the square stake and beat with the planishing hammer by rotating the job until the edge is smooth as shown in Fig 8.

Fig 8



The finished single seam (Paned down joint) is shown in Fig 9.

Fig 9



Setting and double seaming

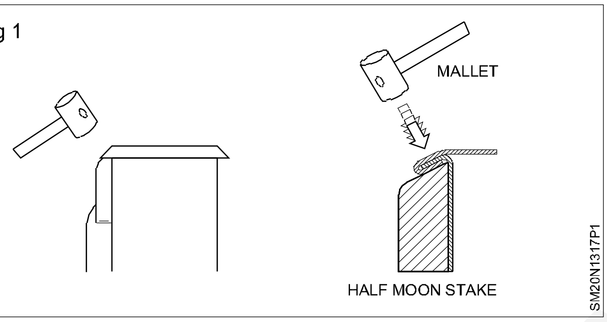
Objectives: This shall help you to

- **place the joint on halfmoon stake and square stake**
- **finish the knocked upjoint**

For knocked up seam, the paned down joint is turned up.

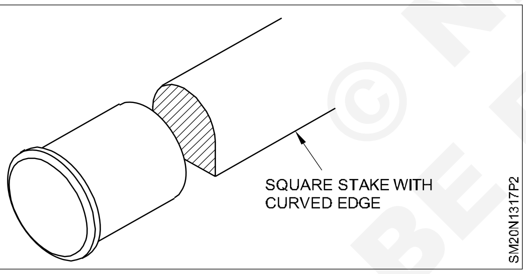
Place the paned down joint on a half moon stake and turn the edge of the joint by a mallet as shown in Fig 1.

Fig 1



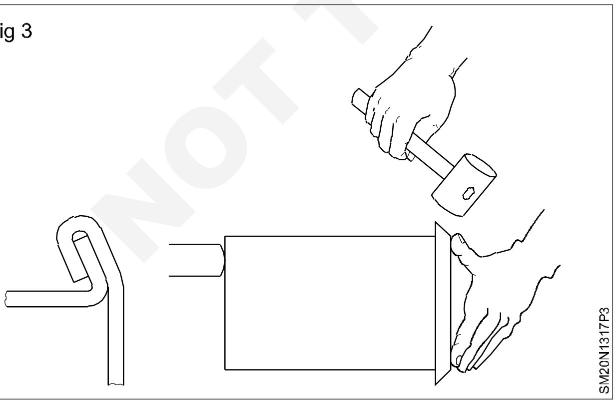
Insert the job on the square stake with curved edge as shown in Fig 2.

Fig 2



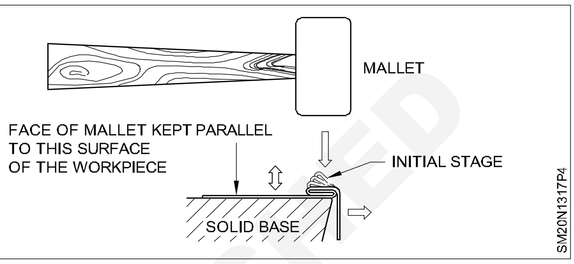
Support the job by hand and strike with the mallet all around to an angle as shown in Fig 3.

Fig 3



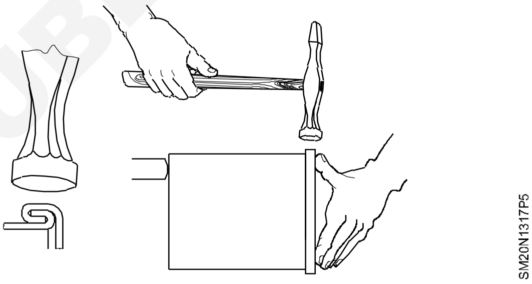
Increase the angle of the bend gradually, while striking with the mallet all around the seam as shown in Fig 4.

Fig 4



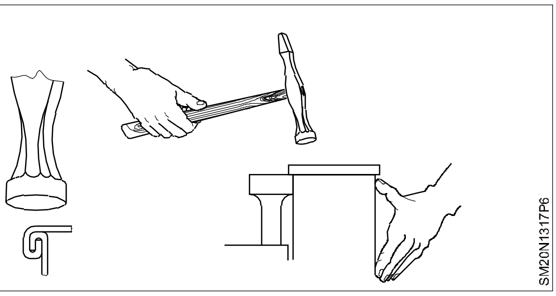
Tighten the double seam (knocked up joint) using the planishing hammer as shown in Fig 5.

Fig 5



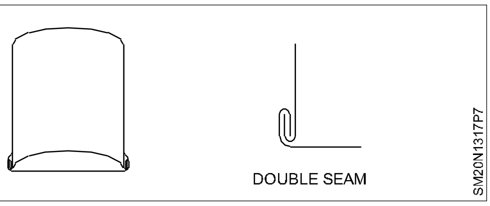
Place the edge of the joint on the square stake and slightly dress the bottom with the planishing hammer as shown in Fig 6.

Fig 6



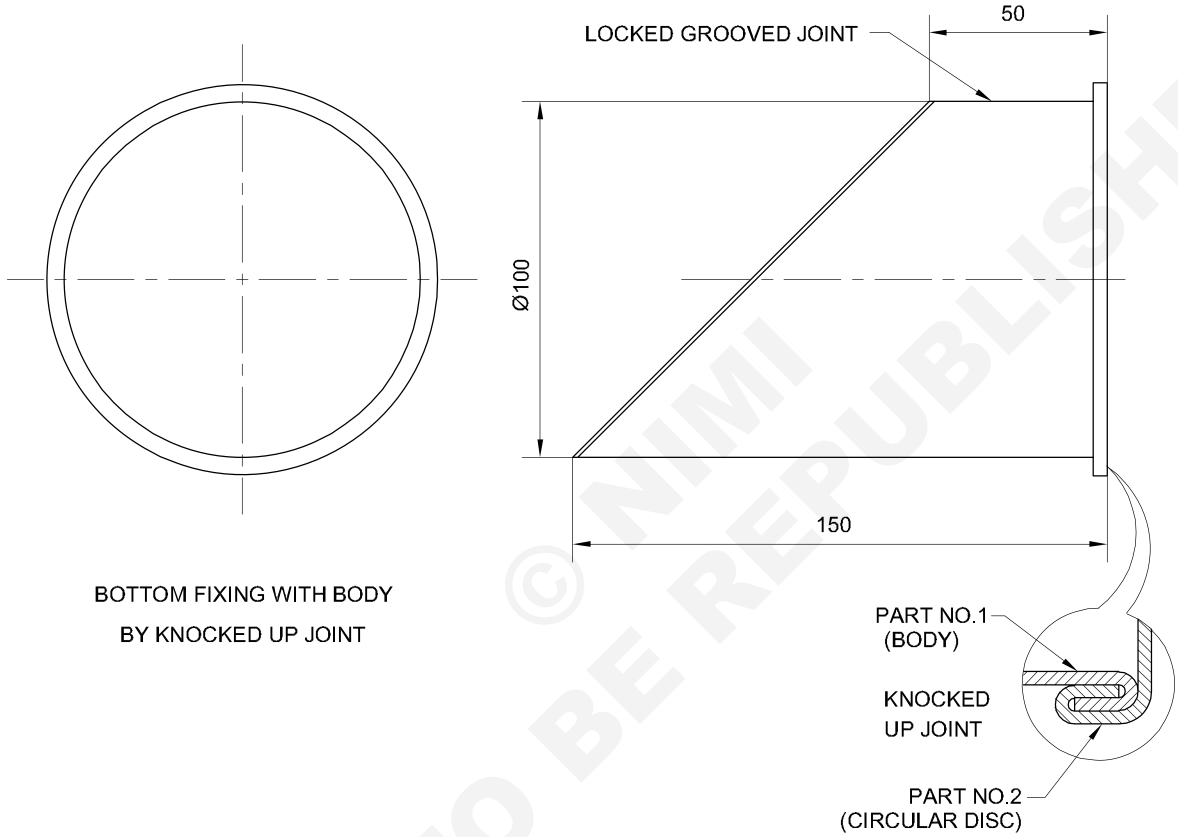
The finished double seam (knocked up joint) is shown in Fig 7.

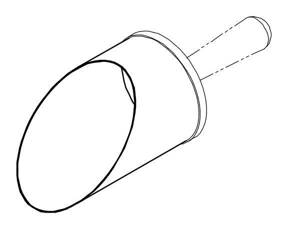
Fig 7



Making a scoop

Objectives: At the end of this exercise you shall be able to
- **cut the circles of a given diameter using straight snips**
- **develop and layout the pattern for a cylinder cut oblique by parallel line method**
- **make a single hem on the cut oblique edge of the cylindrical body using a half moon stake**
- **develop and layout the pattern for a cylinder cut oblique by parallel line method**
- **turn the edge of cylinder using anvil stake and setting hammer to make pane down joint**
- **turn the edge of the circular disc by hand process**
- **make a single seam (paned down joint) using hand tools**
- **make a double seam (knocked up joint) using hand tools.**





1			GI SHEET	2	2	-
1	--		GI SHEET	2	1	1.3.17
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

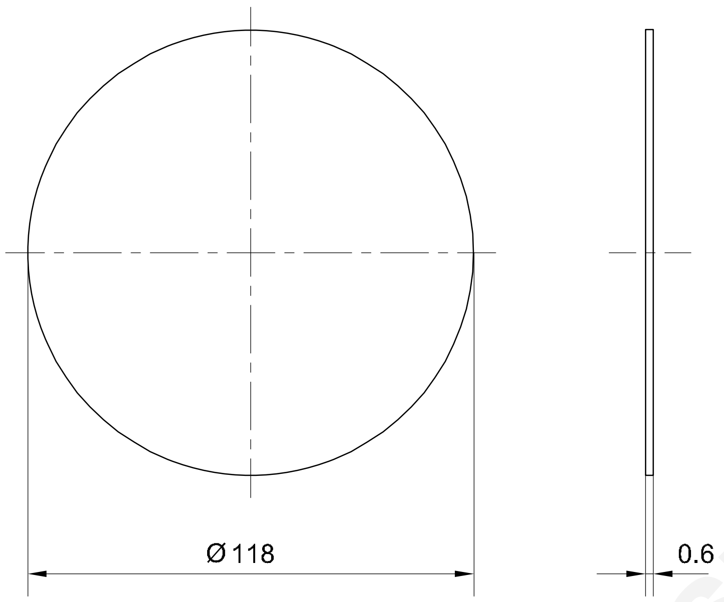
SCALE 1:2

MAKING A SCOOP
(SINGLE SEAM AND DOUBLE SEAM
KNOCKED UP JOINT BY HAND PROCESS)

DEVIATIONS ±1

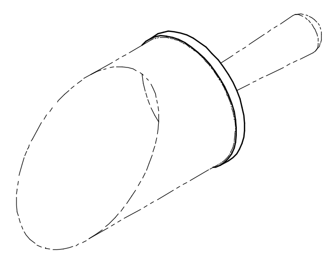
TIME 20h

CODE NO. SM20N1317E4



Job Sequence

- Planish the sheet on a timan's anvil using a mallet.
- check the size of the sheet as per job drawing using steel rule.
- Identify the centre point by drawing diagonal lines on sheet.
- Make a punch mark at the centre point using dot punch and 1/2 1b Ball pone hammer.
- Mark circle ϕ118, ϕ110, ϕ100 using a steel rule and a compass.
- Cut circle of ϕ 118
- For skill squence refer Exercise :1.2.18



SCOOP

1	ISSH 135 x 135 x 0.6	——► BS-2-20	G.I SHEET	2	2	1.3.17
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**MAKING A SCOOP** **(CUTTING OFF CIRCULAR DISC** **BY HAND PROCESS FOR THE BASE OF SCOOP)**	DEVIATIONS ±1	TIME
		CODE NO. SM20N1317E5	

Skill Sequence

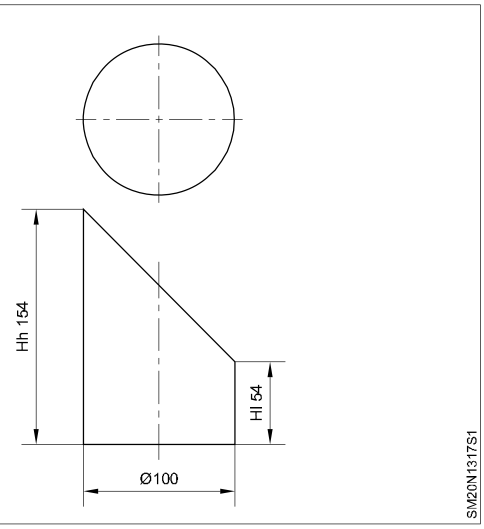
Develop and layout the pattern for obliquely cut cylinder

Objectives: This shall help you to

- **develop and layout the pattern for a cylinder cut oblique by parallel line method.**

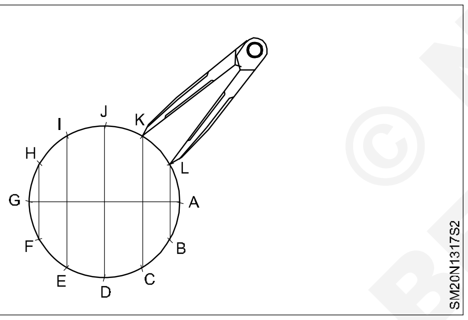
Draw the front elevation and the plan of the given object on a paper. (Fig 1)

Fig 1



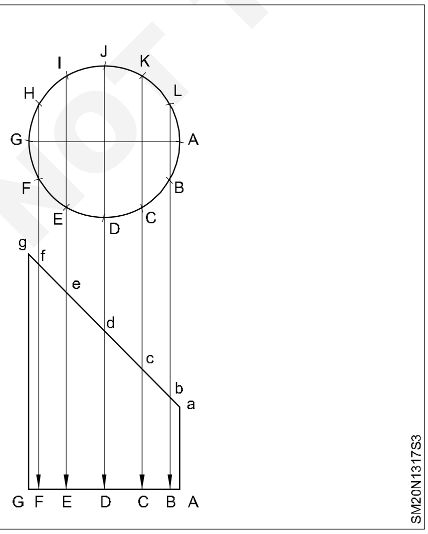
Divide the plan into 12 equal parts and check each division. (Fig 2)

Fig 2



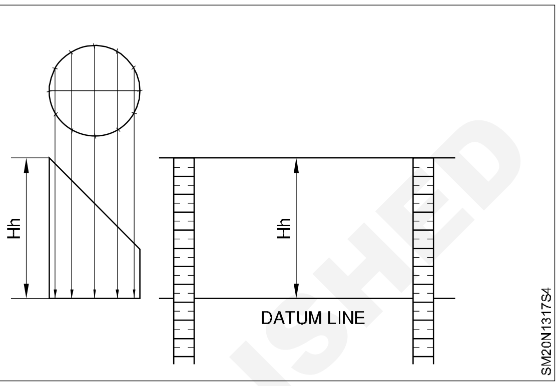
Draw lines perpendicular to the bake of front view from equally divided points of the plan and name them in elevation as in Fig 3. Draw perpendiculars accurately.

Fig 3



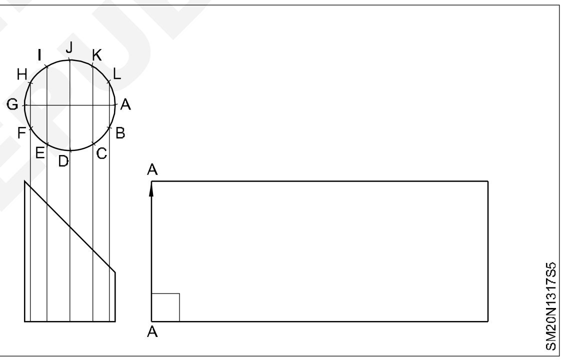
Draw parallel lines having the product height Hh as a distance to a length more than the circumferential lenth (D+ a little more as shown in figure. These are called as Daturm line (Fig 4)

Fig 4



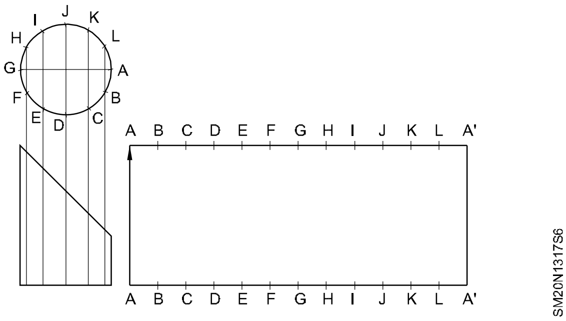
Draw a perpendicular line A,A from the left end of the datum line. (Fig 5)

Fig 5



Transfer the equidistant points of the plan on to the circumferential line as shown in (Fig 6).

Fig 6



Draw perpendicular lines from points A,B,C,D to A' to the base line as in (Fig 7).

From points a to g in elevation, draw parallel lines to the base line. These lines will meet the vertical lines correspondingly. Check the points as in (Fig 8).

Fig 7

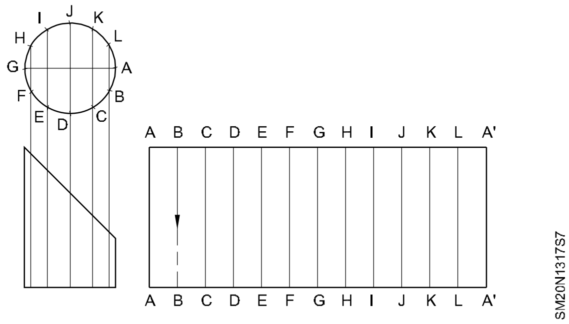
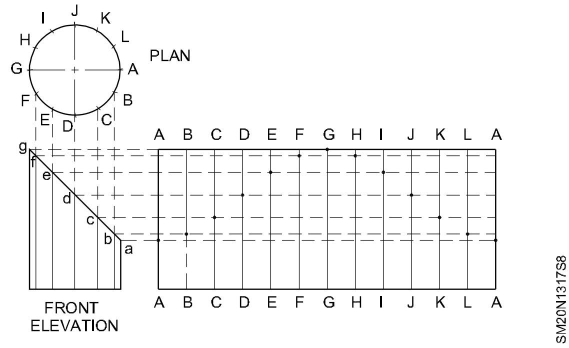


Fig 8



Join the points with a smooth curve as shown in (Fig 9).

Draw parallel lines for allowances for locked grooved joint 5 + 10 mm), hemming (4 mm) and knocked up joint (4 mm). See (Fig 10).

Complete the pattern and check once again. (Fig 11)

Fig 9

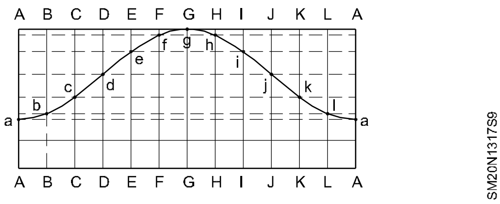


Fig 10

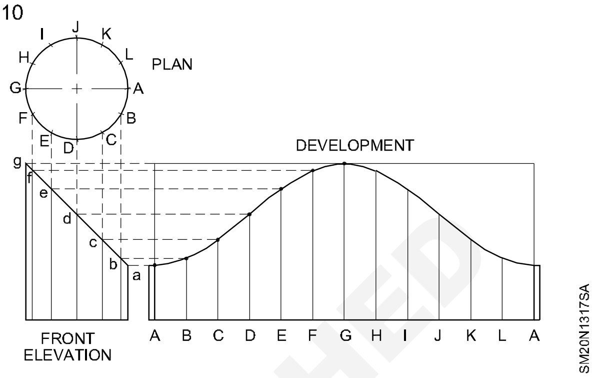
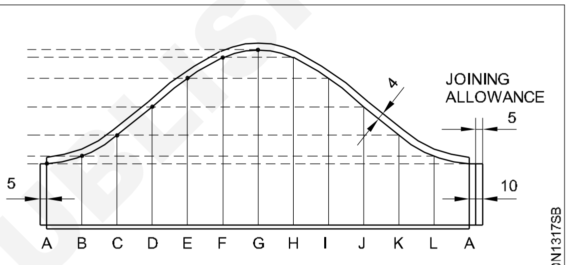


Fig 11

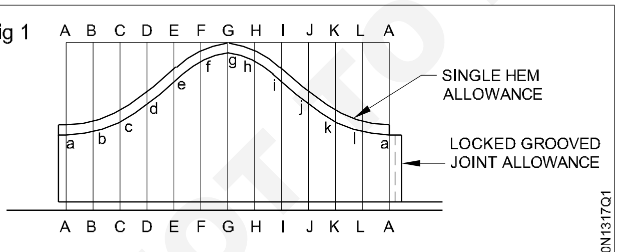


DEVELOPED PATTERN

Job Sequence

- Ensure for the correct size of the material.
- Develop and Layout the pattern for the obliquely cut cylinder with all allowances on a plain paper. (Fig 1)

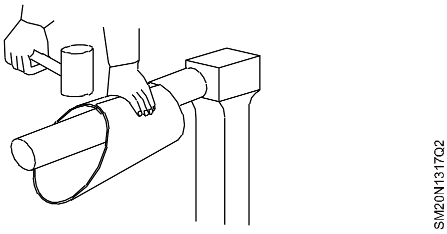
Fig 1



DEVELOPING PATTERN

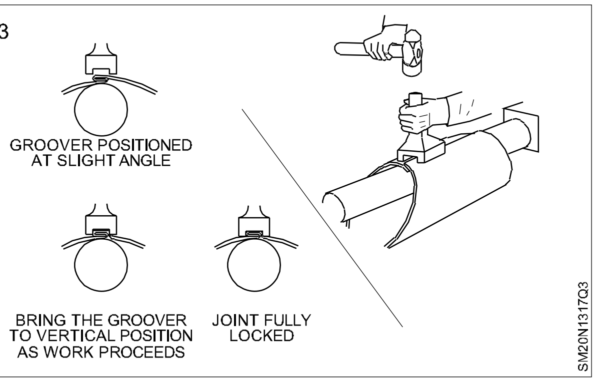
- Cut the paper pattern and paste it on the given sheet.
- Cut the straight edges and notches of the pattern by 300 mm straight snips.
- Cut the curved edges of the pattern by 150 mm bend snips.
- Deburr the edges using a 150 mm long smooth flat file.
- Make hooks at both sides in opposite direction for Locked Grooved seam using a hatchet stake and a mallet.
- Form the sheet to the cylindrical shape using a round mandrel stake and a mallet. (Fig 2)

Fig 2



- Make the locked grooved joint using a hand groover. Fig 3

Fig 3



- Make a single hem on the oblong edge of the cylindrical body using a half moon stake and a hammer. Fig 4 (Refer Skill sequence Ex. 1.2.18)
- Dress the job to a regular cylindrical shape (Fig 5)

Fig 4

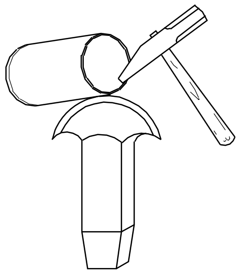
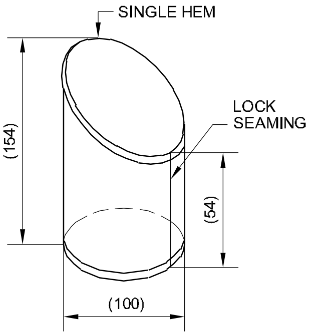
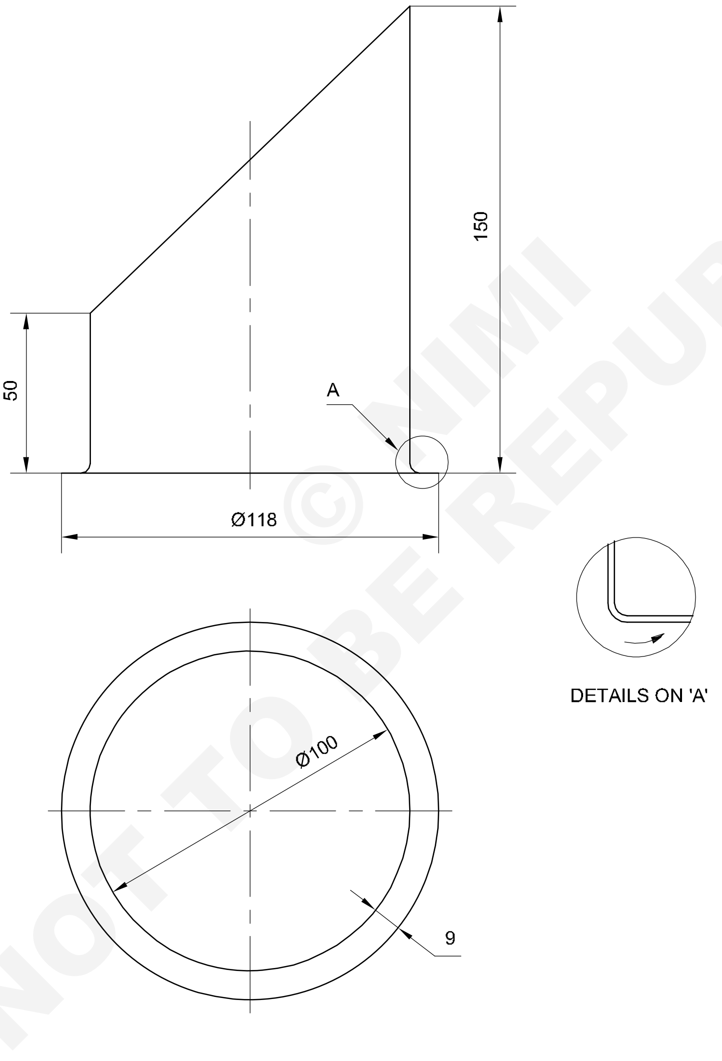
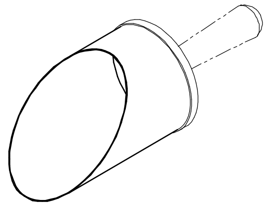


Fig 5







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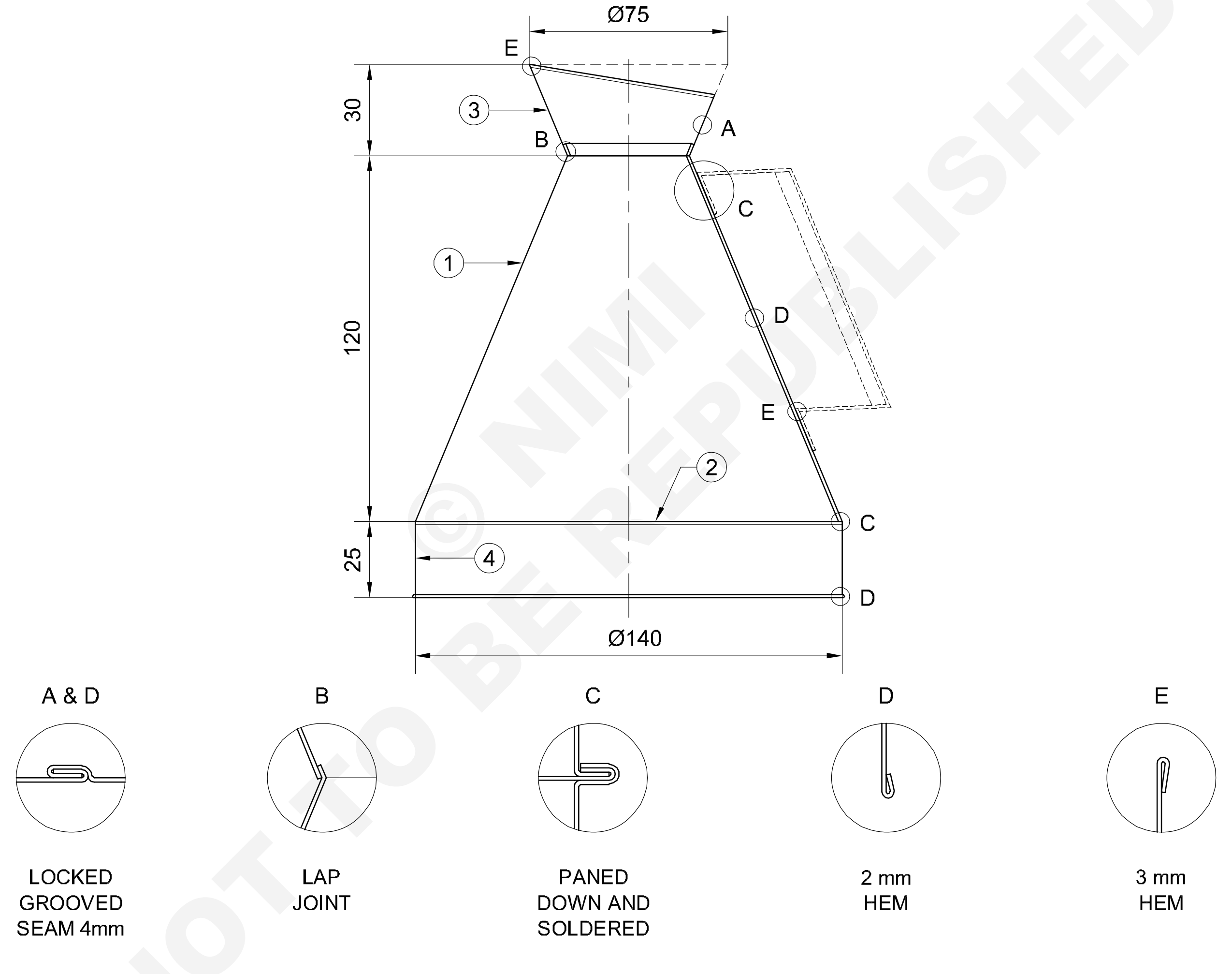
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	**MAKING A SCOOP (FLANGING THE BODY)**	DEVIATIONS ±1	TIME
		CODE NO. SM20N1317E6	

Making a Measuring Can

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

- **cut the circle of a given diameter using a straight snips**
- **develop and layout the pattern for the frustrum of a cone, cut obliquely, by the radial line development method.**
- **turn the edge of a circular disc using a half moon stake and a wooden mallet**
- **form the frustum of a cone by locked grooved joint using a round Mandrel, a funnel stake, a hand groover, a wooden mallet and a Ball pane hammer**
- **turn the bottom edge for the paned down joint using an anvil stake, setting hammer and a wooden mallet**
- **fix the body and the bottom by paned down joint, using a setting hammer and an anvil stake**
- **develop and layout the pattern for spout by radial line method**
- **make a spout of the measuring can as per job drawing using a funnel stake, half moon stake, hand grooves, ball peen hammer and mallet.**
- **assemble all parts of the measuring can as per drawing.**



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
1	ISSH 475 x 40 x 0.6		GI SHEET	3	4	1.3.17
1	ISSH 250 x 150 x 0.6		GI SHEET	3	3	1.3.17
1	ISSH 170 x 170 x 0.6		GI SHEET	3	2	1.3.17
1	ISSH 230 x 400 x 0.6		GI SHEET	3	1	1.3.17

SCALE NTS

MAKING A MEASURING CAN

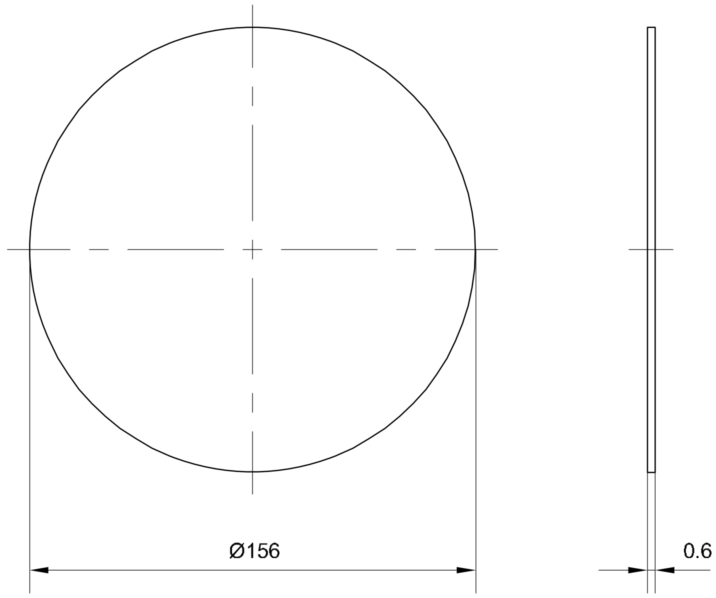
PROJECT: MEASURING CAN

PART: 1.BODY
2.CIRCULAR DISC
3.SPOUT4.FERRULE

DEVIATIONS ±1

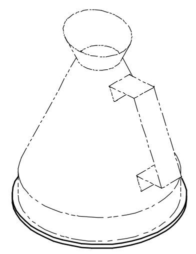
TIME 25h

CODE NO. SM20N1317E8



Job Sequence

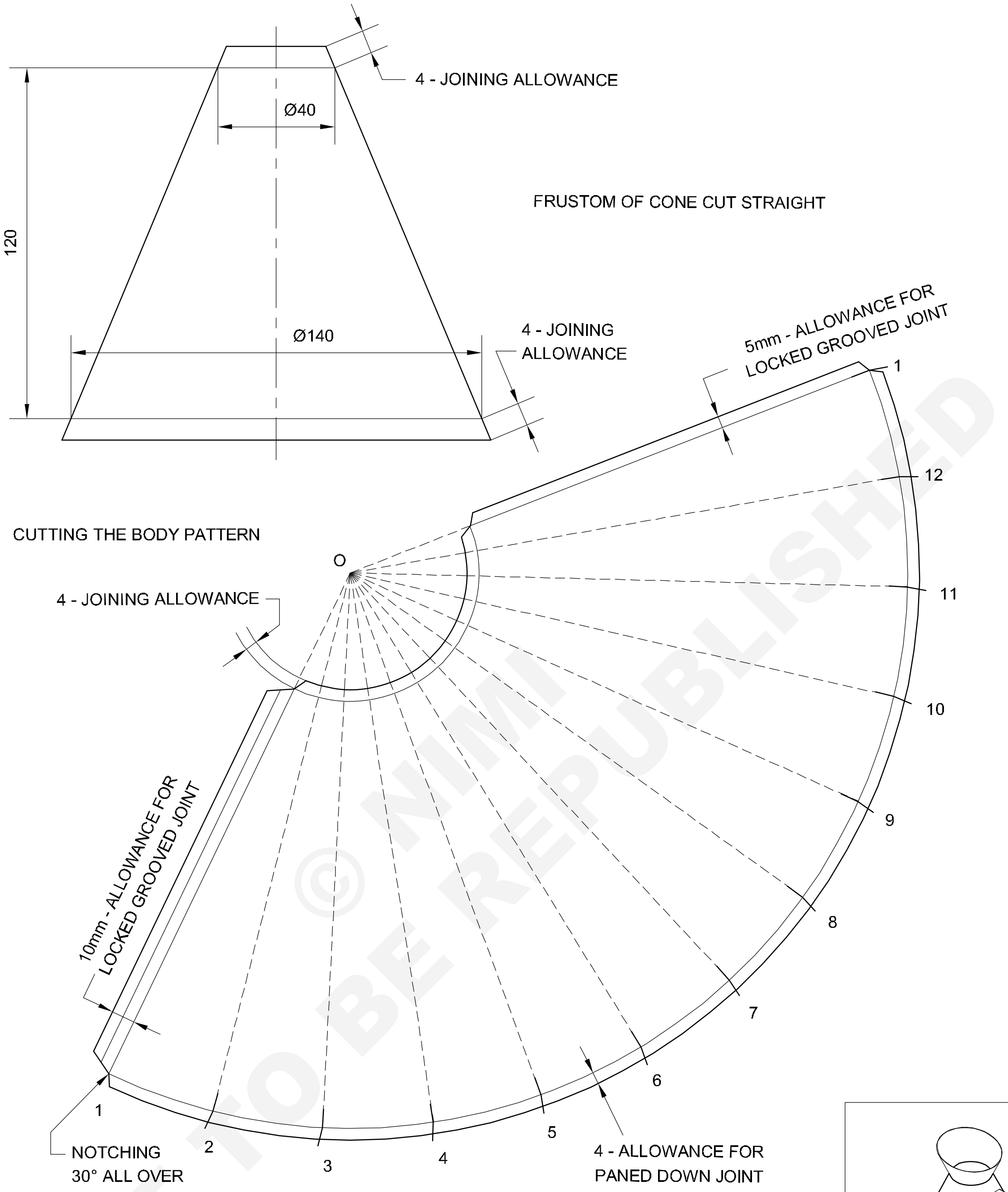
- Planish the sheet on a timan’s anvil using a mallet.
- check the size of the sheet as per job drawing using steel rule.
- Identify the centre point by drawing diagonal lines on sheet.
- Make a pench mark at the centre point using dot pench and 1/2 1b Ball pone hammer.
- Mark circle ϕ156, ϕ148, ϕ138 a using a steel rule and a compass
- Cut circle of ϕ128
- For skill squence refer Exercise :1.2.18

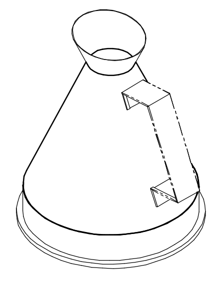


MEASURING CAN

1	ISSH 170 x 170 x 0.6		G.I SHEET	3	2	1.3.17
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

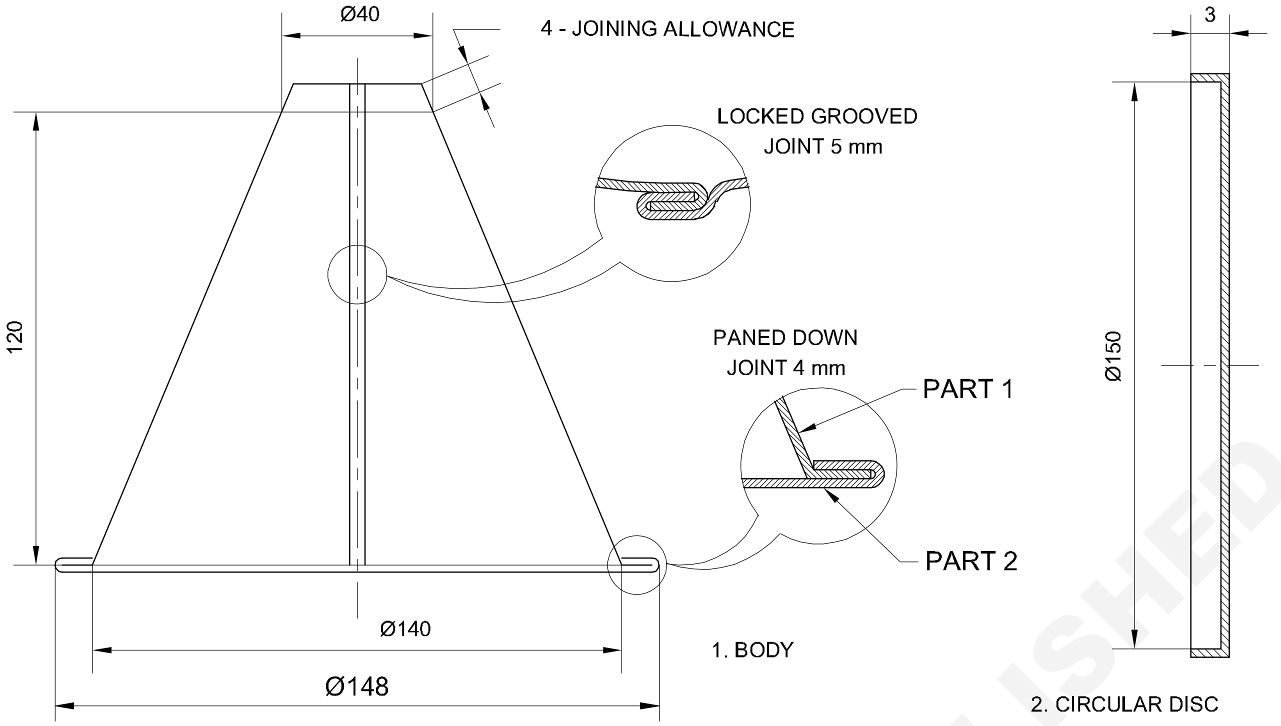
SCALE NTS	**MAKING A MEASURING CAN (CUTTING OFF CIRCULAR DISC BY HAND PROCESS FOR THE BASE OF MEASURING CAN)**	DEVIATIONS ±1	TIME
		CODE NO. SM20N1317E9	





1	ISSH 230 x 400 x 0.6		G.I SHEET	3	1	1.3.17
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	**BODY PATTERN CUTTING**	DEVIATIONS ±1	TIME
		CODE NO. SM20N1317EA	



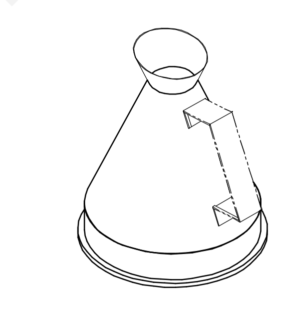
1. BODY

2. CIRCULAR DISC

FIXING THE CIRCULAR DISC WITH BODY

Job Sequence

- Cut the material to the size
- Develop and lay out the pattern for the body of the measuring can by the radial line development method on a drawing paper.
- Parte the drawing paper can the sheet metal by fevicol or gum
- Cut the pattern using a straight snips.
- Take part 1 (body) of the measuring can.
- Make hooks for locked grooved joint, form the conical shape and complete the locked grooved joint.
- Turn the bottom edge of the body suitable to paned down joint.



- Take part 2 (circular disc) of the measuring can and turn the edge as per the job drawing using a half moon stake and a wooden mallet.
- Fix the bottom with body by paned down joint using a setting hammer, a Tinman's anvil and a wooden mallet.

1	--		--	3	2	1.3.17
1	--		--	3	1	1.3.17
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	MAKING A MEASURING CAN	DEVIATIONS ±1	TIME
		CODE NO. SM20N1317EB	

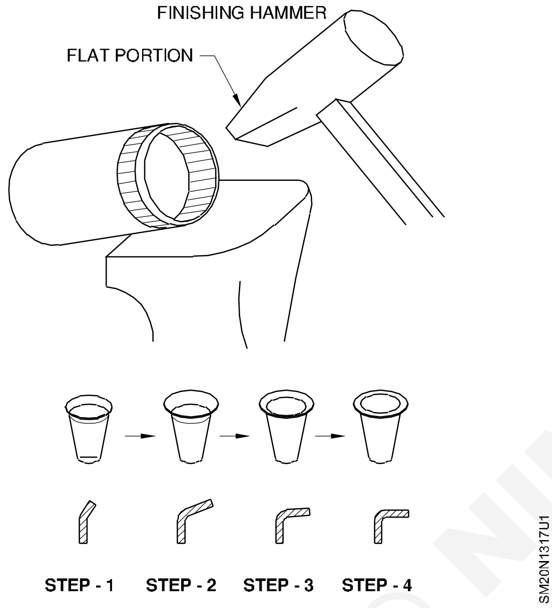
Skill Sequence

Fixing bottom to the body

Objectives: This shall help you to
- **to turn the bottom edge of the body for paned down joint using an anvil stake, a setting hammer and a wooden mallet**
- **fix the bottom to the body by paned down joint using setting a hammer, an anvil stake and a wooden mallet.**

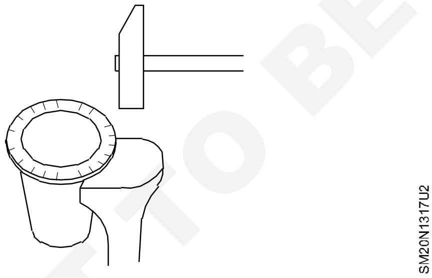
Turn the bottom edge of the body step by step using a Tinman's anvil, a setting hammer and a wooden mallet as shown in Fig 1.

Fig 1



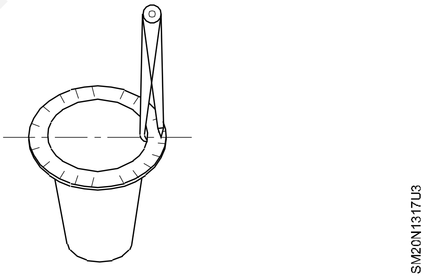
Stretch the flange by the face of the hammer. (Fig 2)

Fig 2



Scribe the flange for the specified size of paned down joint using jenny calipers (Fig 3)

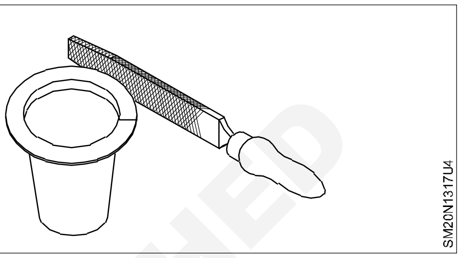
Fig 3



Cut a surplus portion, if excessive, by snips.

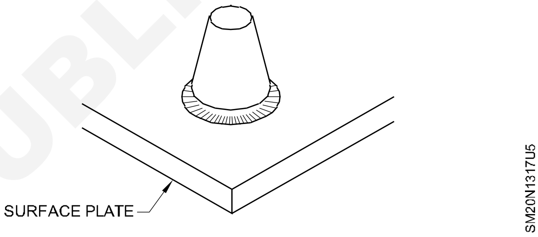
Finish the flange, using a smooth file. (Fig 4)

Fig 4



Check the flatness of the flange on a surface plate. (Fig 5)

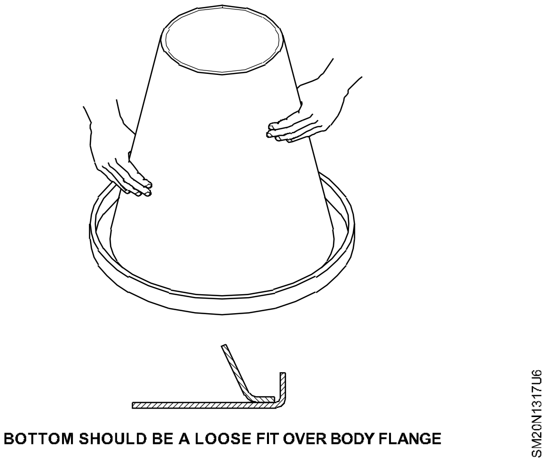
Fig 5



Take the circular disc of required size and turn the flange of required size to suit the paned down joint using a half moon stake and a wooden mallet.

Assemble the body and the bottom (Fig 6) and set the joint by a setting hammer (Fig 7)

Fig 6



Finish the paned down joint step by step (Fig 8).

Strike on the edge of the flange. (Fig 9)

Fig 7

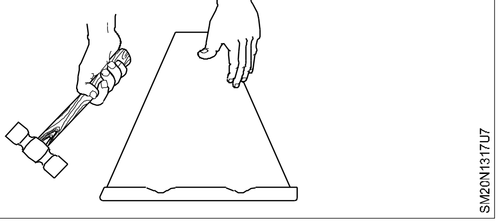


Fig 8

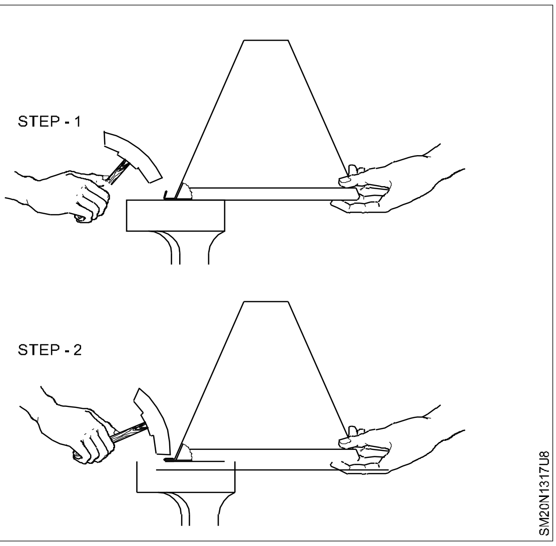
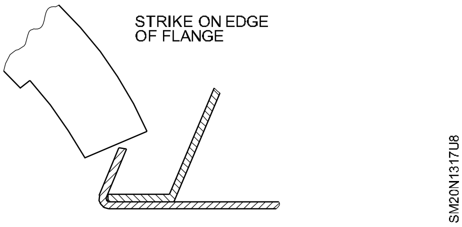
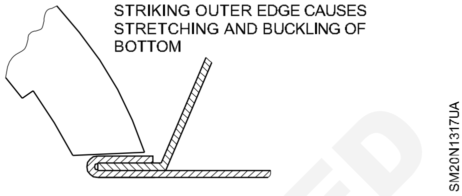


Fig 9



Striking the outer edge causes stretching and buckling of the bottom. (Fig 10)

Fig 10



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Job Sequence

- Cut the material to the size.
- Develop and layout the pattern for spout by the radial line development method on a drawing paper.
- Paste the drawing paper on the sheet metal by fevicol or gum.
- Cut the pattern using a straight snip.

Skill Sequence

Develop layout and cut the pattern for the frustum of a cone cut obliquely

Objectives: This shall help you to

- **develop layout and cut the pattern for the frustum of a cone cut obliquely.**

Draw the elevation of the frustum of a cone cut obliquely. Extend the slant lengths from A & B to meet at the Apex point '0'.

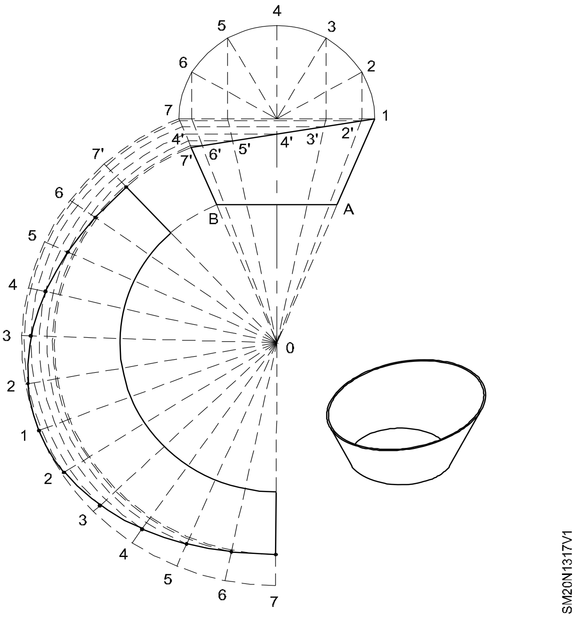
Draw the semi-circle of the base below the elevation and divide the semi-circle into 6 equal parts.

Draw perpendiculars to the base 1-7 from points 2-3-4-5-6 and join these points to the apex '0' by lines, which will cut the obliquely cut bottom (shown by 17' in Fig 1) at the points 2'-3'-4'-5'-6'. Transfer these points horizontally on the slant lengths 0-7 as in Fig 1.

With '0' as centre and OB as radius draw an arc similarly taking '0' as centre and radius equal to 07',06',05',04',03',02',01', (07) draw arcs. (See fig 1)

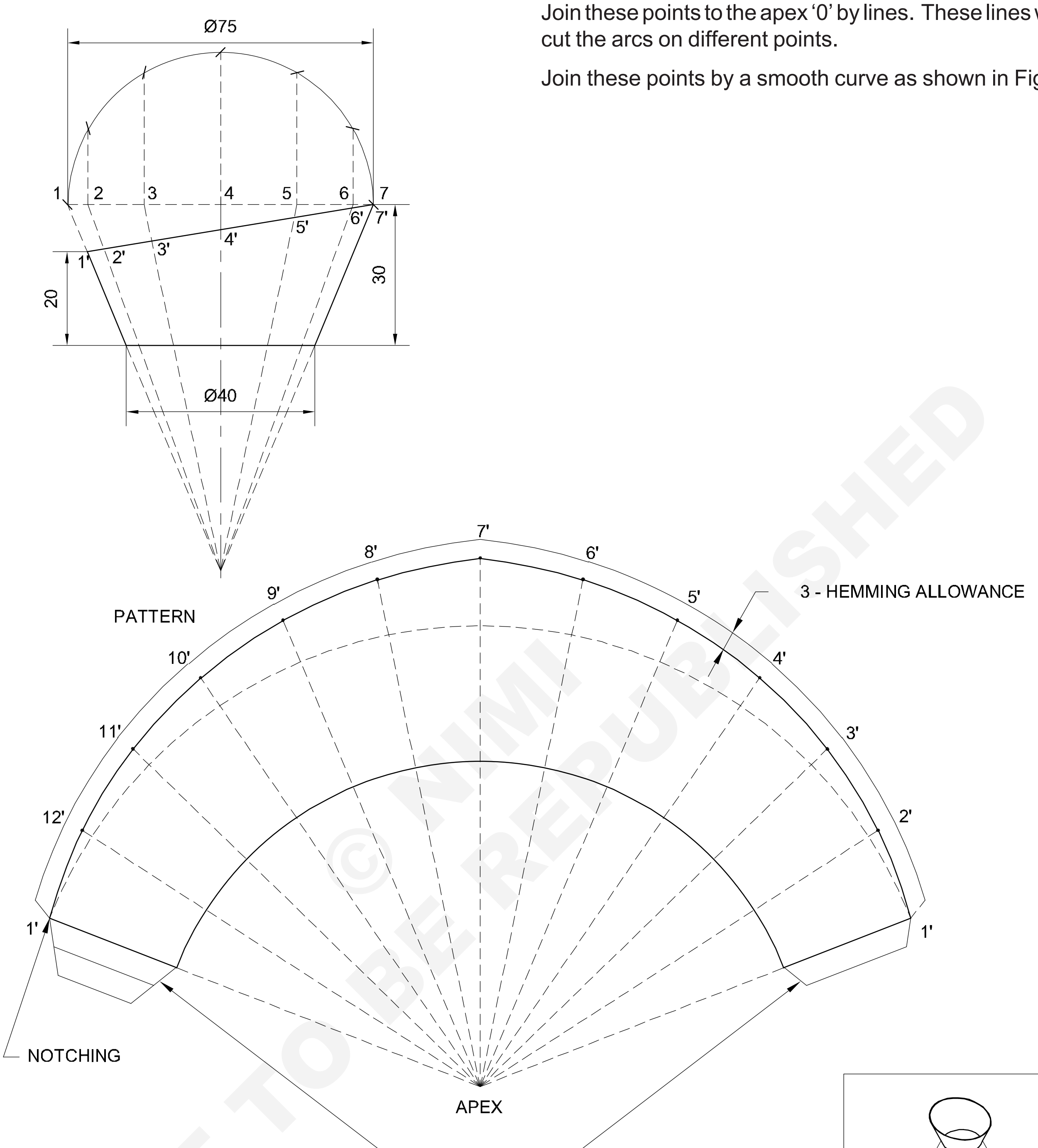
Taking distance 1-2, mark off twelve equal divisions on the major arc 7-7'. Name these points as 7,6,5,4,3,2,1,2,3,4,5,6,7 as shown in Fig 1

Fig 1

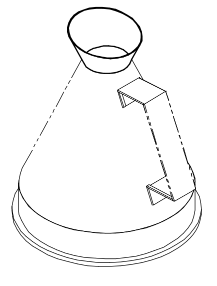


Join these points to the apex '0' by lines. These lines will cut the arcs on different points.

Join these points by a smooth curve as shown in Fig 1

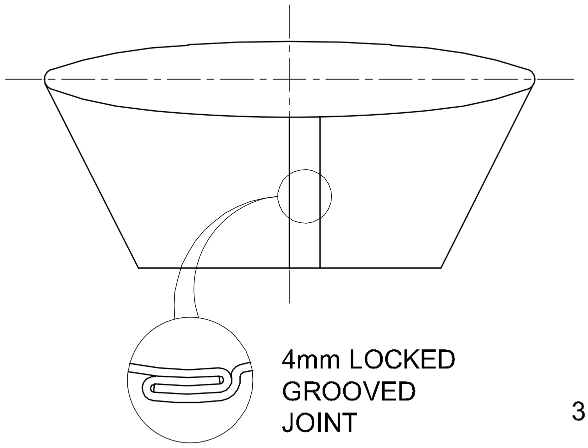


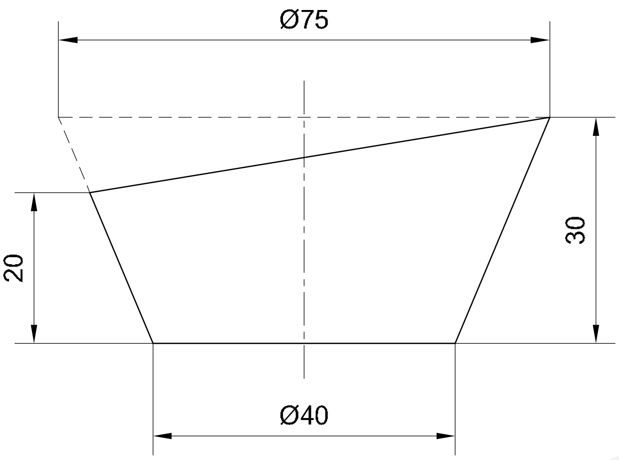
CUTTING THE SPOUT PATTERN
(FRUSTOM OF CONE CUT OBLIQUE)



1	ISSH 250 x 150 x 0.6		GI SHEET	8	3	17
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**SPOUT PATTERN CUTTING**	DEVIATIONS ±1	TIME
		CODE NO. SM20N1317EC	





3. SPOUT

Job Sequence

- Check the pattern for Part No.3. (spout)
- From to concical shape and Lock Groove the joint.
- Make a 3 mm hem on the mouth of the spout. spout. (Part 3)
- Place the spout (Part 3) in position and flare the mouth of the body (Part No. 1).

Fig 1

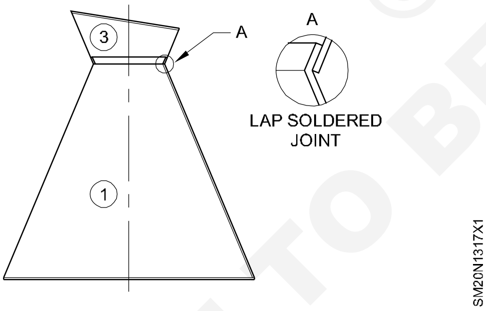
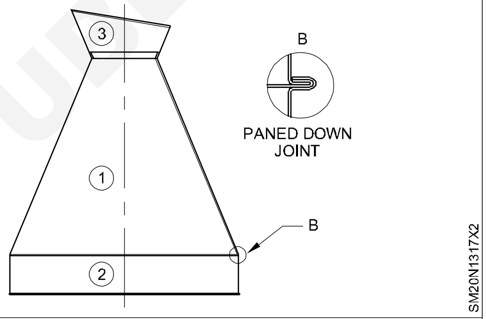


Fig 2



- Place the body (Part 1) in the flanged diameter of the ferrul and complete the paned down joit as in.

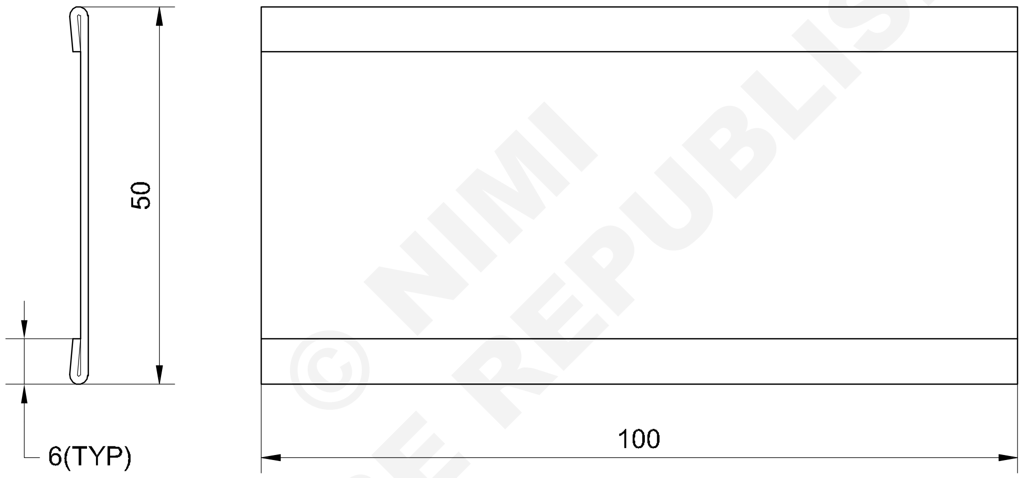
1	ISSH 250 x 150 x 0.6		GI SHEET	--	3	1.3.17
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	MEASURING CAN	DEVIATIONS ±1	TIME
		CODE NO. SM20N1317ED	

Single hemming on the straight edge by hand process

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

- **fold the edge of the sheet metal at right angle using a hatchet stake**
- **make single hemming along the straight edge of the sheet metal using a hatchet stake.**



Job sequence

- Mark and cut the raw material as per drawing.
- Flatten the sheet using a mallet on a dressing plate.
- Mark two lines at a distance of 6 mm from both edges for hemming.
- Hem one edge of the sheet using a hatchet stake and a mallet.
- Hem the other edge similarly.

1	ISSH 105 x 70 x 0.6	⟶ 1-2-07	G.I SHEET	–	–	18
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1

SINGLE HEMMING BY HAND PROCESS

DEVIATIONS ±1

TIME 5h

CODE NO. SM20N1318E1

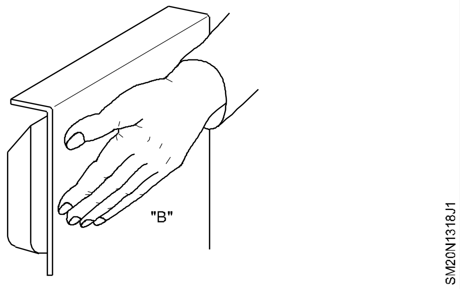
Skill sequence

Single hemming

Objectives: This shall help you to
- **make single hemming at the edge of the sheet using a hatchet stake.**

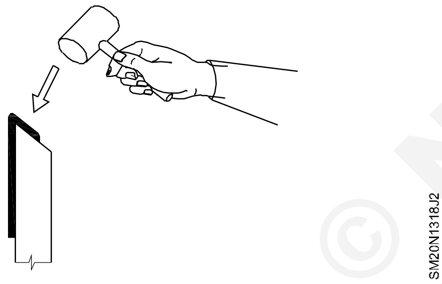
Fold the edge of the workpiece to approximately 90° using a hatchet stake and a wooden mallet. (Ref. Skill sequence of folding at right angle using a hatchet stake)

Fig 1



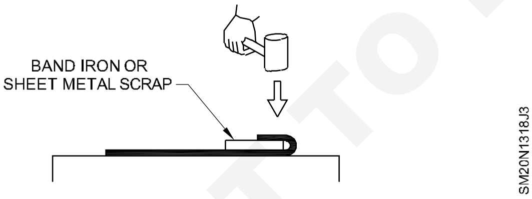
Placing the workpiece vertically on the hatchet stake as shown in Fig 1, increase the angle of bend, by striking with the wooden mallet. (Fig 2)

Fig 2



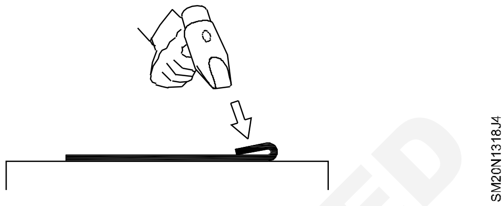
Place a piece of waste sheet and flatten the edge as shown in Fig 3.

Fig 3



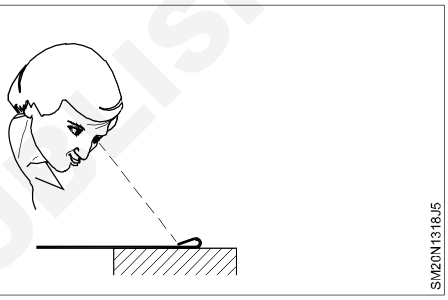
Remove the waste piece and edge down the fold by striking it with end faced mallet in angular position as shown in Fig 4.

Fig 4



Examine the edge for any gap between the edge and the surface of the workpiece. (Fig 5)

Fig 5



If any, finish the edge to get uniform hemming.

Do not crush the folded portions excessively while bending otherwise it may crack.

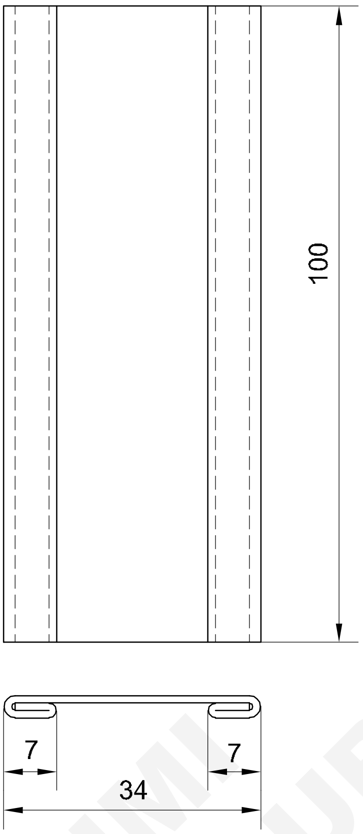
Double hemming by hand process

Objectives: At the end of this exercise you shall be able to
- **mark the allowance for double hemming**
- **make double hemming at the edges of a sheet metal using a hatchet stake.**

Job sequence

Double hemming by hand process

- Use exercise 11 as raw material. Exercise No.11 is already single hemmed.
- Flatten the single hemmed edge of the job material on the dressing plate using a mallet.
- Double hem the edge.
- Repeat the same process to double hem another edge.
- Check the flatness and the straightness. If not, rectify.



1		1-2-07 ←	G.I SHEET	--	--	18
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**DOUBLE HEMMING BY HAND PROCESS**	DEVIATIONS ±1	TIME 5h
		CODE NO. SM20N1318E2	

Skill Sequence

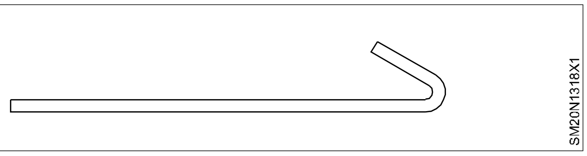
Marking and folding

Objectives: This shall help you to
- **mark the allowance for double hemming**
- **do double hemming on the edges of the sheet using a hatchet stake.**

Mark the first hemming allowance equal to double hemming dimensions ie., 2 times the thickness of thesheet to be used.

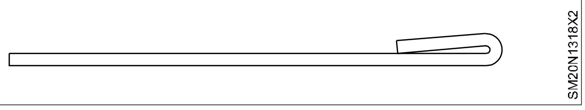
Fold the sheet metal; edge to be folded more than 90^{0} on the hatchet stake using a mallet. (Fig 1)

Fig 1



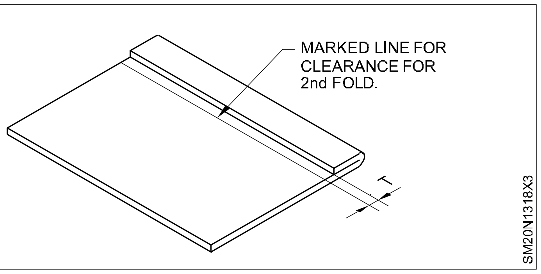
Flat the folded edge on the dressing plate using the mallet. Ensure that there is no gap between the folded edges. (Fig 2)

Fig 2



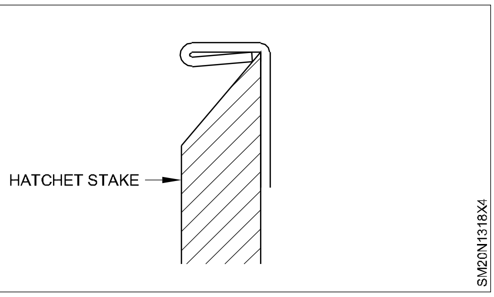
Mark a line from the folded edge at a distance equal to the thickness of the sheet, providing clearance for the second fold. (Fig 3)

Fig 3



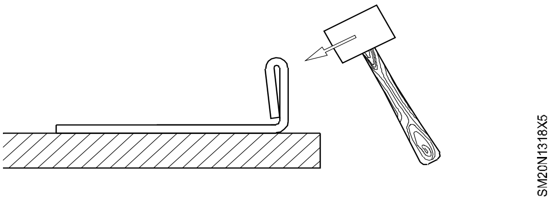
Hold the workpiece vertical, set the marked line matching with the bevelled edge of the hatchet stake and fold the edge to approximately 90^0 using a mallet. (Fig 4)

Fig 4



Now fold the edge further on the dressing plate using the mallet. (Fig 5)

Fig 5

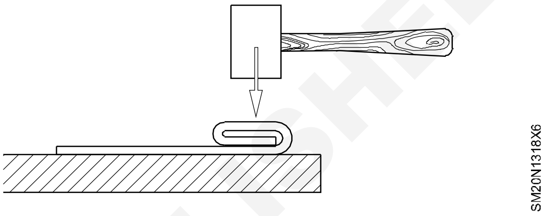


Flatten the edge, without any gap, using the mallet. (Fig 6)

Check the double hemmed edge for flatness and straightness.

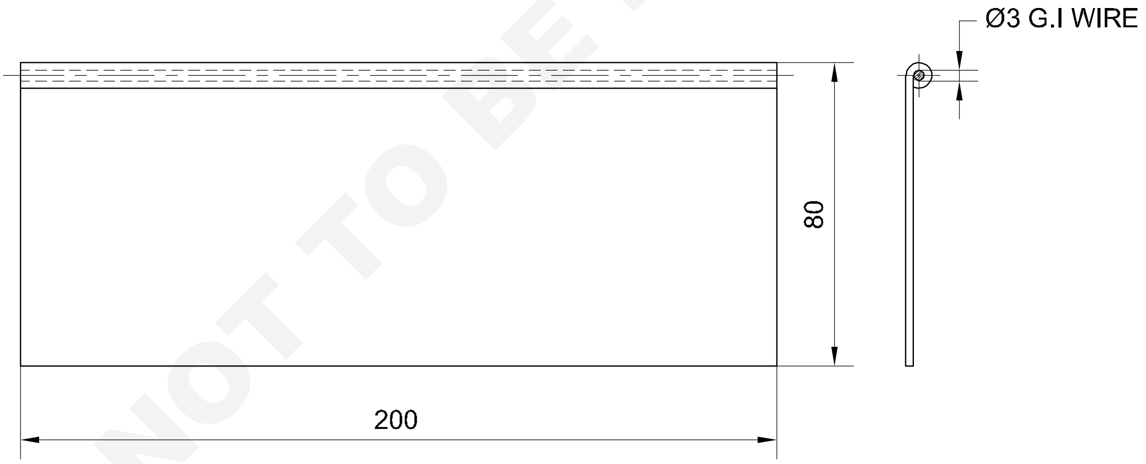
Rectify, if necessary.

Fig 6



Making a straight edge wiring

Objectives: At the end of this exercise you shall be able to
- **calculate theallowance for wiring**
- **make false wiring at the straight edge of the sheet metal by hand process.**



1	Ø3 - 205	--	G.I WIRE	--	--	18
1	ISSH 210 x 95 x 0.5	--	G.I SHEET	--	--	18
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	**MAKING A STRAIGHT EDGE WIRING (BY HAND PROCESS)**	DEVIATIONS ±1	TIME 5h
		CODE NO. SM20N1318E3	

Job Sequence

- Cut the sheet metal to the size 88 x 210mm, using a straight snip and chek the size with a steel rule.
- Flatten the sheet metal on the dressing plate with a wooden mallet.
- Deburr the edges with a smooth flat file 200mm.
- Make 3mm wiring at the straight edge of the sheet metal using an anvil stake, a hatchet stake and a wooden mallet.
- Cut off the surplus wire at the ends using Hacksaw frame with fine blade.
- File the wire ends by a flat smooth file 200mm.

Skill Sequence

Making wired straight edge for stiffening by hand process

Objectives: This shall help you to
- **calculate the wiring allowance and total length**
- **form the edge around the wire and finish as a hatchet stake.**

Calculate the wiring allowance for the given wire of diameter ‘d’ and sheet thickness ‘t’.

Wiring allowance = 2.5 times the diameter of the wire + the Sheet thickness.

Determine the total length of the side.

Total length = length of the side + Wiring allowance.

Cut the sheet metal to the required size using a straight snip.

Flatten the sheet on the dressing plate by a mallet and deburr the cut edges by a flat smooth file.

Mark two lines parallel to the edge of the sheet metal at a distance of 1/4th of the total wiring allowance.

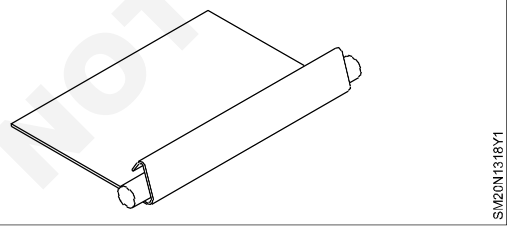
Fold at the first line nearer to the edge at right angle on the steel plate or the hatchet stake using a wooden mallet.

Make an another fold at the second marked line to 30° on a hatchet stake using a wooden mallet.

Take a wire of given diameter slightly longer than the length of the edge to be wired.

Place the wire at the folded edge and tap the edge by a wooden mallet using an Anvil or Anvil stake as base. (Fig 1)

Fig 1



Form the edge around the wire by striking the wooden mallet. (Fig 2)

If the edge is too narrow, give blows in the direction shown in Fig 3.

If the edge is too wide give blows in the direction shown in Fig 4.

Fig 2

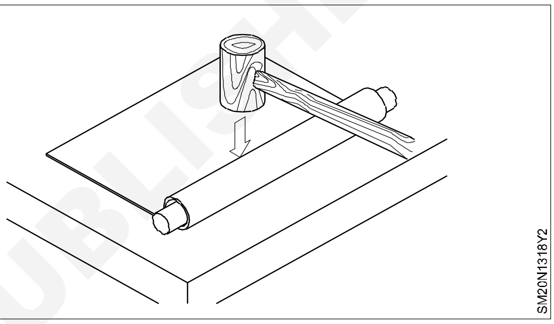


Fig 3

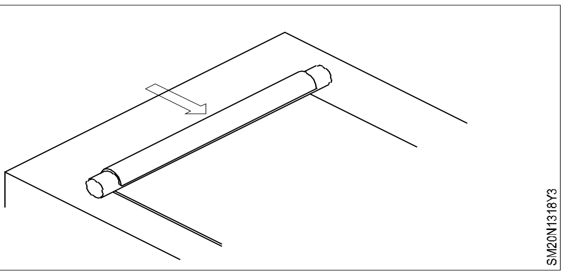
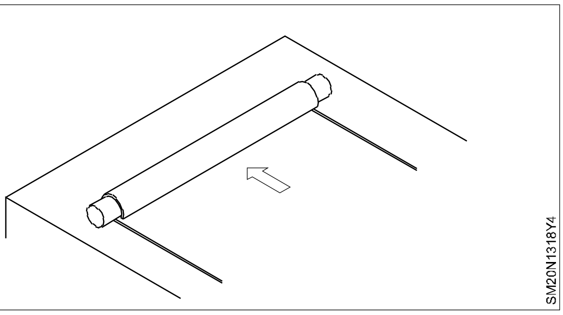


Fig 4



Finish the wired edge on the edge of the Anvil or Anvil stake by striking the wooden mallet in different directions. (Fig 5&6)

Finally finish the wired edge on a hatchet stake as shown in the Fig 7.

Cut off the surplus wire at the ends.

File the ends of wire using a flat smooth file.

Fig 5

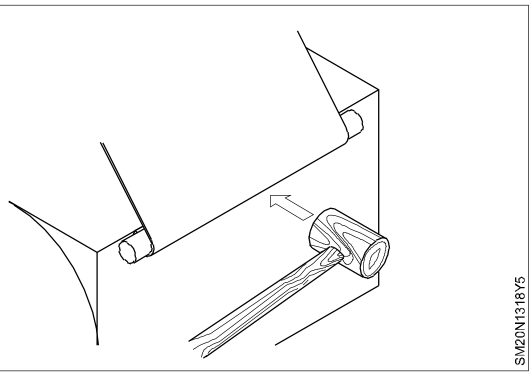


Fig 7

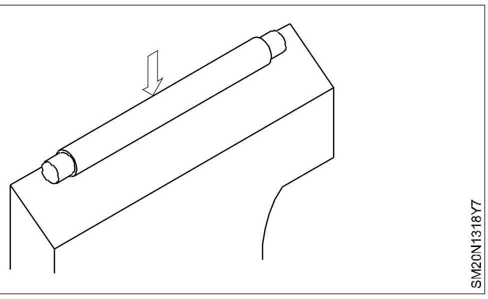
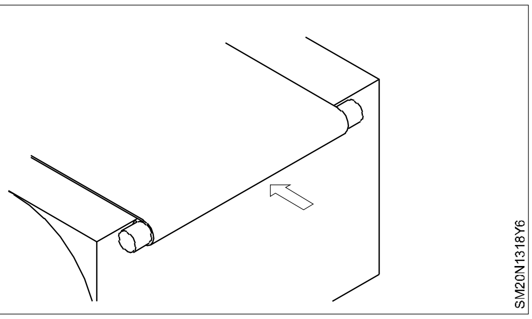
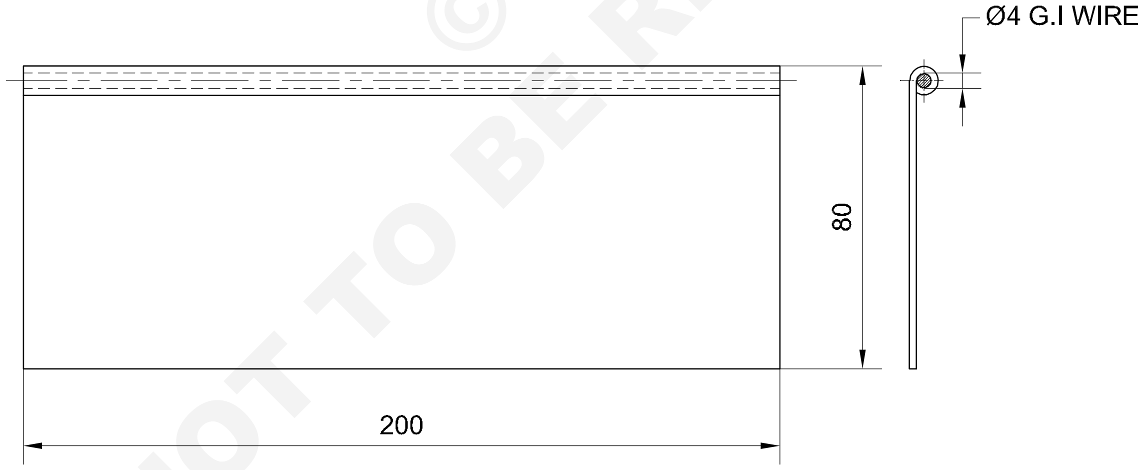


Fig 6



Making a false wiring at straight edge

Objectives: At the end of this exercise you shall be able to
- **calculate theallowance for wiring**
- **make false wiring at the straight edge of the sheet metal by hand process.**



–	Fe 310 x Ø4 - 210	–	G.I. WIRE	–	–	18
1	ISSH 210 x 100 x 0.5	–	G.I. SHEET	–	–	18
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	**MAKING A FALSE WIRING AT STRAIGHT EDGE (BY HAND PROCESS)**	DEVIATIONS ±1	TIME 5h
		CODE NO. SM20N1318E4	

Job Sequence

- The job sequence is similar to Exercise : 1.2.21 of making straight wired edge except after finishing straight wired edge, remove the wire by holding the wire end in the benchvice and slowly pulling out the workpiece by hand.

Skill Sequence

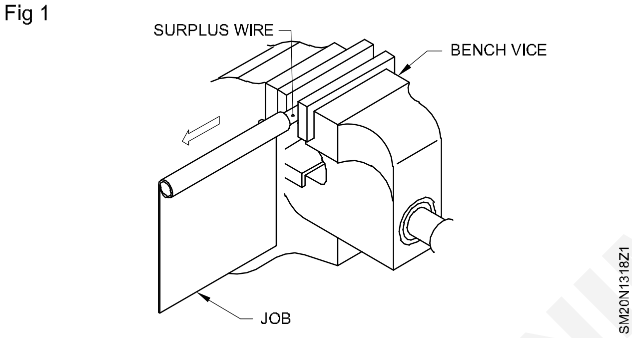
Making false wiring at the sraight edge

Objectives: This shall help you to

- **make false wiring at the straight edge of sheet metal by hand process**

This skill is similar to Ex.No.38 of “making straight wired edge” except after finishing straight wired edge, remove wire from the edge holding the surplus wire at the end in benchvice and pulling out workpiece by hand. (Fig 1)

Fig 1



Apply few drops of oil from the ends of edge, for easy removal of wire from the edge.

Sometimes, oiling is done on the surface of edge before forming the sheet around the wire for easy removal of the wire.

Sometimes the wire is pulled out by hand, holding it in cutting plier (Fig 2) or the surplus length of the wire outside the edge is bent for gripping the wire in hand and it is pulled out by rotating it. (Fig 3)

Fig 2

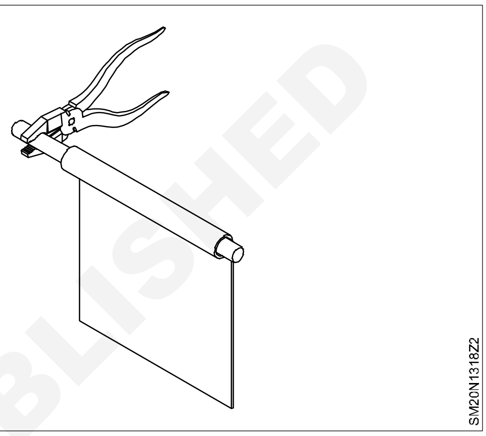
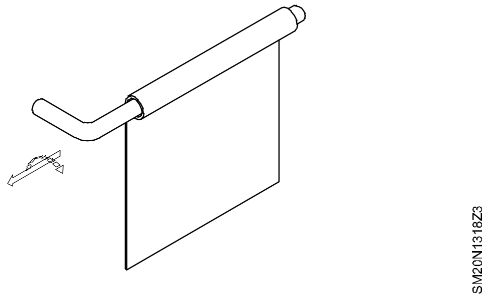


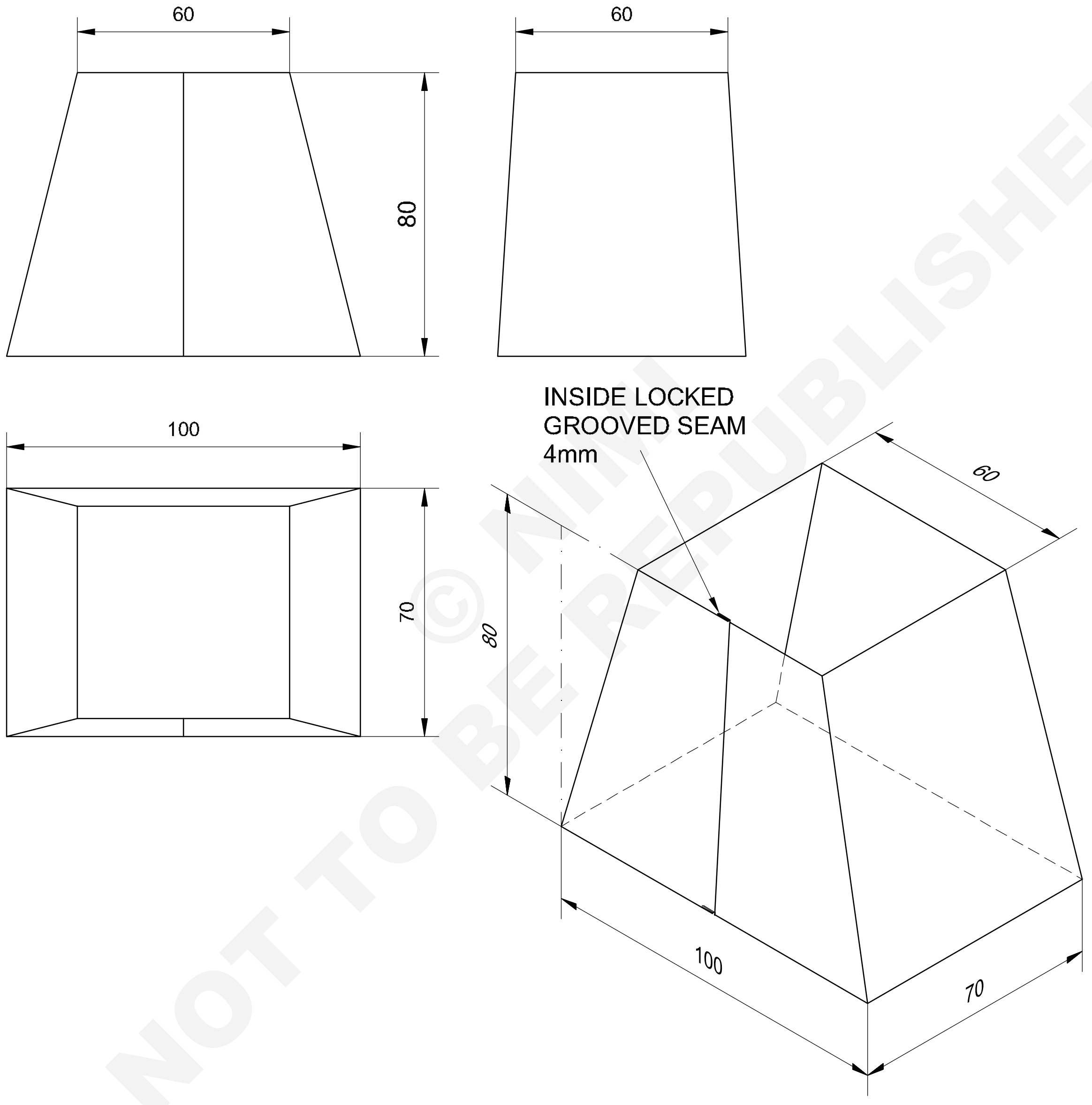
Fig 3



Making a taper chute square to rectangle transistor

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

- **develop the pattern for making square to rectangle transition with the given accuracy by triangulation method**
- **form square to rectangle transition pipe using beak iron stake and wooden mallet.**



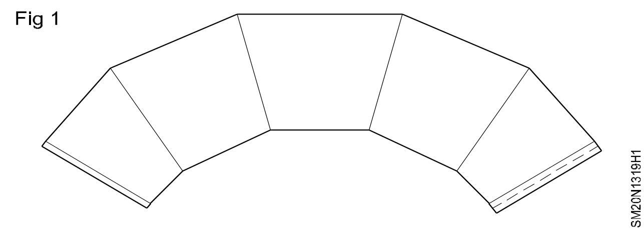
1	ISSH 340 x 0.61 - 160	–	G.I. SHEET	–	–	19
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	MAKING A TAPER CHUTE SQUARE TO RECTANGLE TRANSITION	DEVIATIONS ±1	TIME 5h
		CODE NO. SM20N1319E1	

Job Squence

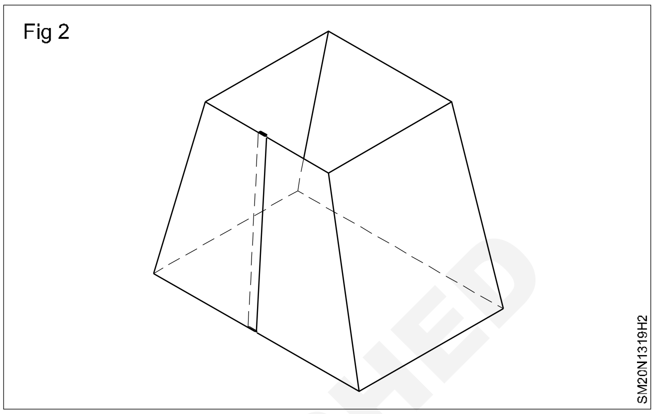
- Develop the pattern by triangulation method for square to rectangle transition. (Fig 1)

Fig 1



- Cut the pattern and deburr the edge using file.
- Form hooks on opposite sides and fold the sheet to the required shape and make a grooved joint.
- Make inside locked grooved joint on the body using seam closing machine (seaming machine).
- Form the square to rectangle transition pipe using beak iron stake and wooden mallet and check its dimensions as shown in (Fig 2).

Fig 2



Skill sequence

Developing pattern for square to rectangle transition

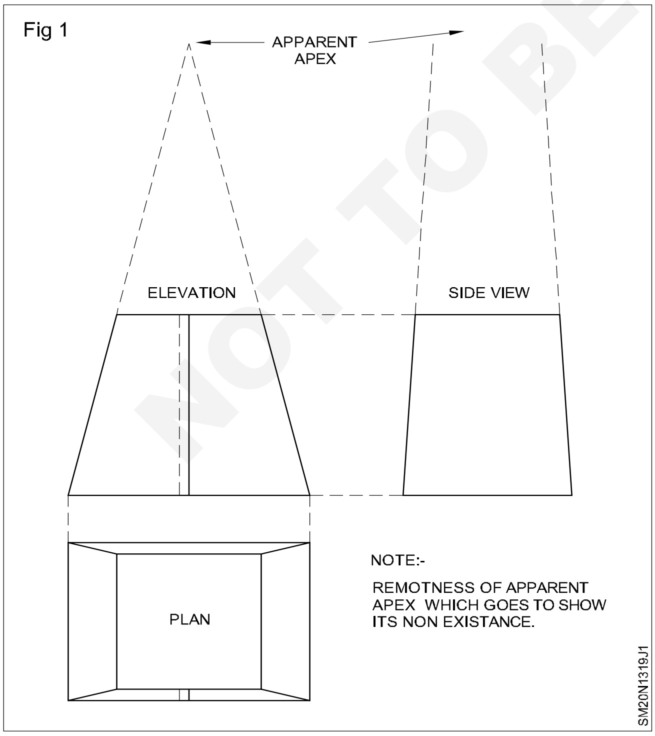
Objectives: This shall help you to

- **develop the pattern for square to rectangle transition by trianmgulation method**

Draw elevation, side view and plan as per drawing and project its sides as shown in Fig 1. While projecting the sides in elevation and side view, the produce do not converge to an apex of equal height. (Fig 1)

Therefore, it is impossible to develop the pattern by radial line method or by parallel line method development.

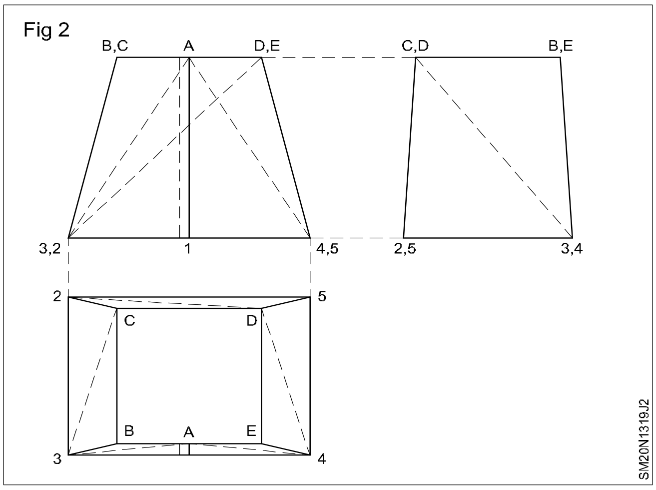
Fig 1



NOTE:-
REMOTNESS OF APPARENT APEX WHICH GOES TO SHOW ITS NON EXISTANCE.

Number and letter the points and draw diagonals by dotted lines and form series of triangles (10 Nos.) on its surface. (Fig 2) In this, length of the sides of square and rectangle and vertical height alone are true lengths. Others are false. To find out true slant height and diagonals draw vertical height line XY 80 mm. At the base of the vertical line draw horizontal line on right and left sides. (Fig 3)

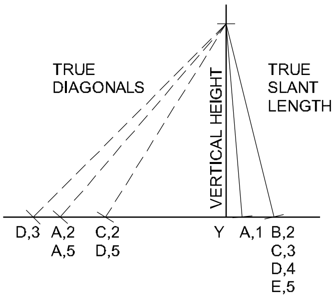
Fig 2



Take plan slant length A.1 and mark it off on the horizontal line on right side from Y. Join this point to X. This gives the true slant length of point A1. Then take plan slant length B2 and repeat as previously done. This gives true slant lengths of B2,C3,D4 and E5.

Take plan diagonal A2 and mark it off on the horizontal line left side from Y. Join this point to X. This gives the true diagonal length of point A2 and E5. Take plan diagonal of point C2, D5 and D3 and repeat as previously done. This gives true diagonals of C2, D5 and D3 as shown in Fig 3.

Fig 3



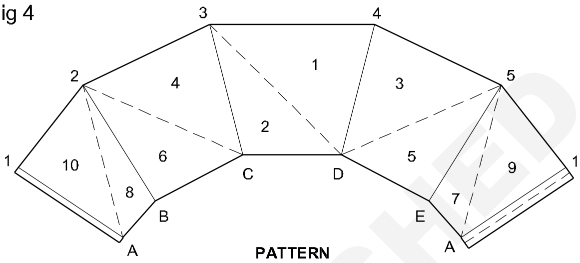
TRUE SLANT LENGTH AND DIAGONALS

Pattern development: To draw triangle No.1(34D) take length of 3.4 from plan and draw a line horizontally and name as 3-4. Obtain true slant length of 4-D and diagonal of 3-D, swing arcs from 4 and 3 respectively. It cuts at one point, name it as D. Join 4-D as thick line and 3-D as dotted line. This gives triangle No.1(34D). To draw triangle No.2 (3CD) take true slant length of 3-C and side length of C-D from plan, swing arcs from 3 and D respectively. It cuts at one point, name it as C. Join 3C and D-C as thick line. This gives triangle No.2(3CD).

Repeat the same procedure of laying triangles No.3(4D5), No.4(3C2), No.5(5DE)), No.6(2CB), No.7(5EA), No.8(2BA), No.9(5A1) and in No.10(2A1) side by side by proper order by obtaining true lengths and true diagonal and sides alone from plan and complete pattern as shown in Fig 4.

Mark the joining allowances on both ends of the pattern.

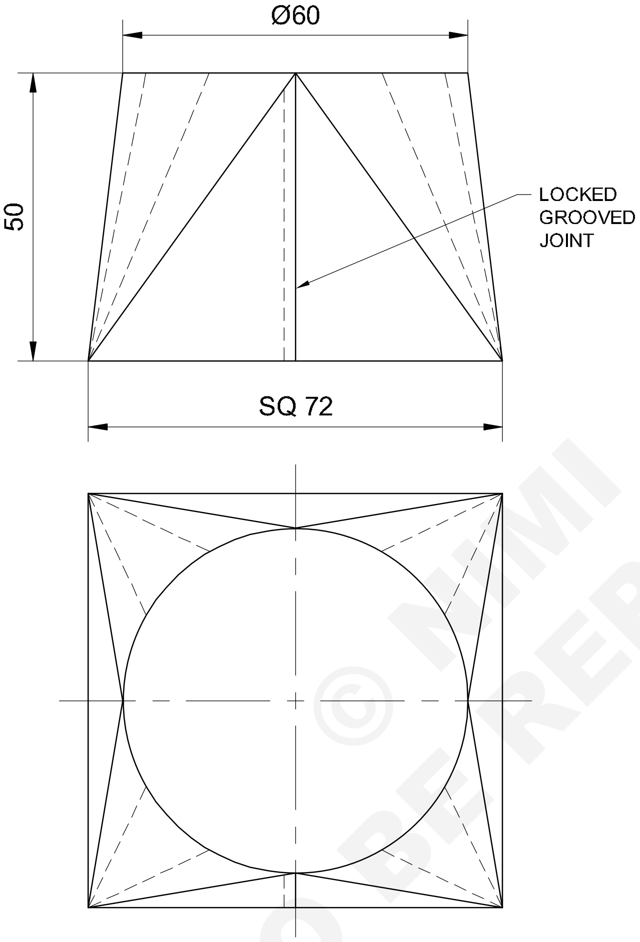
Fig 4

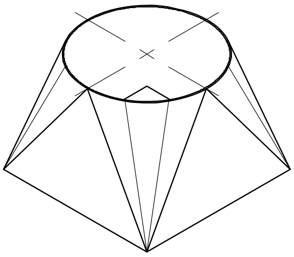


PATTERN

Making a taper chute square to round transition

Objectives: At the end of this exercise you shall be able to
- **develop the pattern for square to round transition by triangulation method**
- **form square to round transition and join by locked grooved joint.**





Job sequence

- Cut the material to the required size.
- Develop and layout the pattern for square to round transition by triangulation method and cut it.
- Form the shape using hatchet stake, wedge piece and mallet.
- Join with locked grooved joint.

1	ISSH 225 x 0.61 - 105	–	G.I. SHEET	–	–	20
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**MAKING A TAPER CHUTE SQUARE TO ROUND TRANSITION**	DEVIATIONS ±1	TIME 5h
		CODE NO. SM20N1320E1	

Skill sequence

Make square to round transmission

Objectives: This shall help you to

- **to form the square to round transition using hatchet stake, wedge piece and wooden mallet and join by locked grooved joint.**

Check the pattern already cut with reference to the job drawing.

Make hook shape on both ends in opposite direction in order to make locked grooved joint by using hatchet stake and wooden mallet.

Make impression on each line of the pattern by wedge.

Fold the impression regularly and bring to the shape as per job drawing.

Set the locked grooved joint and lock it with 4 mm. Hand groover and 1 1/2 lb Ball pane hammer.

Form the correct shape of round and square using beak iron stake and flat bar.

Check the dimension of the square and round.

Develop and layout the pattern for square to round transition by triangulation method

Objectives: This shall help you to

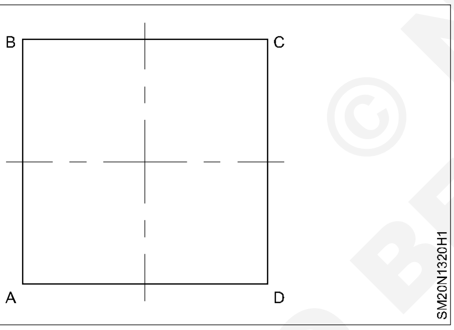
- **develop and layout the pattern for square to round transition by triangulation method.**

To draw the plan

Draw horizontal and vertical centre lines.

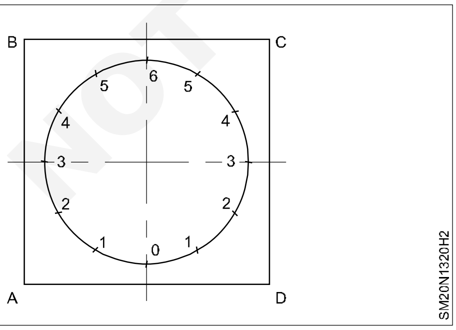
Based on the centre line mark 72 mm square and name the corner points by letters A,B,C,D as shown in Fig 1.

Fig 1



From the centre of the Fig 1. draw a 60 mm dia circle and divide it into twelve equal parts and number as “o” to “6” and “6” to “0” as shown in Fig 2.

Fig 2



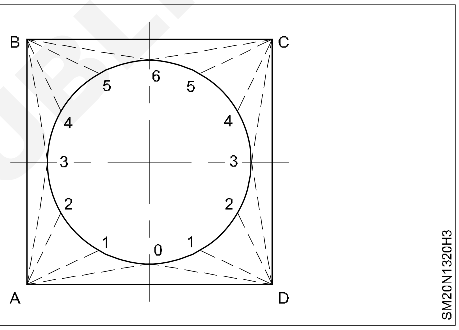
Join the A0, A1, A2, A3, B3, B4, B5, B6, C6, C5, C4, C3, D3, D2, D1, D0 as shown in Fig 3.

Now the plan is completed.

To draw the front view

Draw a parallel line to BC, line of the plan. Give letter AD.

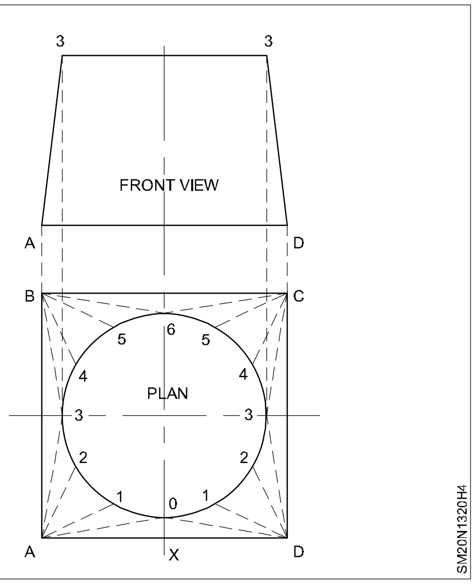
Fig 3



From the centre of AD line draw a perpendicular line for the height of 50 mm.

From that point draw a parallel line and mark 30 mm on both sides. Give number 3, 3 as shown in Fig 4.

Fig 4

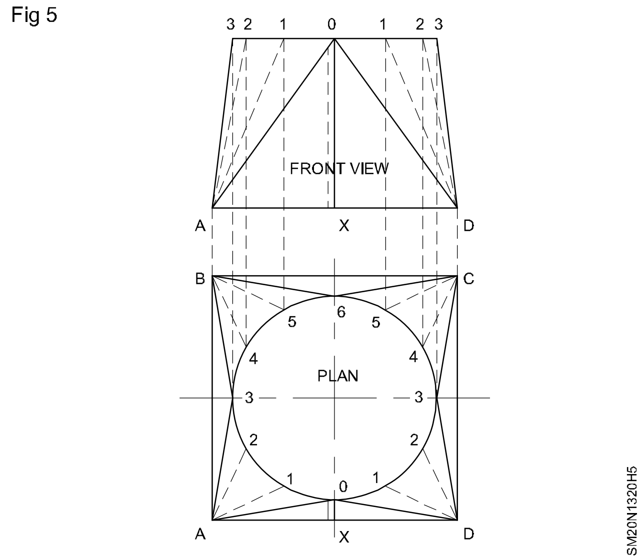


Join A3, and D3 as shown in Fig 4.

Now you get the outline of the front view.

From the plan, project all the lines from each point as shown in Fig 5.

Fig 5

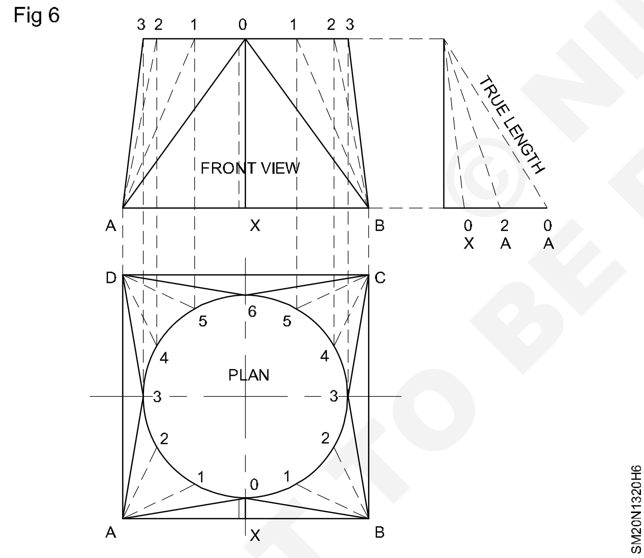


To draw true length

To draw the true length extend the base line of the front and from any point draw a perpendicular line.

Extend the top of the front view (Fig 6) in order to cut the perpendicular line.

Fig 6



Now the distance between the base line and top line is the vertical height.

Take the distance from plan X to 0, 1 to A, 0 to A and cut on the base line.

From these points, join all the lines to the top of the vertical height as shown in Fig 6.

Now you get the true length of all the sides.

A0, A3, B3, B6, C6, C3, D3, D0 all are equal to A as shown in Fig 6.

A1, A2, B4, B5, C5, C4, D2, D1 all are equal to A1 as shown in Fig 6.

OX is the joint line as shown in Fig 6.

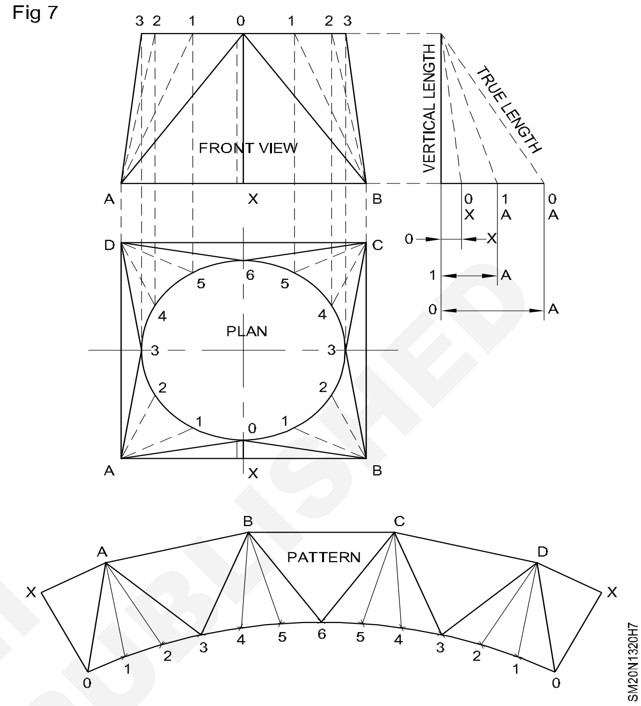
To draw the pattern

Draw a straight line the distance of OX from true length.

Take the true length of OA and mark an arc taking 0 as centre.

From X cut the arc from the distance of XA as in Fig 7.

Fig 7



Now you get "OXA" as triangle.

From "A" take the true length of A1 and mark an arc.

From "O" take distance 01 from plan and cut an arc.

Now join the arc point to "A".

Now you get "01A" as a triangle.

Take true distance for a A to 2 and mark an arc from A.

Take one division 1 to 2 and cut an arc from 1.

Now you will get 12A as a triangle.

Take true length of A3 and mark an arc from A.

From "2" take distance 2.3 from plan and cut at "3".

Joint "3A". Now you get "23A" as a triangle.

Take the distance "AB" from plan and mark an arc.

From 3 take the true length 3B and cut an arc.

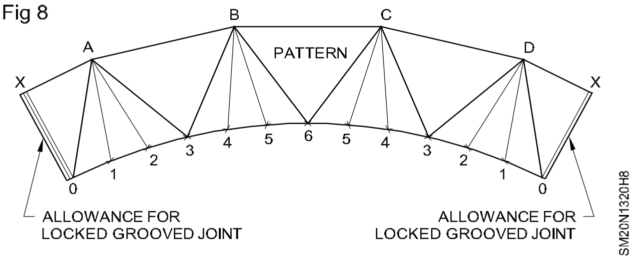
Now join this point to "A" and 3.

Now you get AB3 as a triangle.

Accordingly, complete the entire pattern as shown in Fig7.

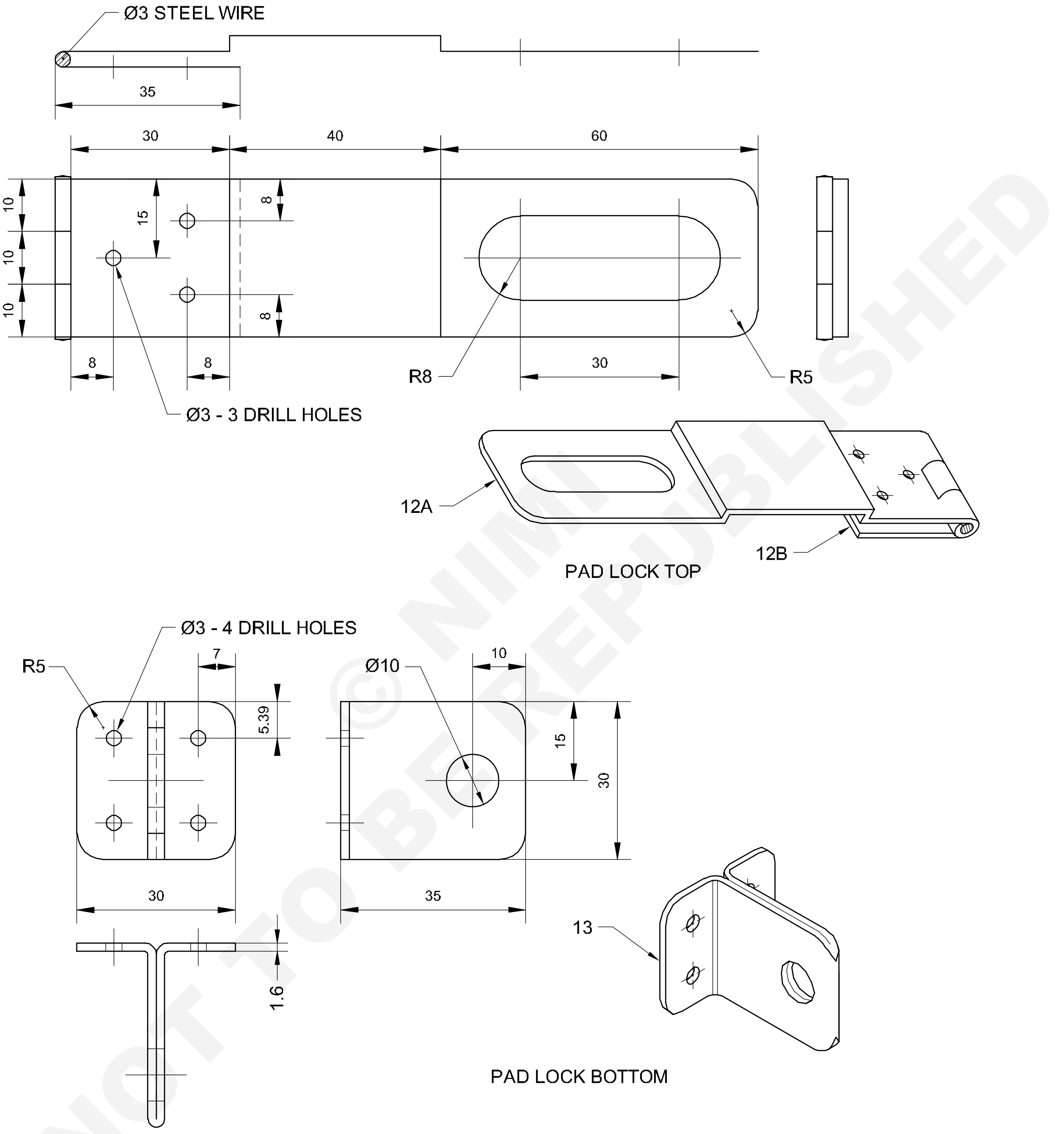
Then add allowance for locked grooved joint on both ends as shown in Fig 8.

Fig 8



Making holes with solid punches, round punches as per Bis

Objective: At the end of this exercise you shall be able to
- **state the punch holes of different diameters.**



1	ISSH 1100 x 35 - 1.6	–	M.S SHEET		13	03
1	Fe Ø 3.5 - 40	–	M.S WIRE		12	03
1	ISSH 200 x 35 - 1.6	–	M.S SHEET		12	03
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1

PROJECT: TRUNK BOX (ASSEMBLY)
PART: **12. PAD LOCK TOP**
PART: **13. PAD LOCK BOTTOM**

DEVIATIONS ±
TIME h
CODE NO. SM20N1321E1

Job Squence

Pad lock top

- Calculate the length and width required to make pad lock top as per job drawing by allowing allowance for cramped joint, tabs and mark centres to drill holes.
- Make pad lock hinge by joining two sheet metal pieces of pad lock top by cramped joint and check its movement.
- Make slot on Part A and 3 mm f holes on Part B. Form the same to the required shape.

Pad lock bottom.

- Cut and deburr the marked piece of the pad lock bottom form it to the required shape by folding.
- Drill ϕ 10 mm and ϕ 3 mm holes at their respective centres and remove the burr.
- Make 5 mm radius on the corners of the bottom.

Skill sequence

Making holes with solid punches, round punches as per Bis

Objective : This shall help you to

- **state the hinges with free movement by hand process.**

Preparation hinge

Mark out wire edge and tabs allowance as in Fig 1.

For better illustration let us take the following dimensions.

X = $2\frac{1}{2}$ d = 4 x 2.5 = 10 mm

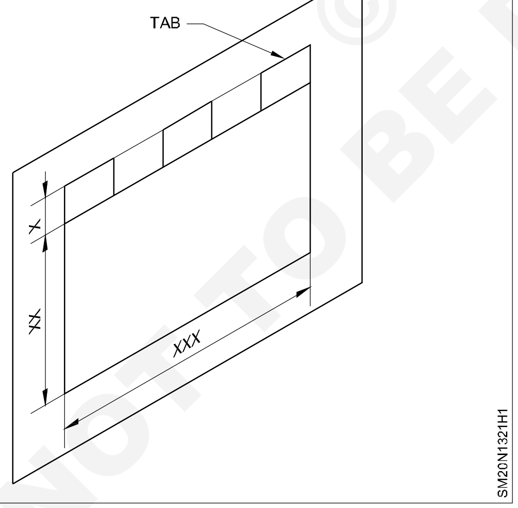
XX = 45 mm

XXX = 75 mm

Tab width = 15 mm

d = diameter of wire 4 mm

Fig 1



Use fixed marking gauge, steel rule, try square and scriber.

Cut unwanted material along the outer line, form taps by slitting, using bench lever shears. Cut off unwanted taps using chisel and hammer and deburr the cut area. (Fig 2)

Bend sheet ‘A’ to right angle along the scribed line on the benchvice. Then fold down to sharp angle using hatched stake and hammer. (Fig 3)

Take 90 mm long 4 mmϕ wire and deburr the ends.

Fig 2

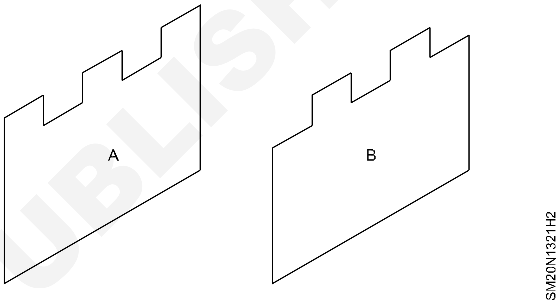
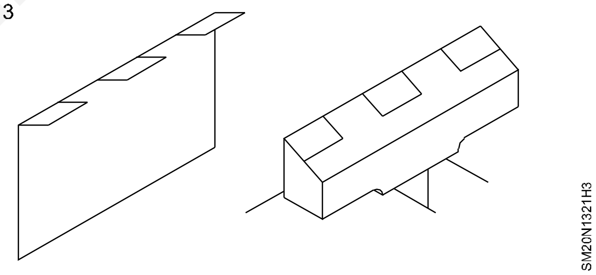


Fig 3



Place the wire as in Fig 4 and tap over the edge by keeping the sheet on the anvil stake. (Fig 5)

Fig 4

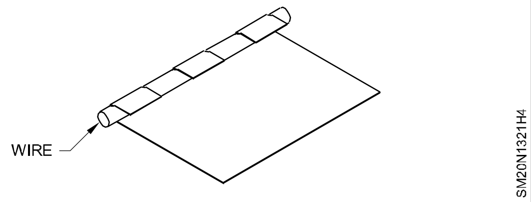
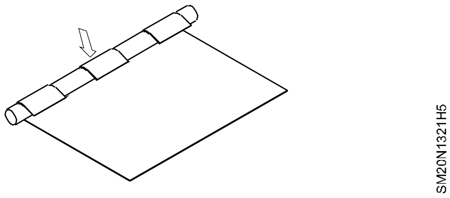


Fig 5



If the edge is too narrow after tapping, give below in the direction, indicated in Fig 6. If the edge is too wide give blows in the direction. Indicated in Fig 7, 8 & 9.

Fig 6

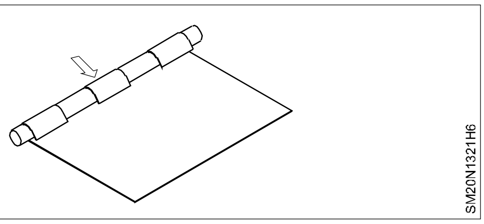


Fig 7

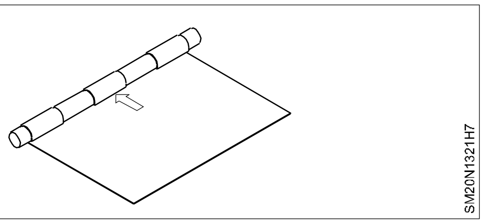


Fig 8

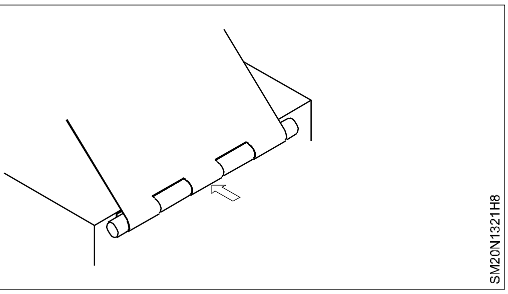
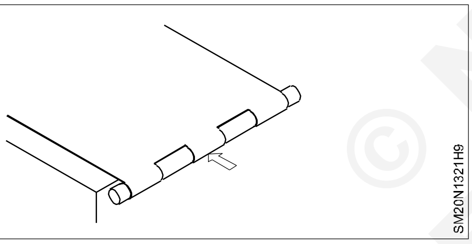
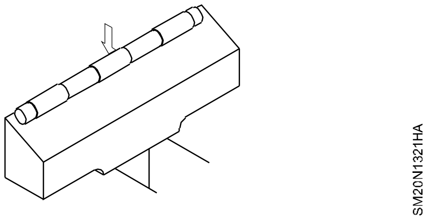


Fig 9



Finish the wired edge step by step by giving blows in the direction, indicated by arrow as shown in Fig 10. First two steps should be done on the edge of the anvil stake and final step on the hatchet stake.

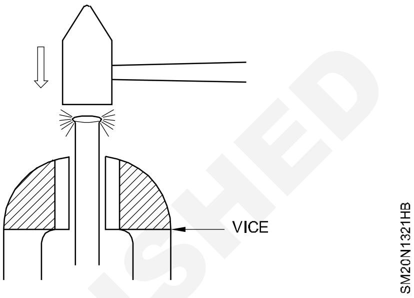
Fig 10



Remove the wire from the wired edge. Take sheet 'B' and make wired edge as is done for 'A' and remove the wire.

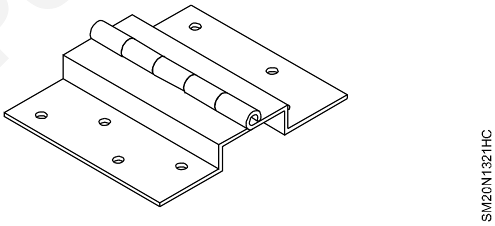
Hold ϕ 4 mm wire on the benchvice and form, snap on one end by hammer as shown in Fig 11.

Fig 11



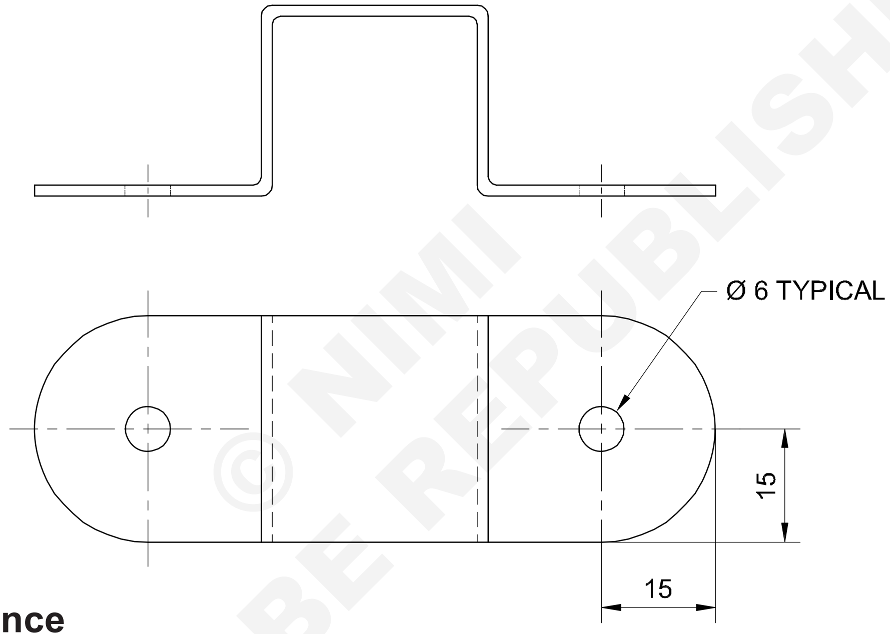
Place two wired edges opposite to one another (if the wired edge is not meshed with one another, file the edge by flat file gently and mesh it) and insert the snap formed wire and form snap on the other end and finish the hinge. (Fig 12)

Fig 12



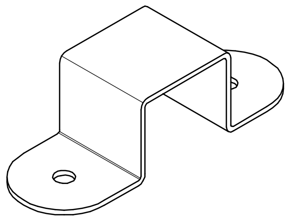
Punching holes using a solid punch

Objectives: At the end of this exercise you shall be able to
- **file the burr at the edges of a shhet metal using a flat file smooth**
- **punch correct size holes using a solid punch**
- **Finish the punched hole by removing burr and planish the bulging.**



Job Sequence

- File the burr on both sides of the job, using a smooth round file.
- Planish the punched area on a tinman's anvil for flatness.



1	ISSH 145 x 40 x 0.6		–			22
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**PUNCHING HOLES USING A SOLID PUNCH**	DEVIATIONS ±1	TIME 10h
		CODE NO. SM20N1322E1	

Skill Sequence

Positioning the punch and finishing the punch holes in solid and round punch

Objectives: This shall help you to

- **position the centre of the punch hole**
- **planish the bulging of punched hole.**

Punching is an operation of producing holes on a thin section material using a punch.

Hold the solid punch in vertical position on locating marks on the workpiece by one hand and strike the head of the punch by ball peen hammer in other hand till you get the hole. (Fig 1)

Position the punch such that the four locating points, coincide with the circular cutting edges of the punch, otherwise the centre of the punched hole will get displaced.

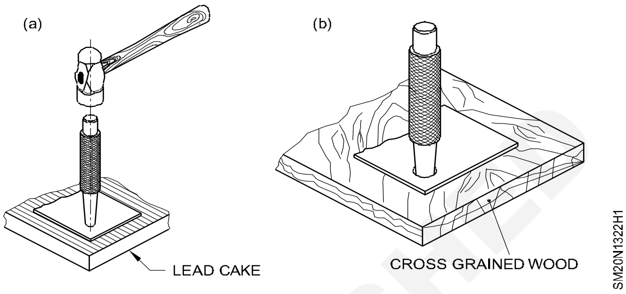
Use a lead cake or a cross grained wooden block as a supporting base.

While striking, watch the cutting point and not the head of the punch.

While striking the hammer, ensure that, the hammer strikes at the centre of its bottom face and top face of the punch. Otherwise, the position of the punch gets disturbed and oblong hole is produced. Sometimes, the punch may slip off from its position and cause accident.

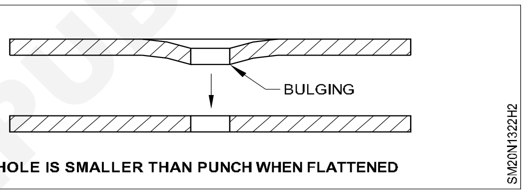
While using wooden block as the supporting base, the sheet should be placed at gross grained end of the wood, otherwise, distortion is caused. (Fig 2)

Fig 1



A punched hole diameter reduces slightly, when the sheet is flattened after punching . Finishing the punched hole. File the burr, then planish the bulging caused due to punching. (Fig 3)

Fig 2



Resharpening of a solid punch

Objectives: This shall help you to

- **resharpen the blunt cutting edges of a solid punch on a bench grinder/pedestal grinder.**

After continuous use, the cutting edges of a solid punch gets blunt. In order to get the punch for reuse, the punch is resharpened.

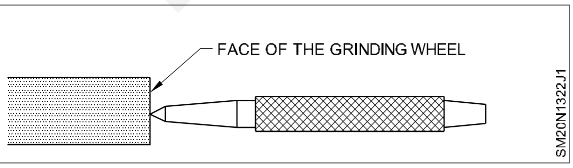
Resharpening is done on a bench or a pedestal grinder. Grinding is done on face and tapered diameter of the solid punch.

Before grinding, ensure that the grinding wheel is properly dressed and the wheel is true.

Ensure that the gap between the grinding wheel face and the tool rest is approximately 2 mm.

Hold the solid punch on the tool rest, perpendicular to the face of the grinding wheel. (See Fig 1)

Fig 1



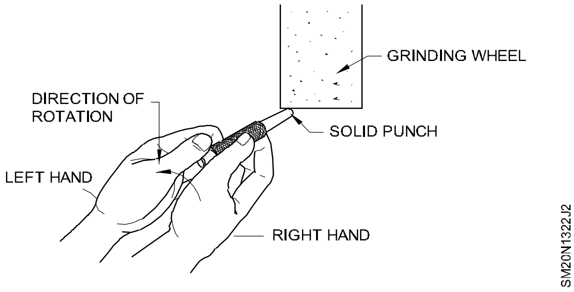
Grind the face of the punch slowly by rotating it in clockwise direction.

While rotating, hold the punch rigidly on the tool rest and see that excessive force is not applied while grinding.

Continue grinding till the face of the punch becomes flat.

Now hold the punch at an angle as shown in Fig 2 and grind slowly the diameter of the solid punch by rotating the punch clockwise. While grinding see that the punch is held tangential and the diameter of the punch is just touching with light force to the face of the grinding wheel. Rotate the punch uniformly for proper grinding of the diameter.

Fig 2

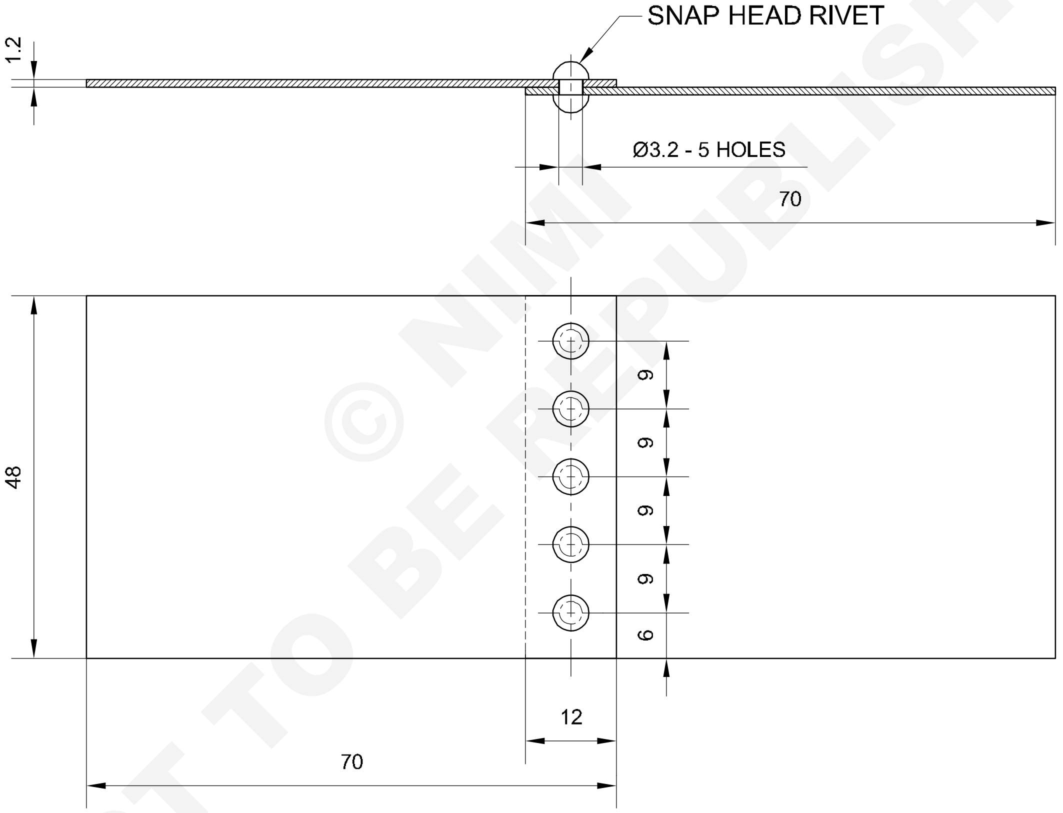


Dont use sides of grinding wheel for grinding diameter or face of the punch.

Dont apply excess pressure while grinding, otherwise it will damage the punch or even it may cause accident.

Single riveted lap joint

Objectives: At the end of this exercise you shall be able to
- **layout the spacing for rivet holes to make single riveted lap joint**
- **drill the correct size holes using a power operated portable drilling machine**
- **rivet the snap head rivets with the help of a rivet set, a rivet snap, a dolly using ball peen hammer, to make single riveted lap joint without a slack.**



5	IS:2155 - Ø3 - 6	--	M.S. SNAP HEAD RIVET	--	--	23
1	ISSH 145 x 52 - 1.2	--	MILD STEEL SHEET	--	--	23
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**SINGLE RIVETED LAP JOINT**	DEVIATIONS ±0.6	TIME 5h
		CODE NO. SM20N1323E1	

Job Sequence

- Cut and check the given material to the size 140 mm x 48 mm using a steel rule.
- Flatten the sheet on the dressing plate by a mallet.
- Deburr the edges using a flat smooth file.
- Mark the centre line of length 140 mm and cut the sheet into two pieces of size 70 x 48 using straight snips.
- Layout the spacing for rivet holes to make single riveted lap joint using a scriber and a steel rule on both pieces of the sheet, and mark the centre points of rivet holes using a centre punch and a setting hammer. (See Fig 1 & 2 of Skill sequence)

Fig 1

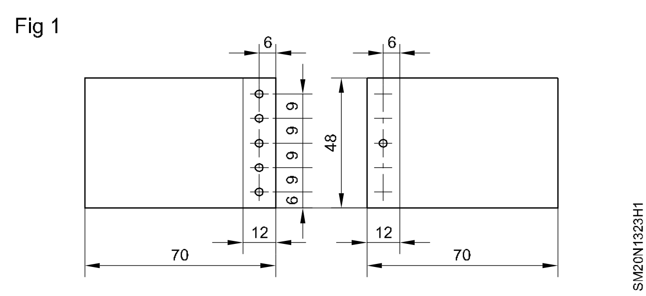
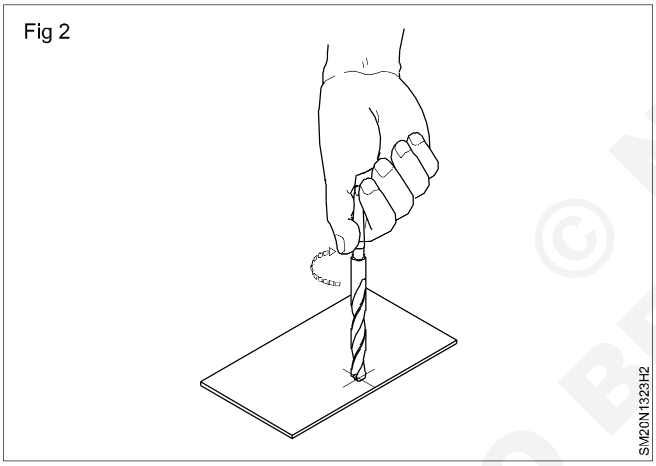
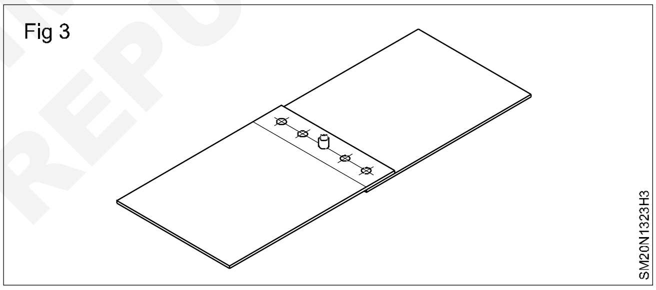


Fig 2



- Drill ϕ 3.2 holes on all centre points on one piece of the sheet and one central hole on another piece of sheet using a power operated portable drilling machine. (Fig 1)
- Deburr the holes with larger sized drill rotating it on drilled holes, by hand. (Fig 2)
- Place the piece of sheet having all holes drilled above another, such that the overlapped edges of the sheets coincide with the marked lines.
- Insert 3 mm dia snap head rivet in the centre hole. (Fig 3)
- Form the rivet head, with the help of the rivet snap and dolly using ball peen hammer.
- Drill the remaining four holes on the bottom piece of the sheet, through the holes, already drilled on the upper piece of the sheet.
- Deburr the holes with the larger sized drill, rotating it on the drilled holes, by hand.
- Insert the rivets in alternate holes and form the rivet heads, one by one to make a single riveted lap joint, with the help of a rivet set, rivet snap, a dolly and a ball peen hammer.

Fig 3



Skill Sequence

Layout the spacing for rivet holes to make a single iveted lap joint

Objectives: This shall help you to

- **calculate the distance of the lap, the distance between centre of first rivet and edges and the distance of pitch as per BIS standard**
- **layout the spacing for rivet holes to make a single riveted lap joint.**

Ensure the edges of the workpieces to be joined are free of burr and straight.

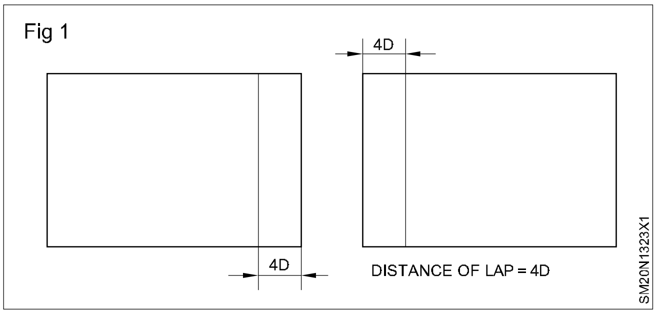
Calculate the distance of the lap.

Distance of the lap = 4 x Dia of the rivet (D)

Diameter of the rivet = 2.5 or 3t from the known thickness, calculate the dia of the rivet, and calculate the distance of the lap.

Mark the line of distance of the lap parallel to the edge, on both workpieces using a scriber and a steel rule. (Fig 1)

Fig 1



Calculate distance of the rivet line from the edge of the sheet.

Distance of the rivet line from the edge = 2 x the diameter of the rivet (D)

Mark the rivet lines parallel to the edge, on both workpieces (Fig 2).

Calculate the distance of the first rivets from the side edge.

Distance of the first rivet from the edge = 2 x dia of rivet (D)

Mark the distance of the first rivets from the side edges on the rivet line, on both the workpieces using a divider.

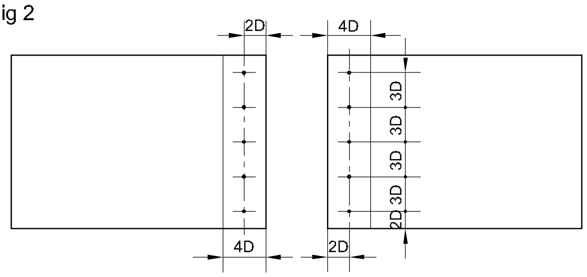
Calculate the distance between two rivets i.e. pitch.

Pitch = 3 x the dia of rivet (D)

Mark the pitch of the rivets on the rivet lines, on both workpieces (Fig 2) using a divider.

Punch the centre points of the reivets using a centre punch and a setting hammer.

Fig 2



DISTANCE OF RIVET LINE FROM EDGE = 2D
DISTANCE OF FIRST RIVET FROM EDGE = 2D
DISTANCE BETWEEN TWO RIVETS (PITCH) = 3D

Drilling on sheetmetal by power operated portable drilling machine

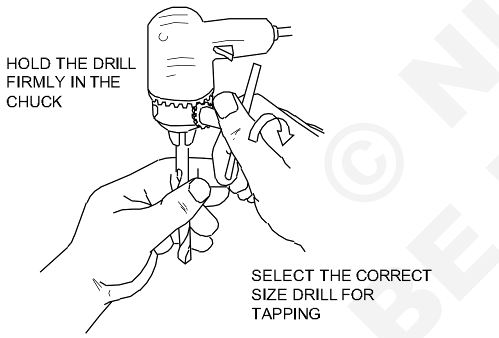
Objectives: This shall help you to

- **drill correct sized hole on sheetmetal by operating power operated portable drilling machiner properly.**

Punch the marked centre points of the holes to be drilled lightly using a centre punch and a setting hammer.

Insert a straight shank, drill bit in the drill chuck of the portable drilling machine and tight with the chuck key. (Fig 1)

Fig 1



Before inserting the drill in the drill chuck of the power operated portable drilling machine, be sure that the switch is off and earthing is provided.

Place the workpiece on a suitable wooden support and clamp with the help of a ‘C’ clamp.(Fig 2)

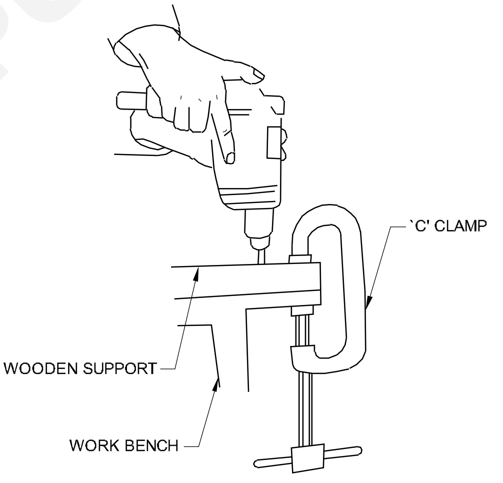
Hold the butt of the portable drilling machine in one hand and grasp the gun with fore finger and thumb of the other hand, such that the drill is perpendicular to the surface of the metal to be drilled. (Fig 2)

Switch ‘ON’ the trigger switch with second finger.

Apply pressure on the drill chuck till you get the hole.

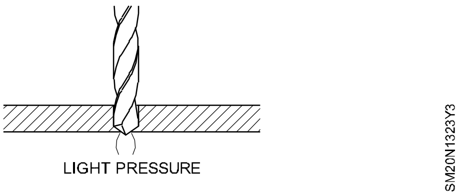
While drilling by electric operated portable drilling machine on a sheet metal, light pressure should be applied otherwise, the drill will stall or pick up the workpiece.(Fig 3)

Fig 2



Switch off the drilling machine after the drilling is completed. Deburr the holes by larger sized drill bit by rotating it on the drilled hole by hand.

Fig 3



Riveting snap head rivet

Objectives: This shall help you to

- **make proper use of the dolly, rivet set and rivet snap to perform correct riveting**
- **form the rivet head in round shape, by applying the hammer blows properly by the ball peen hammer**
- **rivet snap head rivet to make the riveted joint tight without damaging the base metal.**

Ensure that all the rivet holes are drilled on one sheet and only one hole for the centre rivet is drilled on another sheet.

Ensure that the drilled holes are deburred and the sheets are flat.

Hold vice dolly rigidly in the bench vice.

Place the sheet having all holes drilled over the other, align the drilled hole and coincide the marked lines for lap with the edges.

Insert the rivet in the centre hole and place the rivet head on the vice dolly, to avoid deformation, while hammering. (Fig 1 & 2)

Fig 1

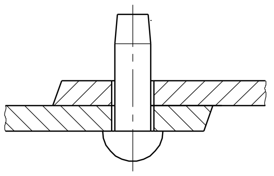
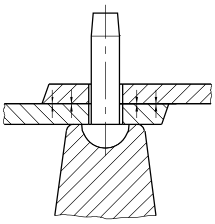


Fig 2

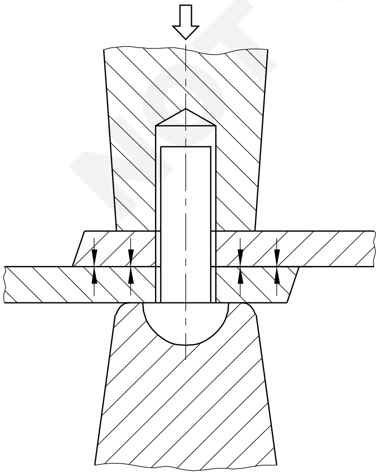


Place the deep hole of the rivet set over the shank of the rivet. (Fig 3)

Strike the rivet set with a ball peen hammer to bring the sheets closer, to set the joint firmly for riveting. (Fig 3)

Remove the rivet set over the shank of the rivet.

Fig 3



Form the rivet head roughly by hammering it down initially and then rounding the head using a ball peen hammer. (Fig 4 & 5)

Fig 4

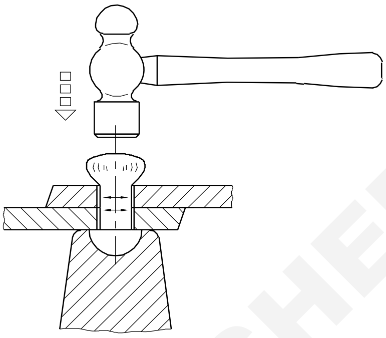
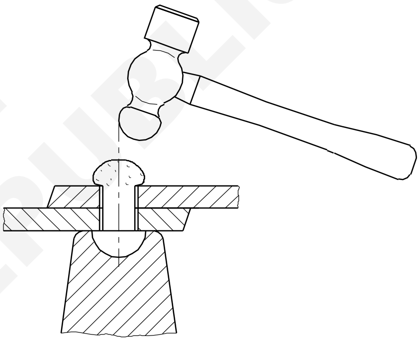
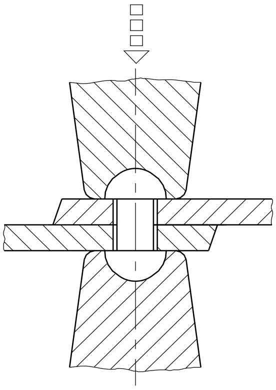


Fig 5



Place the rivet snap over the rounded head of the rivet and strike with a hammer over it to form and finish the rivet head using a ball peen hammer. (Fig 6)

Fig 6

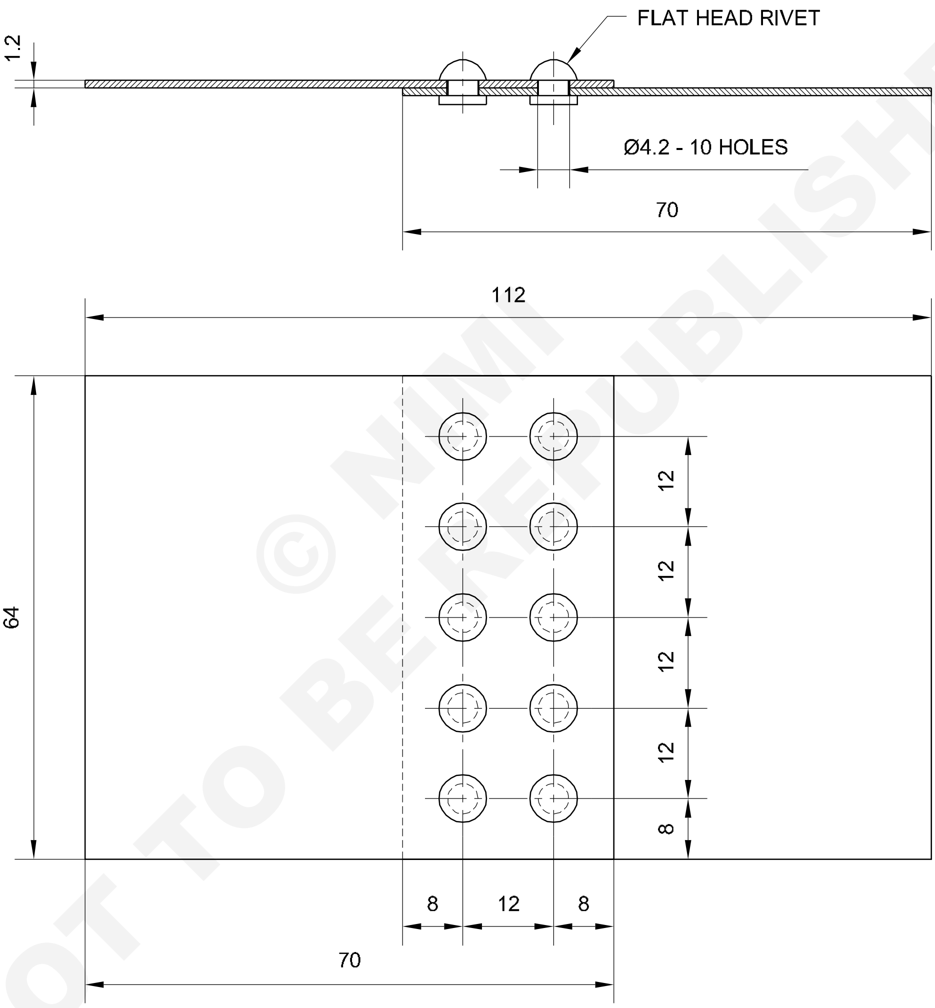


Capital Goods & Manufacturing **Exercise 1.3.24**
Sheet Metal Worker- Folding & Locking

Double riveted lap joint (Chain Seam)

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

- **Mark and cut the sheet metal safely using a hand lever bench shears**
- **layout the spacing of rivets to make double riveted lap joint (chain) correctly**
- **make double riveted lap joint (Chain), to join sheet metal pieces with the required strength and without slackness**
- **remove faulty rivets from sheet metal riveted joints by drilling**
- **remove faulty rivets from sheet metal riveted joints by punching.**



10	IS: 2155- Ø4 x 6	--	M.S. FLAT HEAD RIVET	--	--	24
1	ISSH 145 x 70 - 1.2	--	MILD STEEL SHEET	--	--	24
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1

DOUBLE RIVETED LAP JOINT (CHAIN SEAM)

DEVIATIONS ±0.6

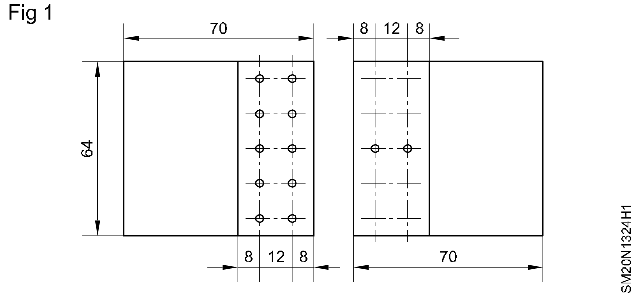
TIME 5h

CODE NO. SM20N1324E1

Job Sequence

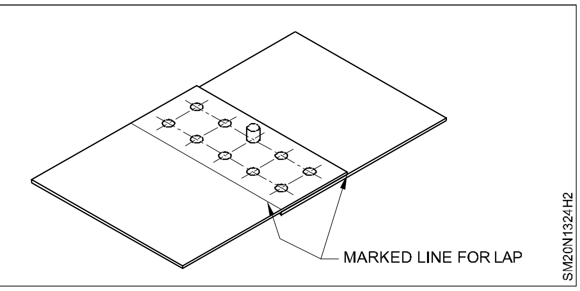
- Cut the given material in two pieces to size 65 x 70 using hand lever bench shears and check the size using a steel rule.
- Flatten the sheet on the dressing a plate by mallet.
- Deburr the edges using a flat smooth file.
- Layout the spacing for rivet holes to make double riveted lap joint using a scriber, a divider and a steel rule on both the pieces of the sheet.
- Mark the centre point for the rivet holes using a centre punch and a setting hammer.
- Drill ϕ 4.2 mm holes at all the points on one piece of the sheet and two centre holes on another piece of sheet using a portable drilling machine. (Fig 1)

Fig 1



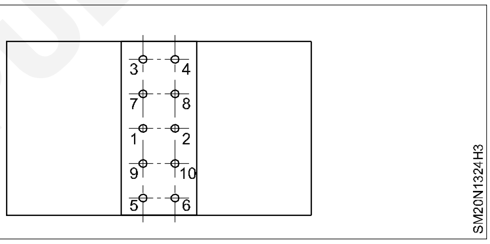
- Deburr the holes with larger sized drill rotating it on the drilled holes by hand.
- Place the piece of sheet having all holes drilled above another such that the edges of the sheet coincides with the marked line for lap. (Fig 2)
- Insert ϕ 4 mm snap head rivet in the centre hole. (Fig 2)

Fig 2



- Form the rivet head with the help of a rivet set and dolly using a ball peen hammer.
- Check that the two sheets are in line using a straight edge.
- Drill the remaining holes on the bottom piece of sheet through the holes, already drilled on the upper piece of sheet.
- Deburr the holes with larger sized drill, rotating it on the drilled holes by hand.
- Insert the rivets in alternate holes and form the rivet heads one by one to make double riveted lap joint (chain) with the help of a rivet set, a dolly and a ball peen hammer. (Fig 3)

Fig 3



Skill Sequence

Layout the spacing for rivet holes to make double riveted lap joint (chain seam)

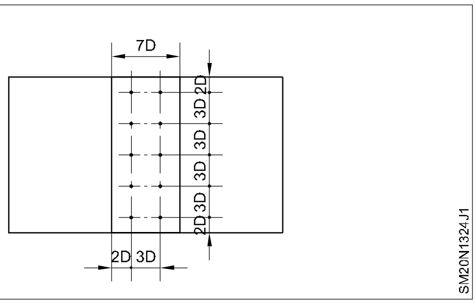
Objectives: This shall help you to

- **determine the distances between the rivets, distances from the edges of the sheet metal and layout the spacing of rivets to make double riveted lap joint correctly.**

Calculation for layout the spacing of rivet holes is similar as single riveted lap joint except the horizontal distance between the two rivets rows is thrice the rivet diameter.

Fig 1 shows the layout for spacing of the rivet holes to make double riveted lap joint (chain), on one sheet. Similarly the layout on another sheet to be made and riveted.

Fig 1



Removing rivets from sheet metal by drilling

Objectives: This shall help you to

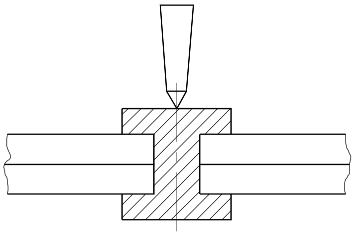
- **remove the rivets from the sheet metal by drilling without damaging the metal.**

The most satisfactory method of removing a rivet on light gauge sheet metal is by drilling.

Carry out the following steps:

– Flatten the rivet head by ball peen hammer and punch the exact centre of the formed head using a centre punch. (Fig 1)

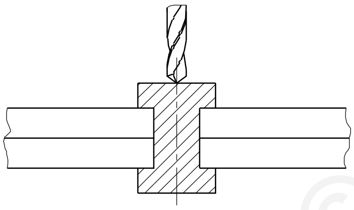
Fig 1



CENTRE-PUNCH HEAD

– Select a twist drill slightly smaller than the shank dia of the rivet. (Fig 2)

Fig 2

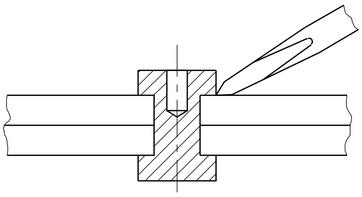


DRILL HEAD

– Drill into the head of the rivet just up to the top surface of the metal. (Fig 3)

– Remove the rivet head with a cold chisel. (Fig 3)

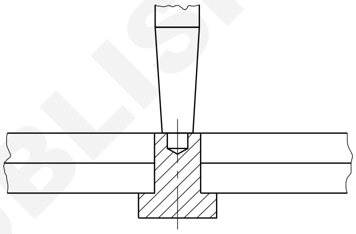
Fig 3



KNOCK HEAD OFF WITH CHISEL

– Place the head of the rivet over a nut, of larger diameter than the head of the rivet. With a solid punch slightly smaller than the size of the rivet shank, drive out the rivet by striking with a ball peen hammer. (Fig 4)

Fig 4



DRIVE RIVET OUT WITH PUNCH

Another simple method for removing the rivets is to cut off the formed head using a sharp cold chisel. The remainder of the rivet is removed with a solid punch, by hammering.

Precaution

The metal should not be distorted.

The rivet hole should not be elongated.

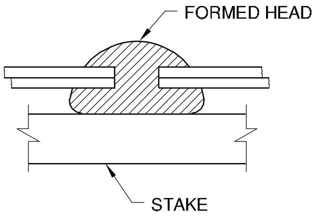
Removing rivets from sheet metal by punching

Objectives: This shall help you to

- **remove the rivet from the sheet metal by punching, without damaging the sheet metal.**

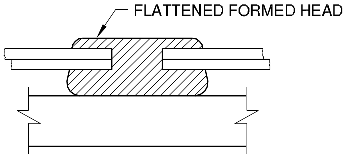
Place the rivet on a solid stake with formed head at upper side, in case of flat head rivet. Use dolly as a support Fig 1 in case of snap head rivet. Flatten the formed head with ball peen hammer to reduce the thickness of the formed head, to approx 1 mm. (Fig 1)

Fig 1



Punch the centre of the head using a centre punch. (Fig 2)

Fig 2



Place the head of the rivet over a nut or a hollow bush of a larger dia than the head of rivet. (Fig 3)

Hold the solid punch of diameter less than the rivet diameter vertically at the centre point already punched and strike with the hammer till the shank comes out of the sheet. (Fig 4)

Fig 3

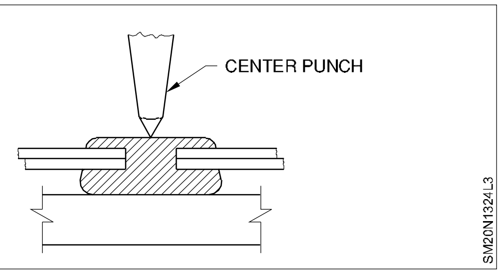
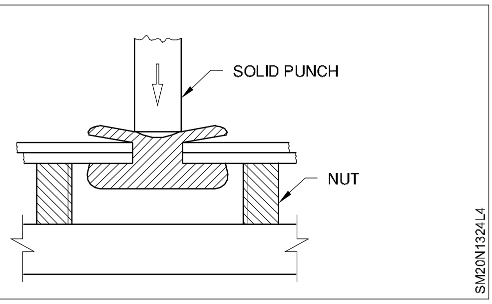
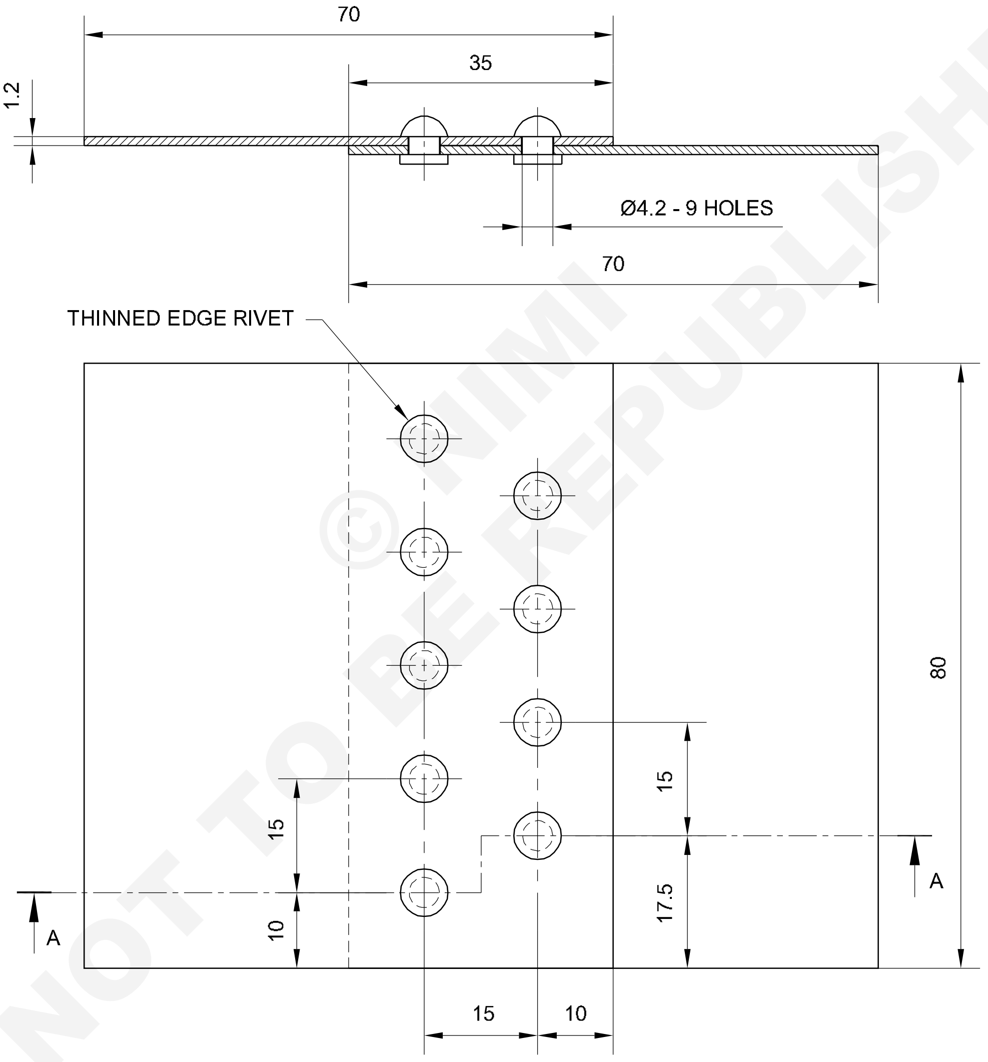


Fig 4



Double riveted lap joint (Zig Zag seam)

Objectives: At the end of this exercise you shall be able to
- **layout the spacing of rivets for double riveted lap joint (zig zag seam)**
- **form the rivet heads of flat head rivets to make double riveted (zig-zig) lap joint without slackness.**



9	IS: 2155 - Ø4 - 6	--	THINNED EDGE COPPER RIVET	--	--	1.3.24
1	ISSH 145 x 85 - 1.2	--	MILD STEEL SHEET	--	--	1.3.24
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1

DOUBLE RIVETED LAP JOINT (ZIGZAG SEAM)

DEVIATIONS ±0.6

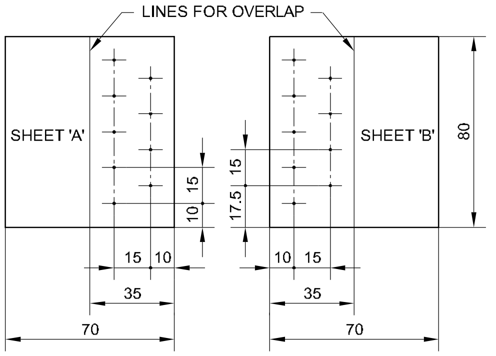
TIME 5h

CODE NO. SM20N1324E2

Job Sequence

- Cut the two pieces 80 x 70 using a straight snip and check the size using a steel rule.
- Flatten the sheet on the dressing plate by a mallet.
- Deburr the edges using a flat smooth file.
- Layout the spacing for rivet holes to make double riveted (zig-zag) lap joint using a scriber, a divider and a steel rule on both the pieces of the sheet (i.e sheet ‘A’ and sheet ‘B’). (Fig 1)

Fig 1



LAYOUT OF RIVET SPACING

- Mark the center point of rivet holes using a center punch and a setting hammer.
- Drill ϕ4.2 holes on sheet A and only on the centre point ‘X’ on sheet ‘B’ by power operated portable hand drilling machine using a flat wooden piece as support. (Fig 1)
- Place sheet ‘A’ over sheet ‘B’, Insert ϕ4 x 6 long thinned edge copper rivet in central hole ‘X’ from the bottom and align the edges of sheet with marked lines for overlap. Place the rivet set on shank of the rivet and strike over it by a ball peen hammer using a flat steel plate as support. Form the rivet head by a ball peen hammer using a flat steel plate as support.
- Finish the rivet head so formed, by placing a rivet snap over the rivet and striking with a ball peen hammer.
- While forming the rivet head, ensure that the alignment of the sheet edges and the marked lines for overlap is not disturbed.
- Drill the remaining holes on the sheet ‘B’, through the holes already drilled on the sheet ‘A’, by power operated portable drilling machine using a wooden support.
- Deburr the holes with larger sized drill, by rotating it on the drilled holes by hand.
- Insert ϕ4 thinned edge copper rivet in alternate holes and form the rivet heads in the similar manner.

Skill Sequence

Layout the spacing for rivet holes (jig-jag seam)

Objectives: This shall help you to

- **layout the correct spacing of rivets for double riveted (zig-zag) lap joint.**

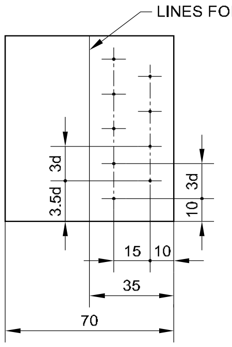
The skill is similar to layout the spacing of rivets for double riveted chain lap joint, except the triangular formation of rivets formed in placement of rivets.

Mark the lines parallel to the edge at a distance of 2d, 3d and 7d.

Mark the points of first rivets from the edges at a distance of 2d and 3.5d and mark further points at a pitch distance of 3d from the first rivet points. (Fig 1)

Mark similarly on another piece of sheet to be joined.

Fig 1



LAYOUT OF RIVET SPACING

Forming the rivet head to make the strong joint

Objectives: This shall help you to

- **form the head of the flat head rivet properly to make the riveted joint strong and without slackness**

Forming the head of the flat head rivet is similar to that of the snap head rivet. Because of flat head, the flat steel plate is used as supporting tool on small place of dolly. Fig 1,2,3 shows, riveting flat head rivet.

Drawing the rivet, for bringing sheet closer by rivet set and ball peen hammer. (Fig 1)

Forming the rivet head by ball peen hammer. (Fig 2)

Fig 1

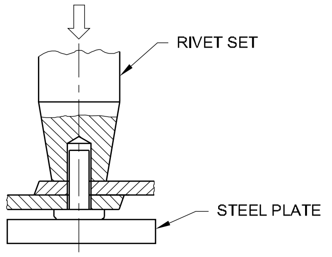
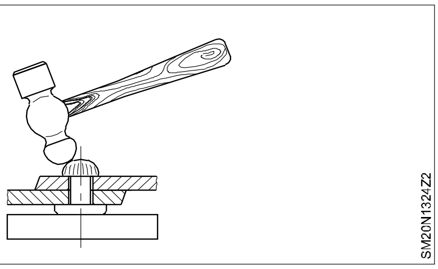
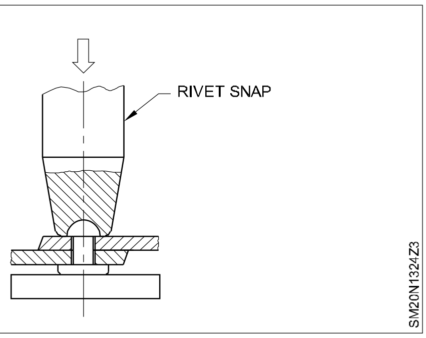


Fig 2



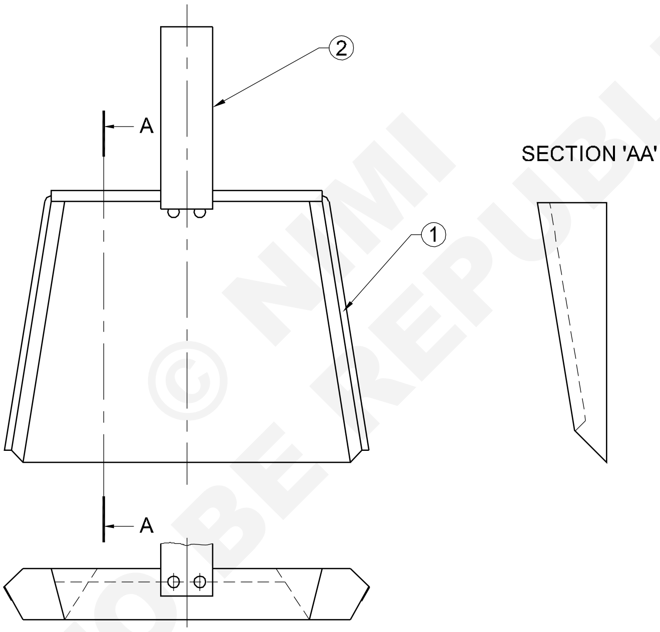
Finishing the head of rivet to final shape, by rivet snap and ball peen hammer. (Fig 3)

Fig 3



Making a dust pan (Handle Riveted dust pan)

Objectives: At the end of this exercise you shall be able to
- **prepare the development of apan with tapered sides**
- **cut the aluminium sheet using straight snips**
- **bend the aluminium sheet**
- **flatten and bend the end of the aluminium tube**
- **assemble the aluminium sheet and tube using rivets.**



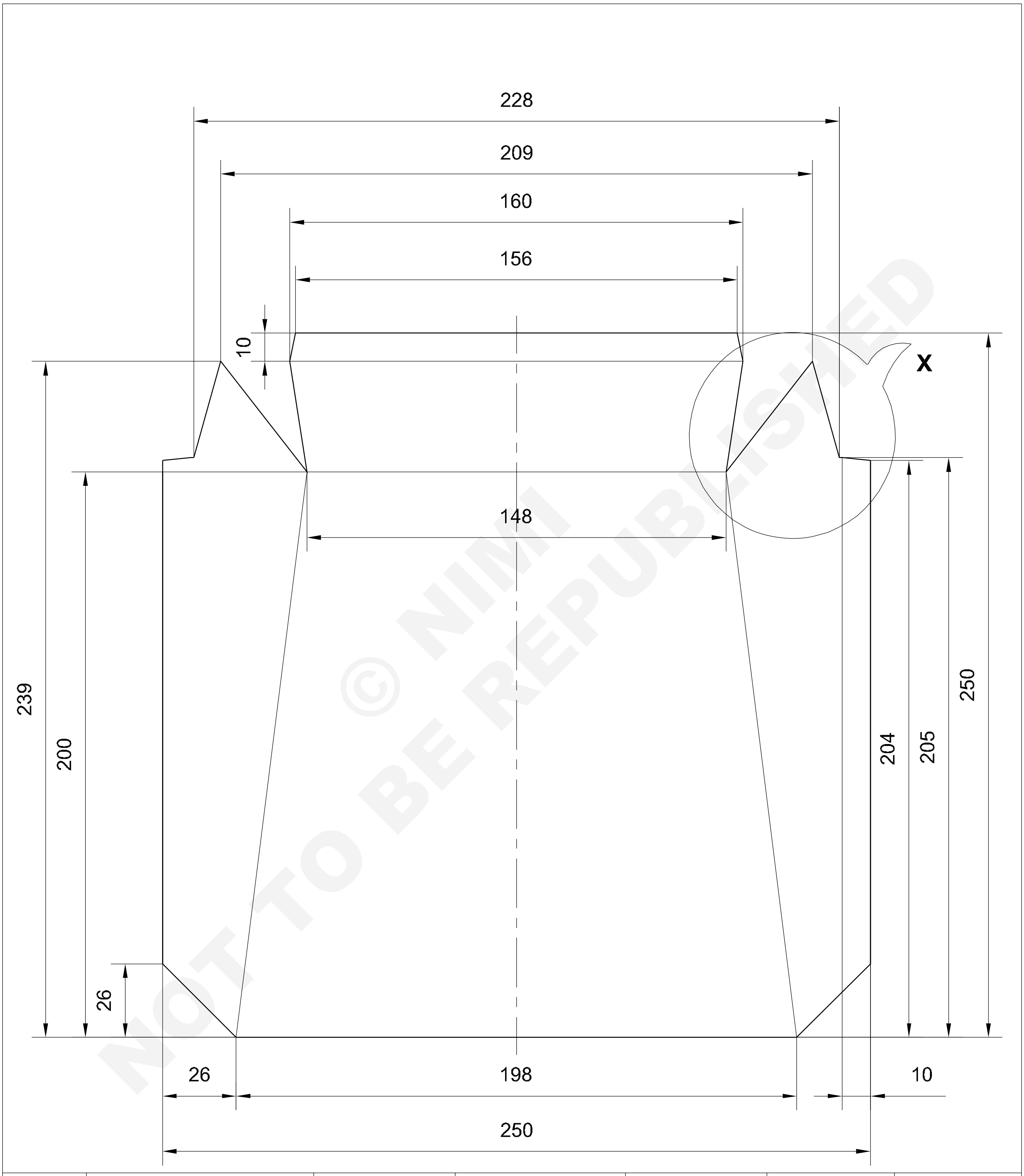
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
2	Ø4 x 10	-	IS:2155	4	3	1.3.24
1	Ø20 x 0.8 - 150	-	ALUMINIUM TUBE	4	2	1.3.24
1	ISSH 260 x 265 x 1.75	-	AL. SHEET	4	1	1.3.24

SCALE NTS	**MAKING A DUST PAN (HANDLE RIVETED)**	DEVIATIONS ±0.5	TIME 15h
	PROJECT: **DUST PAN 1.PAN 2.HANDLE 3.SNAP HEAD RIVET**	CODE NO. SM20N1324E3	

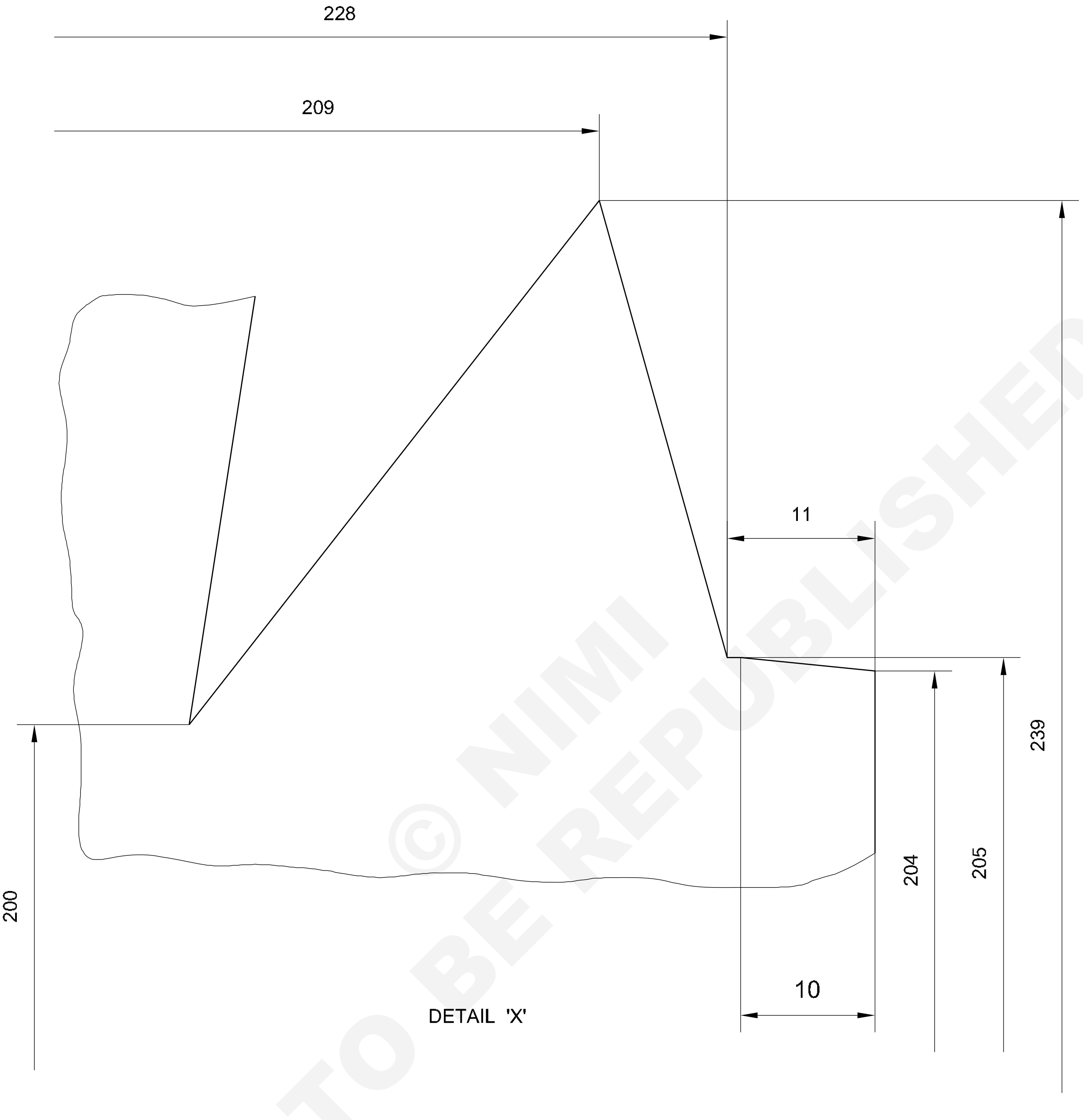
Job Sequence

- Check the size of the aluminium sheet as per sketh using s steel rule.
- Develop the job by the parallel line method as per dimension.
- Cut the aluminum sheet usg straight snips along the marked line.
- Bend the aluminium sheet as per the marked line.
- Cut the aluminium tube as per size in the sketch.
- Mark the end of the pipe for flattening and bending.
- Flatten the end of the pipe by squeezing it in a vice.

- Bend the pipe on the marked line.
- Mark and punch for 2 drill holes on the side of the showel for the riveting holes.
- Drill holes on the sheet and the bent tube.
- Rivet (snap) the handle along with the showel.

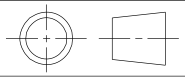


1	ISSH 260 x 260 x 1.75	-	AL.SHEET	4	1	1.3.24
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:2	MAKING A DUST PAN (HAND RIVETED)				DEVIATIONS ±0.5	TIME
	PROJECT : DUST PAN			PART: PAN	CODE NO. SM20N1324E4	



-	-	-	-	4	1	1.3.24
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

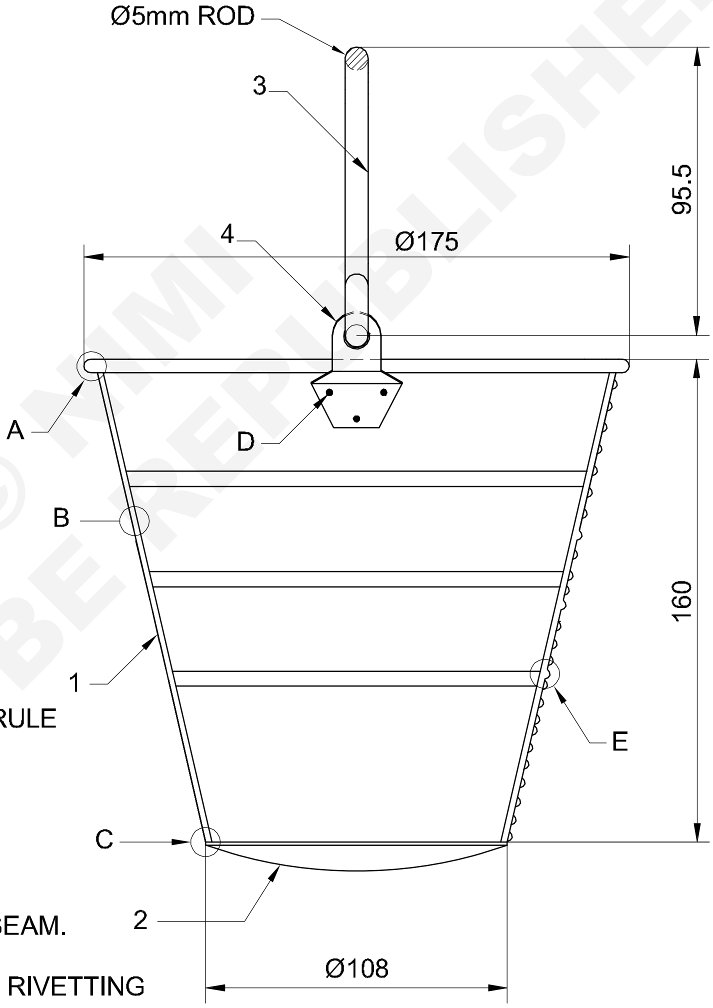
SCALE NTS	MAKING A DUST PAN	DEVIATIONS ±0.5	TIME
		CODE NO. SM20N1324E5	



Making a fire bucket by lap riveted joint

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

- **develop the pattern layout for the parts of the bucket and for the body of the bucket into two halves by radial line method**
- **cut the body of the bucket by portable shearing machine**
- **form the body of the bucket on three roll forming machine with tapered rollers**
- **join the two halves of the body of the bucket by lock grooved seam one side & riveting other side**
- **hollow the bottom of the bucket and fix it to the body by knocked up seam**
- **make the beading on the body of the cylindrical parts using universal swaging machine**
- **assemble the parts by lock grooved seams riveting.**



NOTE:

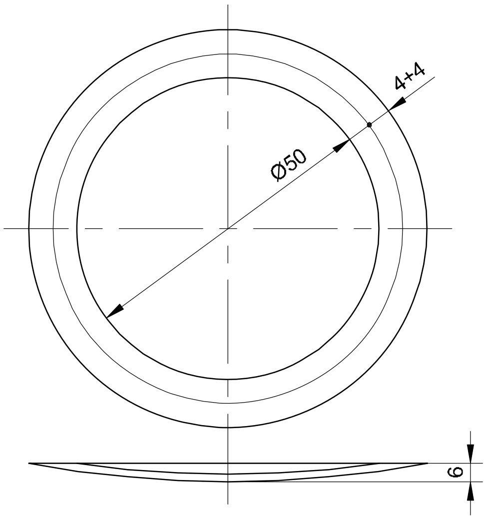
L.G. SEAM, BOTTOM AND FERRULE
ARE TO BE SOLDERED.

DETAILS AT:

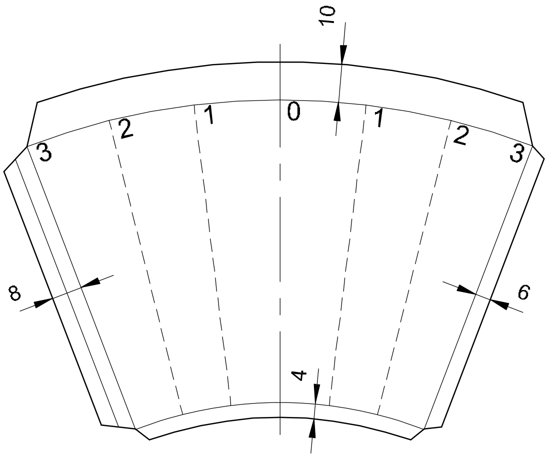
A = 5mm HEMMING.
B = 4mm LOCKED GROOVED SEAM.
C = 4mm KNOCKED UP SEAM.
D = HANDLE BRACKET (EARS) RIVETTING
E = RIVETTING

–	–	–	–	11	–	25
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

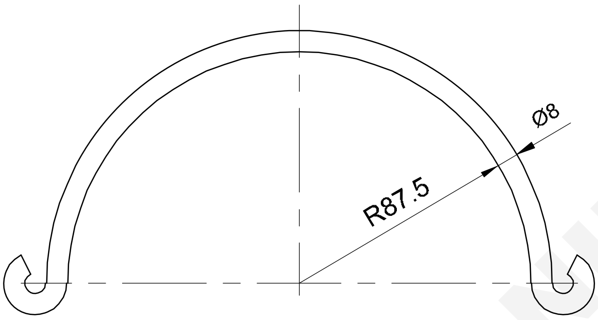
SCALE 1:2	MAKING A FIRE BUCKET BY LAP RIVETED JOINT	DEVIATIONS ±1	TIME 25h
	PROJECT: FIRE BUCKET PART: 1,2,3,4	CODE NO. SM20N1325E1	



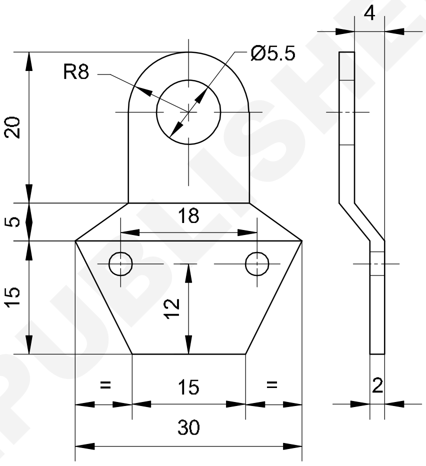
2. BOTTOM



1. BODY



3. HANDLE



4. HANDLE BRACKET (EARS)

4	IS 2155 - Ø3 x 6	–	SNAP HEAD M.S. RIVET	5	–	25
2	ISSH 50 x 2 - 50	–	STEEL SHEET	5	4	25
1	Ø5 - 350	–	G.I ROD	5	3	25
1	ISSH 120 x 0.8 - 120	–	G.I SHEET	5	2	25
2	ISSH 450 x 0.8 - 350	–	G.I SHEET	5	1	25
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS

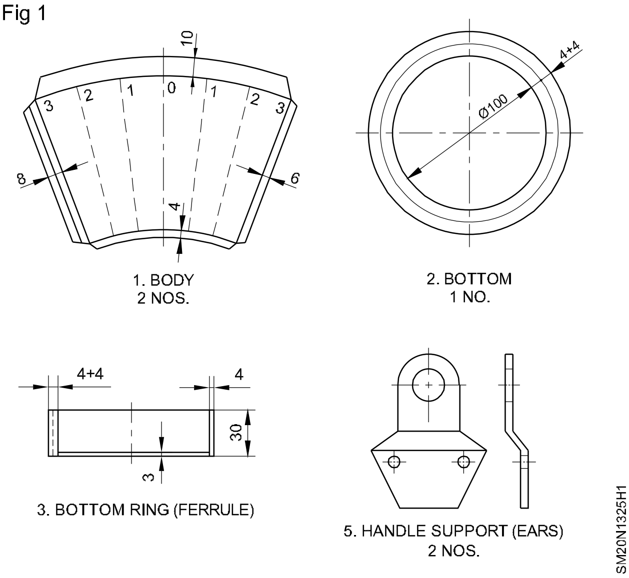
MAKING A FIRE BUCKET BY LAP RIVETED JOINT
PROJECT: BUCKET PART: 1. BODY 2. BOTTOM
3. HANDLE 4. HANDLE BRACKET

DEVIATIONS ±1
TIME
CODE NO. SM20N1325E2

Job sequence

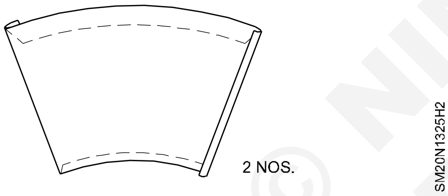
- Develop the pattern layout for the parts of the bucket and for the body of the bucket into two halves. (Fig 1)

Fig 1



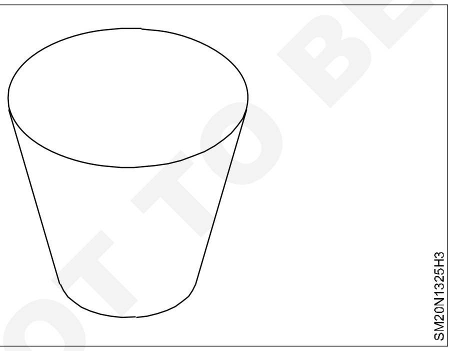
- Fold the edges for lock grooved seam and form the body of the bucket on three roll forming machine. (Fig 2)

Fig 2



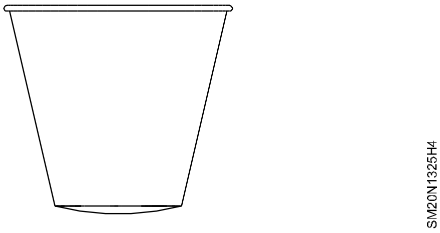
- Join the two halves by lock grooved seam. (Fig 3)

Fig 3



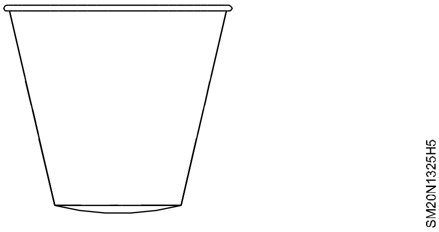
- Cut, form and fix the bottom to the body by knocked up seam. (Fig 4)

Fig 4



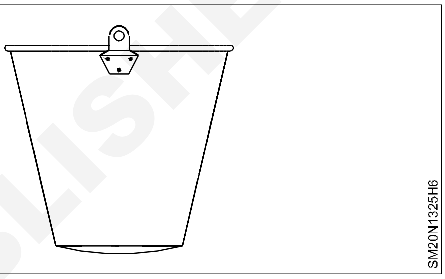
- Make a 3 mm wired edge at the mouth of the bucket. (Fig 4)
- Make three beadings on the body of the bucket by universal swaging machine. (Fig 5)

Fig 5



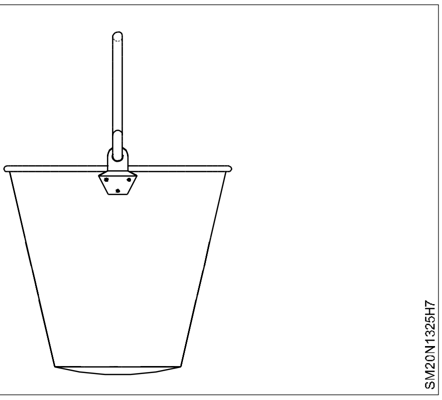
- Make and fix the handle supports (Ears) by riveting. (Fig 6)

Fig 6



- Form the given rod to shape and dimension and fix it to the handle supports (Ears). (Fig 7)
- Dress the body of the bucket to shape and free of dents using a mallet.

Fig 7



Skill sequence

Cutting with a portable shearing machine

Objectives: This shall help you to
- **set shearing blades on a portable shearing machine**
- **adjust the gap between blades to cut different thickness using a feeler gauge**
- **cut sheet metal using the portable shearing machine.**

Check the blades of the shearing machine for their sharpness.

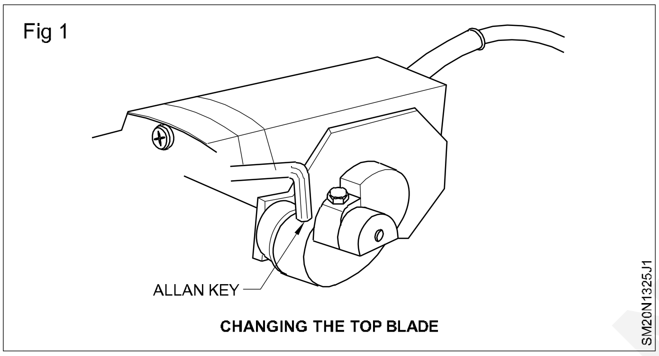
If the blades are blunt, the blades must be replaced or re-sharpened.

Replacing the top blades

Select the correct size Allen key to loosen and remove the locking screw which secures the top blade.

Replace the sharpened or new blade and tighten the lock screw to secure the replaced blade. (Fig 1)

Fig 1



CHANGING THE TOP BLADE

Replacing the bottom blade.

Select the correct size wrench or Allen key and loosen to remove the locking screw, if not bolt head will get spoiled.

Remove the bottom blade.

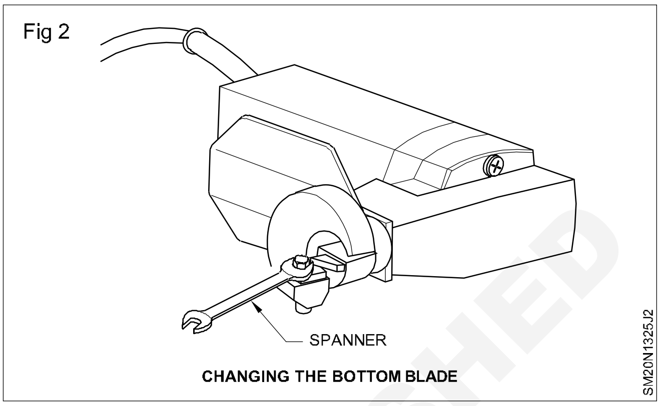
Replace the sharpened or new blade and tighten the screw to secure the replaced blade. (Fig 2)

Straight and curved blades are available. Selection of the blade depends on the shape of the cut to be made.

Blade adjustment

The adjustment or clearance between the blades depends on the thickness of the material to be cut.

Fig 2



CHANGING THE BOTTOM BLADE

The clearance between the blade should be approximately 0.2 times the thickness of the material.

Example

Material to be cut is 1.2 mm thick

Gap = 0.2 x Thickness of metal
= 0.2 x 1.2
= 0.24mm

Loosen the bottom blade so that it just moves.

Insert the feeler gauge of required gap in between the blades and tighten the screw.

Cutting with portable shears.

Once the blades have been set the shear is ready for use.

Position the metal to be cut inbetween the upper and lower blades of the shear.

Make sure that the upper blade is perpendicular to the metal being cut.

Switch on the shear and push it gently forward along the cutting line.

Keep the upper cutting blade perpendicular always.

Form conical portion three roll forming machine with taper rollers

Objectives: This shall help you to
- **form conical parts on three roll forming machine with taper rollers.**

Introduction: The three roll forming machine with tapered rollers is similar to that of a common three roll forming machine except that the rollers of the machine are tapered and are used to form only conical shaped parts. (Fig 1 & Fig 2)

The forming procedures are similar to that of forming on a plain rolling machine.

“Ref. Skill Sequence of Ex.No.5”

“Form cylindrical parts on a three roll forming machine”.

Fig 1

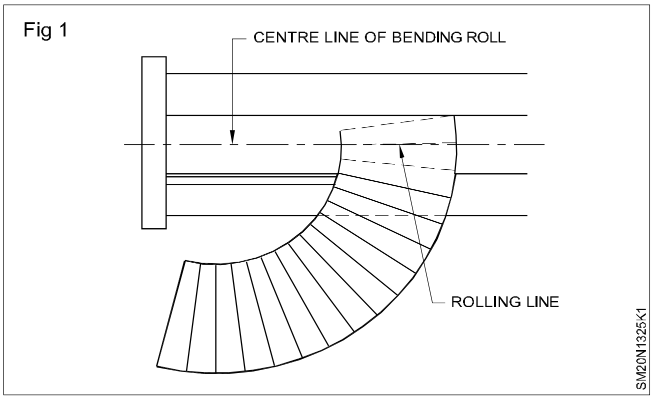
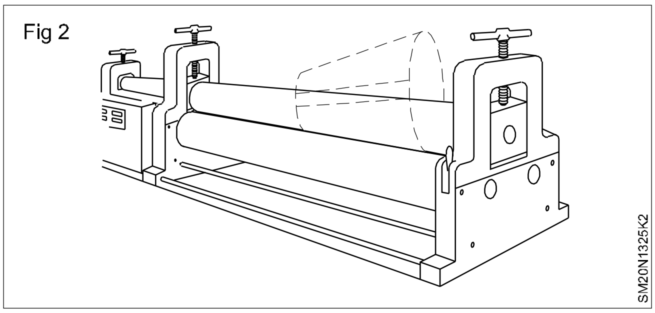


Fig 2



Forming cylinders on roll forming machine

Objectives: This shall help you to
- **form cylindrical parts using roll forming machine**
- **work safely when operating the roll forming machine.**

Check the workpiece to be formed for shape and dimensions.

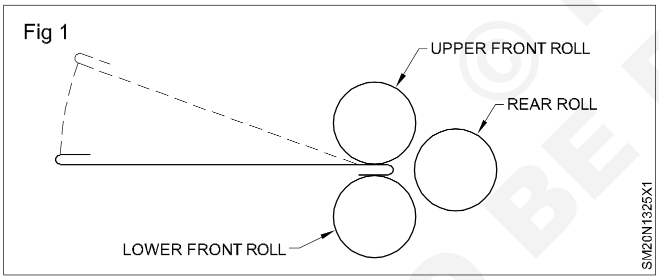
Adjust the gap between the front rollers wide enough to insert the workpiece, by the roller adjusting screw.

Insert the workpiece between the two front rollers. (Fig 1)

Adjust the front rolls to allow just enough clearance between the rolls to avoid crushing of the locks.

Tilt the workpiece slightly upwards. (Fig 1)

Fig 1

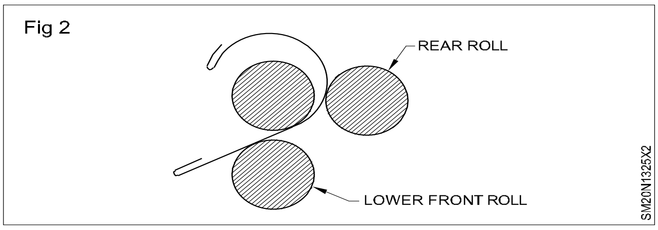


Rotate the operating handle. The metal begins to curve and allow the workpiece to pass between the upper and rear rollers.

The workpiece must be fed perpendicular to the front rolls if not the parts will be twisted and the edges will not match for joining.

The radius of curvature is controlled by the position of the rear roll. (Fig 2)

Fig 2



For smaller radius, the rear roll should be lowered. (Fig 3)

For larger radius, the rear roll should be raised. (Fig 4)

Operate the machine, until the forming is completed.

Release the upper roll, swing the roll and remove the part.

Hook the seams and lock it by hand groover or join as required.

Fig 3

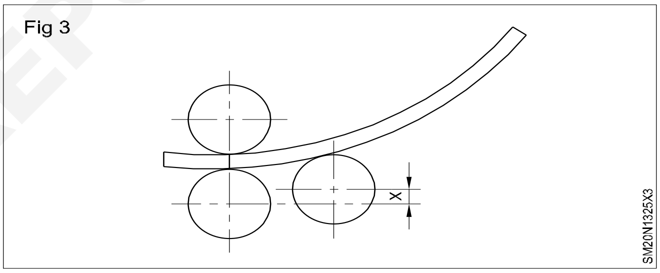
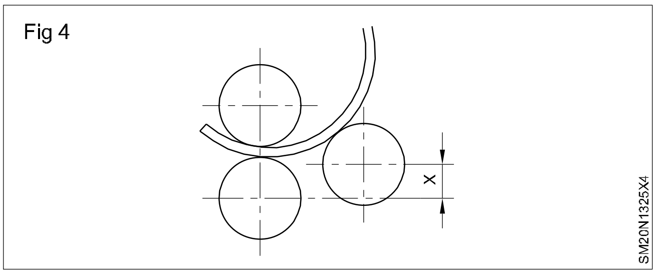


Fig 4



Beading

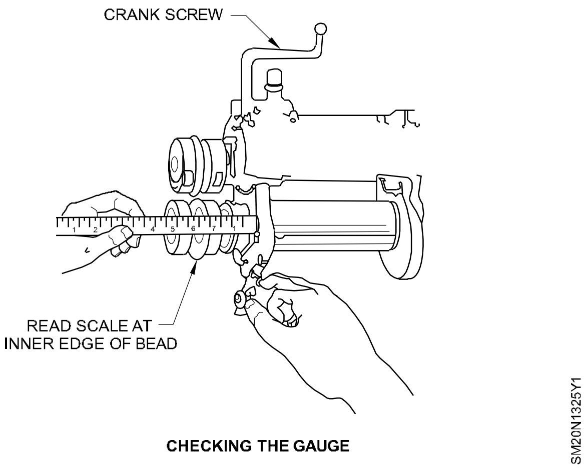
Objectives: This shall help you to
- **form beads on the body of the cylindrical parts using universal swaging machine**
- **follow safety precautions when operating the machine.**

Fix suitable beading rollers on the universal swaging machine.

Open the crank screw and lift the top roller.

Set the adjustable gauge. (Fig 1)

Fig 1

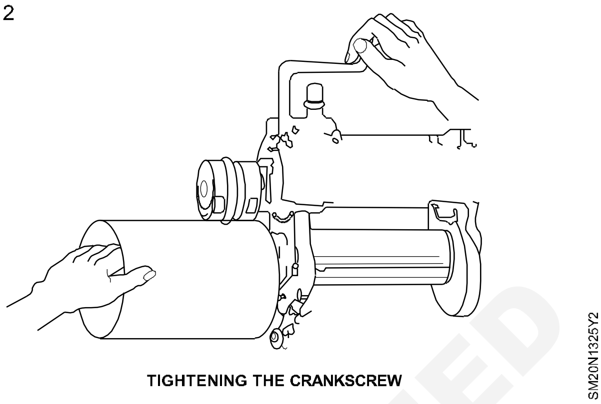


CHECKING THE GAUGE

Tighten the thumb screw of the adjustable gauge, not to slip or move when beading.

Insert the workpiece between the rolls and tighten the crank screw. (Fig 2)

Fig 2



TIGHTENING THE CRANKSCREW

Do not tighten the crank screw too much to avoid rolls cutting the sheet.

Operate the handle, beading impression will be formed on the body.

Guide the workpiece against the gauge to get an uniform bead.

Release the crank screw and remove the part.

Continue to form the beads as above and as required keeping the adjustable gauge as reference.

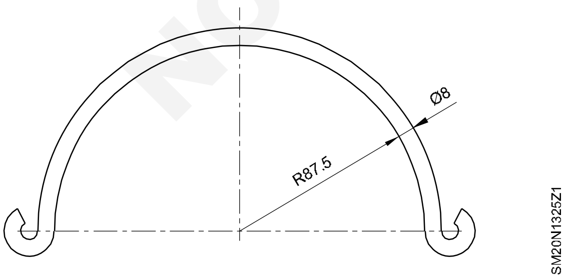
Form a round rod to required shape using a rolling machine and by hand process

Objectives: This shall help you to
- **form a round rod to required dimension using a three roll forming machine**
- **form the ends of the round rod to hook shape by hand process.**

The shape of the rod to be formed is given in Fig 1.

Check and ensure that the given rod is of correct length and diameter.

Fig 1

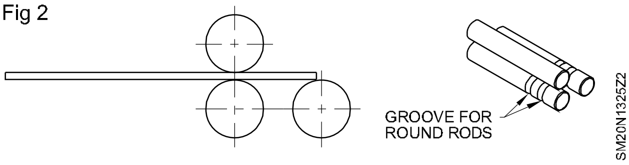


Check the rollers of the rolling machine for its suitability.

Raise the upper roller and place the round rod in the groove provided.

Adjust the top roller to suit the gap of the given rod. (Fig 2)

Fig 2



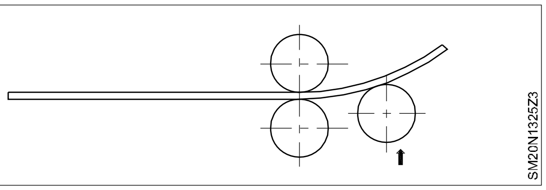
Raise the rear roller slightly by the rear roller adjustment screw so as to start forming the rod with a light curvature.

Do not raise the rear roller too much because the curvature will be too much and the part will be over formed.

Rotate the operating handle and see that the entire length of the rod is formed to a light radius.

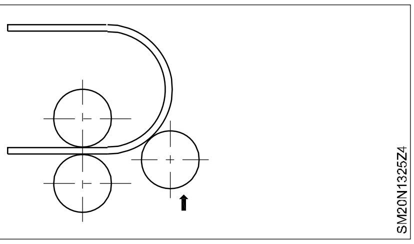
Raise the rear roller slightly and form the rod. (Fig 3)

Fig 3



Similarly, increase the curvature by adjusting the rear roller and form the rod to the required dimension. (Fig 4)

Fig 4

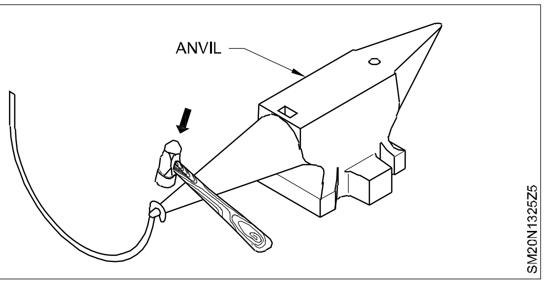


After the completion of forming, lower the rear roller.

Raise the upper roller and remove the rod.

Heat the end of the formed rod by a gas torch or a forge and form the hook on an anvil using a Ball Pane Hammer. (Fig 5)

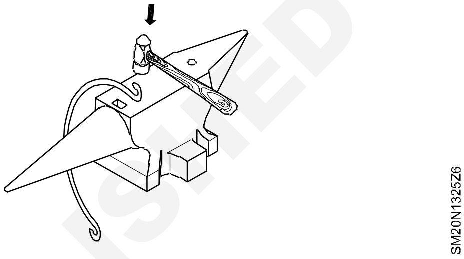
Fig 5



Repeat the same procedure to form the other end of the rod and finish the forming of hook. (Fig 6)

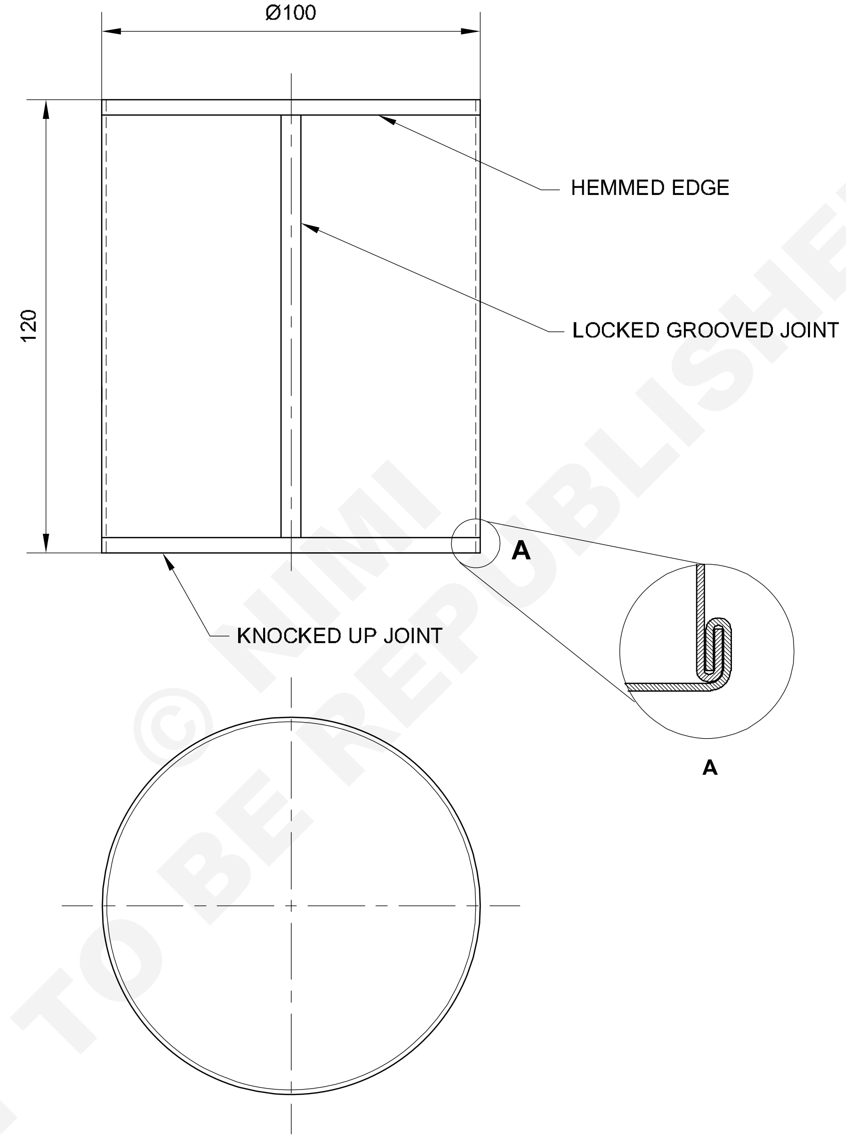
Wear hand gloves when heating and bending the rod.

Fig 6



Bottom holloeing and bottom seam

Objectives: At the end of this exercise you shall be able to
- **make dasble sean knocked UP joint using hand tools.**



BOTTOM FIXING WITH BODY BY KNOCKED UP JOINT.

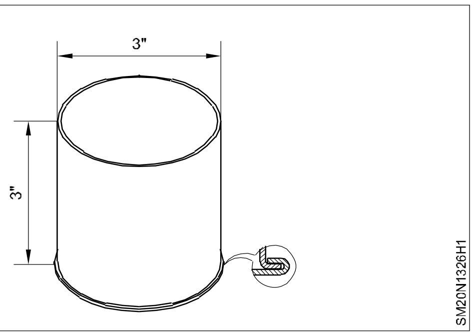
1	--		--	1	2	-
1	--		--	1	1	26
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	**(KNOCKED UP JOINT BY HAND PROCESS)**	DEVIATIONS ±1	TIME
	PROJECT: MUG PART: **1. BASE 2. BODY**	CODE NO. SM20N1326E1	

Job Sequence

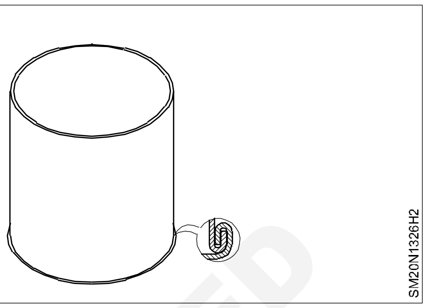
- Check the dia of the base of the cylinder and the dia of the turned disc by using a steel rule as per drawing.

Fig 1



- Make single seam (Paned down joint) by placing the cylindrical body over the bottom disc, using a levelling plate, a square edge a stake, a setting hammer and a wooden mallet. (Fig 1)
- Make double seam (knocked up joint) using a square edge stake, a setting hammer and a wooden mallet. (Fig 2)

Fig 2



Skill Sequence

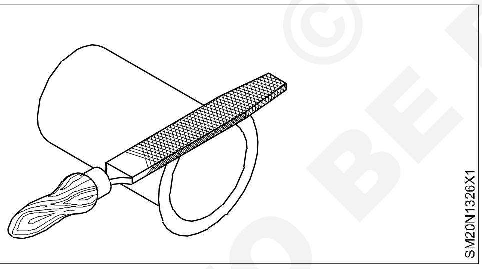
Setting and single seaming

Objectives: This shall help you to
- **set the parts and finish the paned down joint (single seam)**

Check the turned up edge of the circular disc and the flange of the cylindrical body as per the job drawing using a steel rule.

Ensure that the width of the flangand the burred edge of the disc is uniform. If not, rectify by filing with a flat smooth file. (Fig 1)

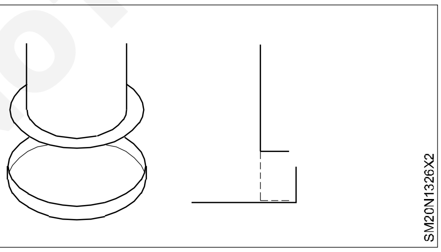
Fig 1



Place the turned disc on the levelling plate.

Place the cylindrical body on the turned disc as shown in Fig 2.

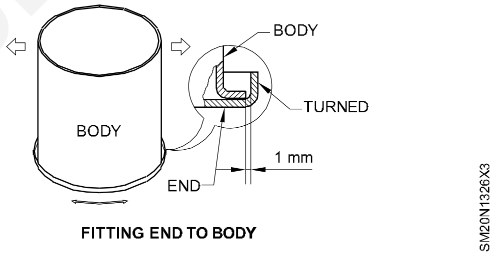
Fig 2



Ensure that the clearance between the cylindrical body and the bottom disc is about 1 mm all around. (Fig 3)

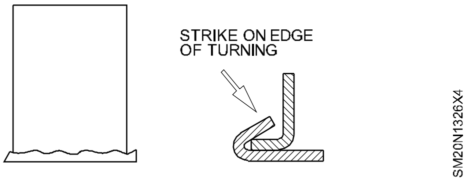
Place the job on the tinman's anvil stake.

Fig 3



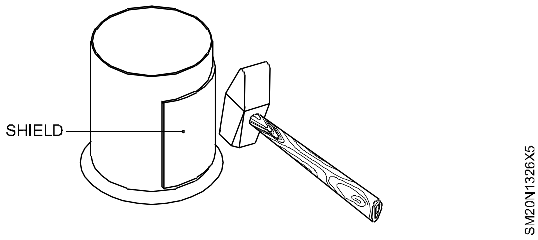
Tap over the bottom edge slightly at several points as shown in Fig 4, to retain the bottom in its position using the setting hammer.

Fig 4



Fold the turned edge gradually using a setting hammer until the single folded seam is obtained. while hammering, use a shield of bent metal piece, to protect the cylindrical body from hammer marks. (Fig 5)

Fig 5



The setting down operation for the single seam (Paned down joint) should be carried out stage by stage as shown in Fig 6.

While striking, stretching and buckling of the metal is occured at the bottom edge. (Fig 7)

Fig 6

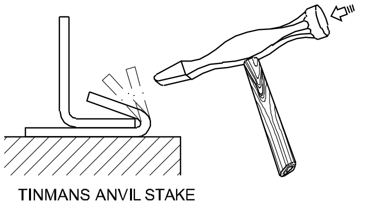
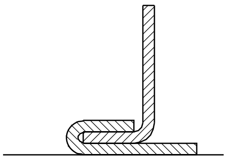


Fig 7



To remove stretching and buckling at the bottom, place the seam over the edge of the square stake and beat with the planishing hammer by rotating the job until the edge is smooth as shown in Fig 8.

The finished single seam (Paned down joint) is shown in Fig 9.

Fig 8

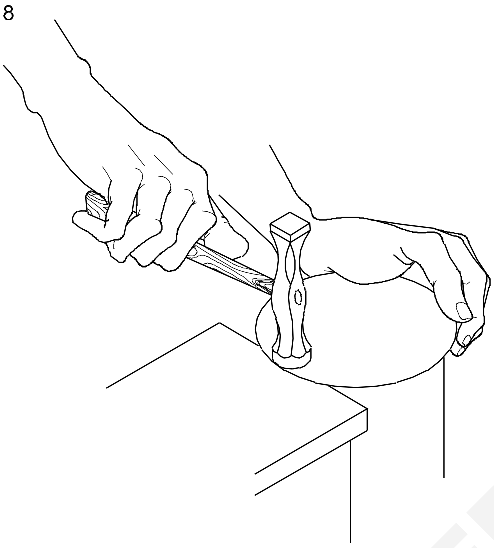
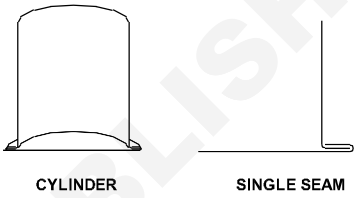


Fig 9



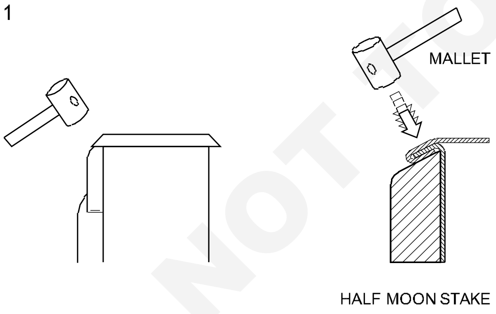
Setting and double seaming

Objectives: This shall help you to
- **place the joint on halfmoon stake and square stake**
- **finish the knocked upjoint**

For knocked up seam, the paned down joint is turned up.

Place the paned down joint on a half moon stake and turn the edge of the joint by a mallet as shown in Fig 1.

Fig 1



Insert the job on the square stake with curved edge as shown in Fig 2.

Support the job by hand and strike with the mallet all around to an angle as shown in Fig 3.

Increase the angle of the bend gradually, while striking with the mallet all around the seam as shown in Fig 4.

Fig 2

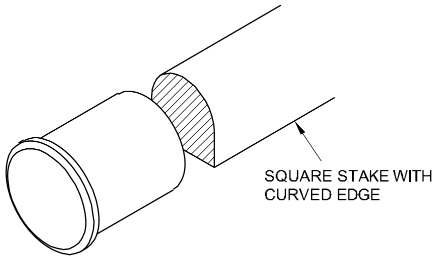


Fig 3

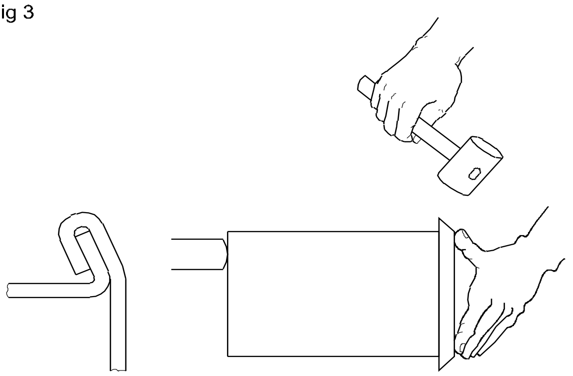
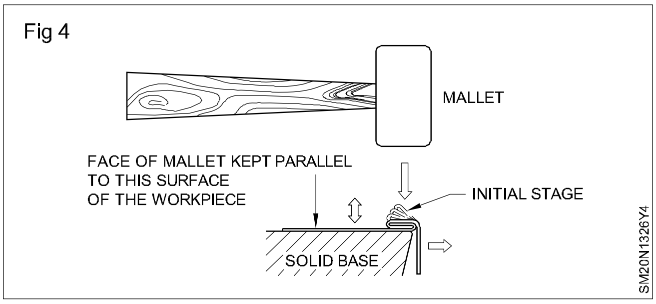
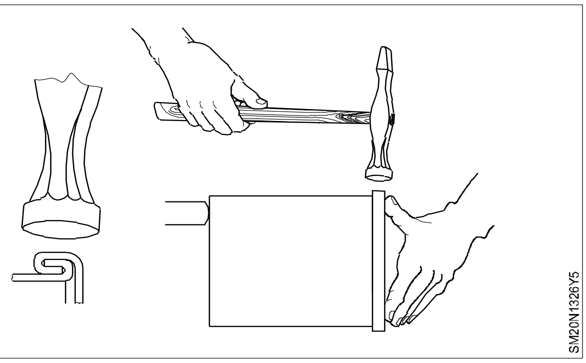


Fig 4



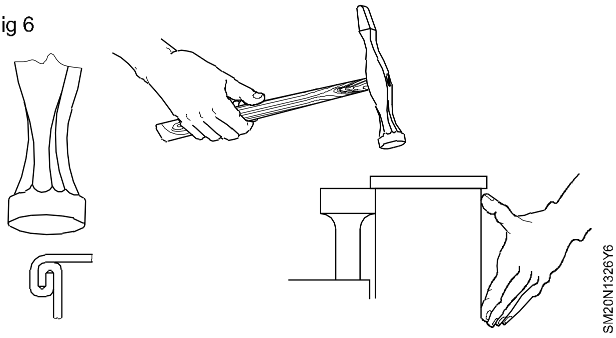
Tighten the double seam (knocked up joint) using the planishing hammer as shown in Fig 5.

Fig 5



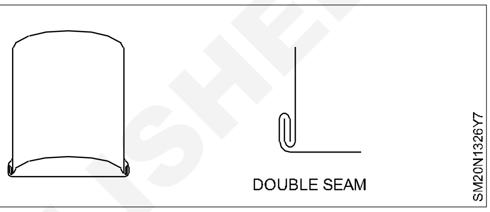
Place the edge of the joint on the square stake and slightly dress the bottom with the planishing hammer as shown in Fig 6.

Fig 6



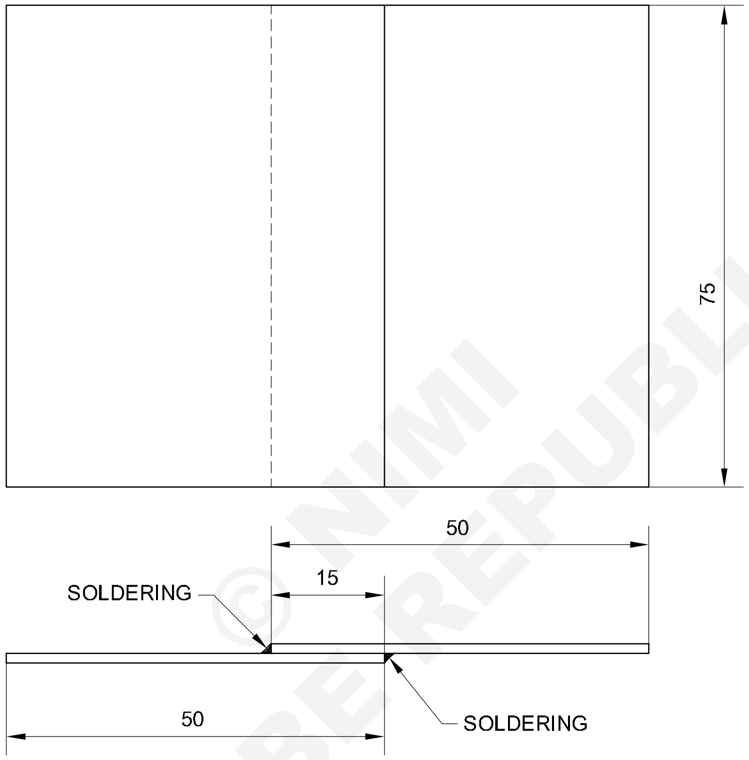
The finished double seam (knocked up joint) is shown in Fig 7.

Fig 7



Soldered lap joint

Objectives: At the end of this exercise you shall be able to
- **prepare soft solder sticks in different proportion for various applications using a hand forge, a crucible and a ladle**
- **set and tack lap joint in correct alignment**
- **solder a lap joint with uniform flow of solder, in flat position**
- **clean and check the lap joint, to ensure that the joint is clean and strong.**



Job Sequence

Make a soldered lap joint

- Cut two pieces of metal to the size 75 x 50.
- Check the size of the material using a steel rule and a trysquare.
- Place two pieces one over the other as shown in job drawing. Prepare the portable hand forge with charcoal and fire with blower.
- Heat the bit and tin the working point of it.
- Tack and solder the joint.
- Clean the joint using water to remove the oxides.

1	--	--	SOFT SOLDER 60:40	--	--	27
1	ISSH 105 x 80 x 0.5	--	G.I SHEET	--	--	27
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	SOLDERED LAP JOINT	DEVIATIONS ±0.1	TIME 10h
		CODE NO. SM20N1427E1	

Skill Sequence

Preparing the soft solders

Objectives: This shall help you to

- **prepare soft solder in varying proportion in the form of stock to suit the metal to be joined.**

In Soft soldering process, soft solder is required to be prepared in the required proportion of tin and lead, when tin and lead are supplied in pure form.

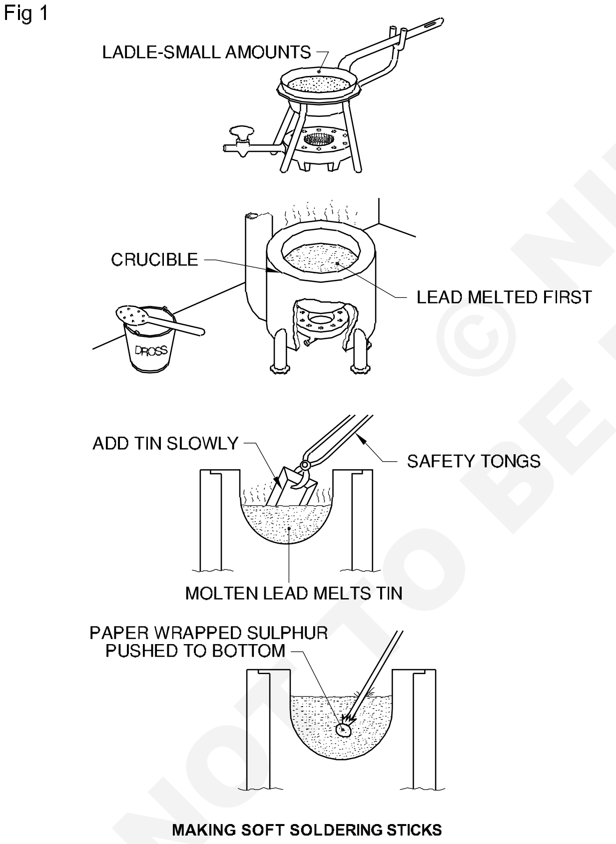
They are generally prepared in the form of triangular sticks.

First measure required quantities of tin and lead in kilograms. For example to prepare 60/40 soft solder, take 600 gms of tin and 400 gms of lead to prepare 1 kg of soft solder.

Melt the lead first in a crucible, cast iron pan or ladle. (Fig 1) Lead is melted first because its melting temperature is higher than tin. (327^0C)

Add tin slowly to the molten lead and blend by stirring the mixture. (Fig 1)

Fig 1



MAKING SOFT SOLDERING STICKS

Reduce the temperature of solder until the mixture will not flow readily.

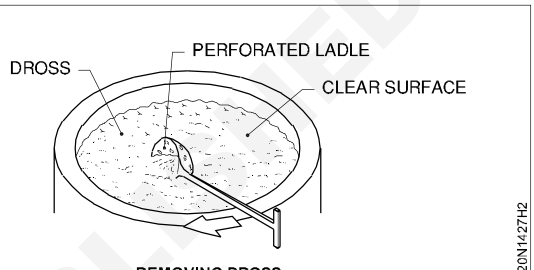
Add little amount of sulphur to the mixture as flux and clean the alloy. (5 gm of sulphur/kg of solder)

Restirr the mixture and increase the temperature until the alloy is free flowing.

Sulphur unites with impurities which rise to the surface, burns and forms a dross.

Remove the dross with a performated ladle. (Fig 2)

Fig 2

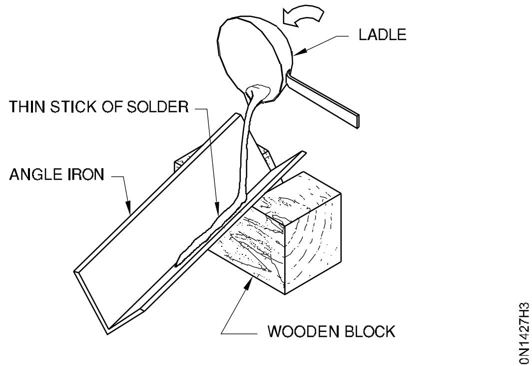


REMOVING DROSS

Use angle iron as a mould.

Clean the angle iron and pour the molten solder carefully and continuously as shown in Fig 3.

Fig 3



MAKING THIN STICKS OF SOLDER

WARNING: Molten solder will splatter violently in contact with moisture. The moulds must be preheated.

Allow the solder to set.

Remove the stick after getting cooled.

Preparing the working point of soldering bit

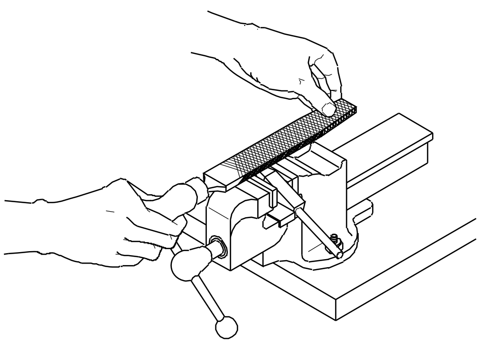
Objectives:This shall help you to

- **tin a soldering bit for free and uniform flow of solder on to the workpiece without oxidation.**

In case of a new bit, hold the bit in a vice and file the burrs from the face and edges and lightly round off the point with a file.

In case of a bit in use, clean the bit point with a file, remove the pitted faces and rough edges. (Fig 1)

Fig 1



If the soldering bit is too hard to file, heat it till it melts the solder freely and then cool it by dipping into cold water.

Heat the bit until colours appear on the faces, Don't over heat the bit.

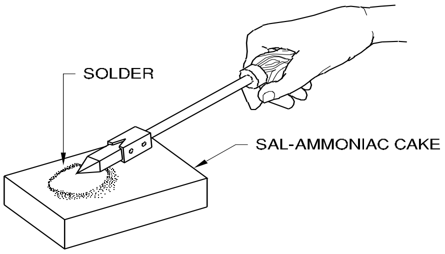
Rub all faces on sal-ammoniac block. (Fig 2)

Apply stick solder to each working face, as it is rubbed on the sal-ammoniac cake.

Spread the solder uniformly over the faces and remove the excess solder by wiping with a piece of rag. (Fig 3)

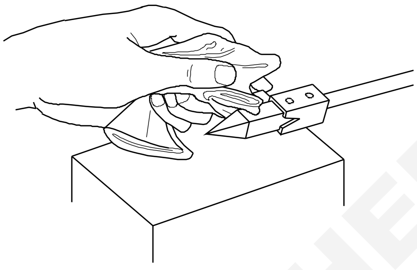
Now a thin bright film called “tin” is formed on the faces of the copper bit. This is called tinning.

Fig 2



RUBBING THE BIT IN SAL-AMMONIAC CAKE

Fig 3



SPREADING THE SOLDER ON FACES OF BIT

Avoid breathing fumes from the sal-ammoniac which causes headache and is injurious to the lungs.

Tacking and soldering the joint

This shall help you to
- **set and tack the lap joint in correct alignment**
- **solder a lap joint with uniform flow of solder, in flat position**
- **inspect a lap joint, to ensure strong joint.**

Check the size of the material using steel rule and trysquare.

Select a suitable type of soldering bit. (Copper)

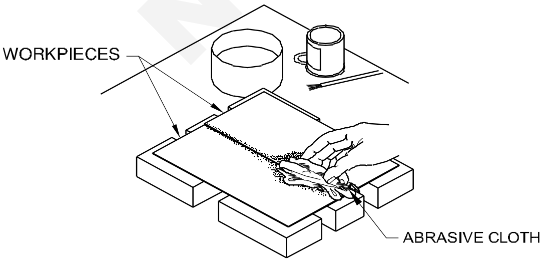
Tin the soldering bit.

Select the suitable flux for the job.

Select the suitable solder for the job.

Clean the surface to be joined with an abrasive cloth and then with a dry cloth, making it free from dirt, rust, oil, grease etc. (Fig 1)

Fig 1

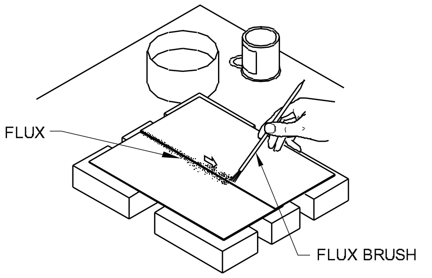


CLEAN THE SURFACES TO BE JOINED

Apply flux to the joint as shown in Fig 2.

Place the surfaces to be joined in correct alignment.

Fig 2



APPLY FLUX

Heat the bit in forge or blow lamp, hot enough to melt the solder readily. The effect of heating the bit is shown in Fig 3.

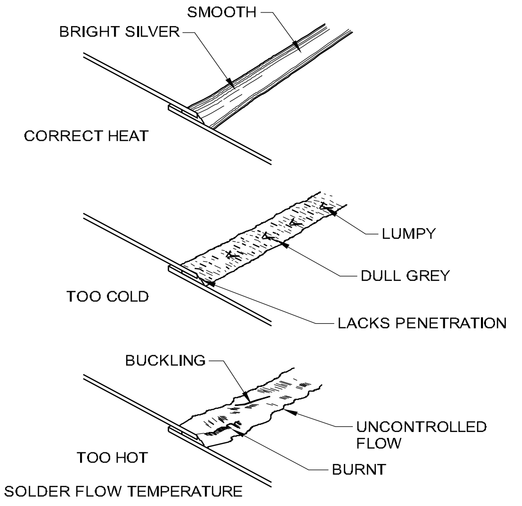
Do not allow it to become red hot otherwise tinning gets burnt off or it will form a bronze coating over the tip, on which solder will not stick properly.

Dip the point of the bit into a dipping solution to avoid oxidation. (Fig 4)

Apply solder to the bit.

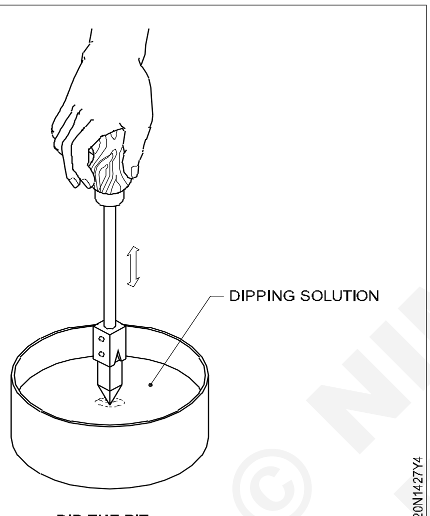
Place the bit in correct position, over the lap opening at one end of the joint. (Fig 5)

Fig 3



HEATING THE BIT

Fig 4

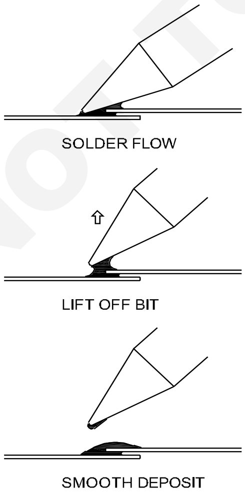


DIP THE BIT

Hold the bit steady till the solder flows onto the workpiece and covers the lap opening. (Fig 5)

Lift the bit from the joint to get a smooth tack of solder. (Fig 5)

Fig 5



TACK SOLDERING

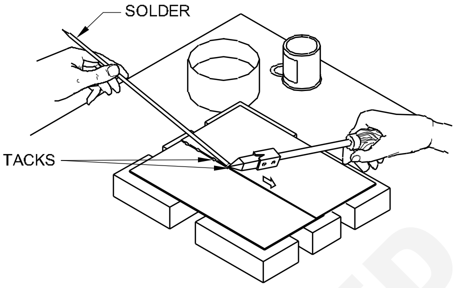
Similarly, tack at regular intervals along the joint. Tacking provides temporary holding of the sheets. (Fig 6)

Re-heat the bit, if necessary.

Place the bit on one end of the seam, add solder to the bit and allow the solder to melt and flow into the joint, which takes place by capillary action.

While soldering, to prevent the lap joint from springing apart, the joint is held in place by a stick of wood.

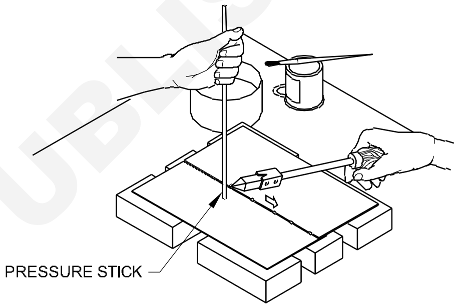
Fig 6



TACKING THE JOINT

Move the bit steadily along the joint with a consistent movement, in one direction. (Fig 7)

Fig 7



DIRECT SOLDERING

Add solder as required.

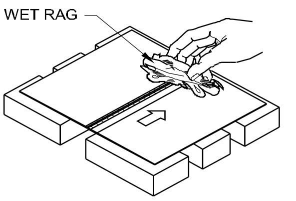
Continue the soldering until the joint is completed.

The joint will not be satisfactory if the solder is just 'struck on' or 'melted on'. Solder should flow freely.

Allow the joint to cool.

Wash off all traces of flux with running water and clean the job with rag. (Fig 8)

Fig 8



CLEANING OF FLUX RESIDUE

Inspect the lap joint for the penetration of the solder into the lapped surfaces.

Ensure that the opening is sealed with a neat, smooth fillet of solder.

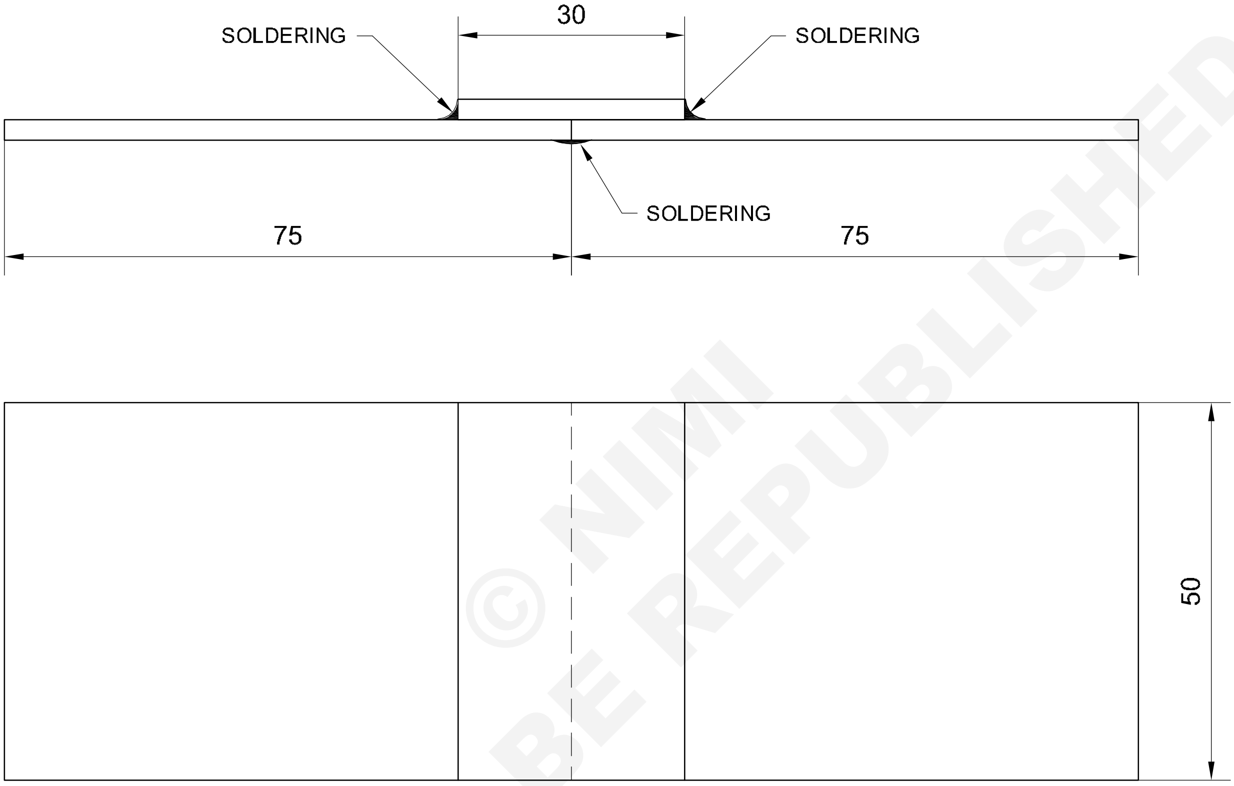
Upper surfaces of the seam should show a smooth, thin coatings of solder, uniform in width with tidy solder margins.

Note: Never file the soldered joint.

Single plated soldered butt joint

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

- **select and heat an Electric soldering iron for soldering**
- **set and tack single plated butt joint in correct alignment, using an electric soldering iron**
- **solder a fillet and butt joint of correct size in flat position, using an electric soldering iron.**



Job Sequence

- Cut the material in three pieces as per the job drawing.
- Make the single plated butt joint using an electric soldering iron as per the job drawing.
- Clean the job using water to remove the oxides.

1	–	–	TINMAN'S SOLDER	–	–	–
1	ISSH 190 x 55 X 0.5	–	TINNED SHEET	–	–	28
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1

SINGLE PLATED SOLDERED BUTT JOINT

DEVIATIONS ±0.5

TIME 5h

CODE NO. SM20N1428E1

Skill Sequence

Making a single plated soldered butt joint

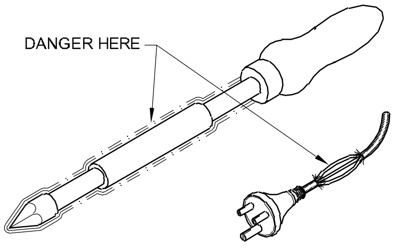
Objectives: This shall help you to
- **set and tack single plated butt joint in correct alignment using electric soldering iron**
- **solder a fillet and butt joint of correct size in flat position using electric soldering iron.**

Check the size of three sheet metal pieces by using a steel rule.

Select a suitable type of an electric soldering bit.

Check if it has loose components connections, frayed or damaged insulation. If found, replace the soldering iron. Short circuiting because of the above faults may cause shocks and fires. (Fig 1)

Fig 1

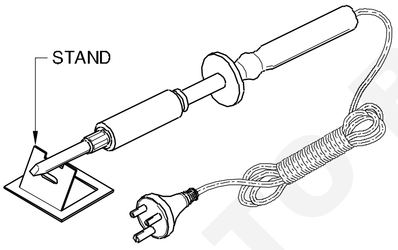


LOOSE COMPONENTS AND FRAYED INSULATION

Do not attempt yourself to repair it. Repairs should be carried out by a qualified electrician.

Plug it in the socket of the switch board and switch 'ON'. Place the electric soldering iron on a suitable support stand. (Fig 2)

Fig 2



SUPPORT STAND

Select the suitable flux for the job.

Select the suitable solder for the job.

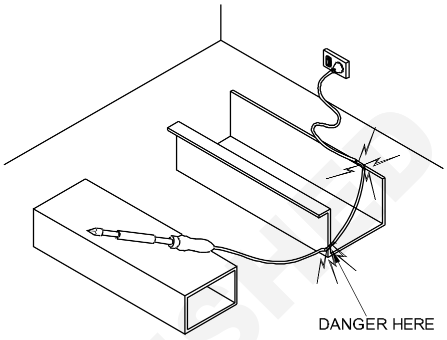
Clean the surface to be joined.

Apply the flux to the joint by using a brush.

Layout three sheet metal pieces to obtain single plated butt joint as per the job drawing.

Place the electrical soldering iron such that its lead does not come across sharp edges of the metal pieces. (Fig 3)

Fig 3



TRACKING OF LEAD-UNSAFE

Tin the point of electric soldering iron by rubbing it on a soft solder.

Tinning on the bit should be bright and should cover the faces of the tip completely.

Set and tack the three metal pieces in correct alignment.

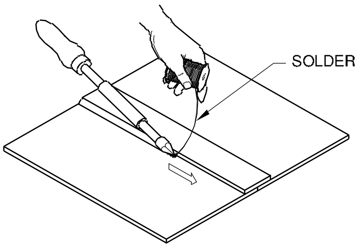
Solder the butt edge at the bottom and cover the plate edges at the top. (Fig 4)

Switch off the power, then remove the plug from the switch board after soldering is completed.

Clean the job in cold water to remove the oxides.

Check the joint and rectify, if required.

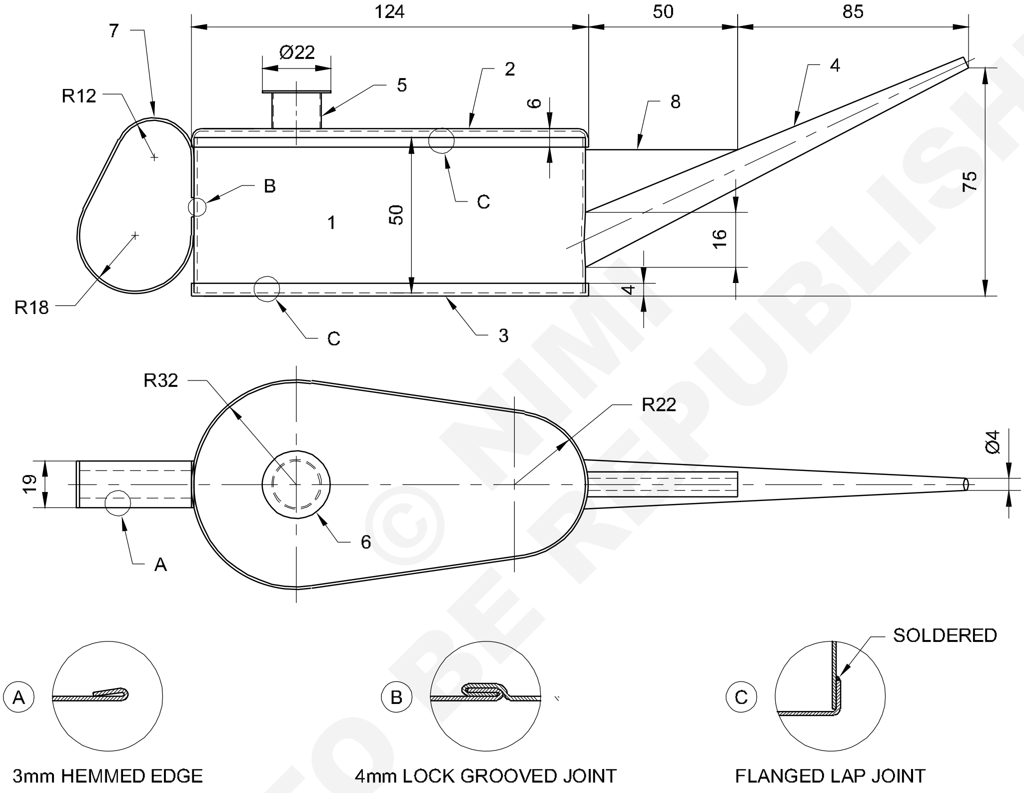
Fig 4



Make an oil can (By hand process)

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

- **develop and layout the pattern for the body, cover, bottom, handle and the support of the oil can by geometrical construction method**
- **form the parts to shape and make joints as per the job drawing using the hand tools**
- **develop and layout the pattern for conical spout of the oilcan using radial line method and its cut out on the body using parallel line method**
- **assemble all parts in position as per drawing by soft soldering**
- **inspect the assembly, check for leakage and finish the article.**



NOTE: ALL JOINTS ARE TO BE SOLDERED

NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
--	--	–	SOFT SOLDER 60:40	7	--	29
1	ISSH 80 x 65 x 0.508	–	G.I SHEET	7	8	29
1	ISSH 160 x 25 x 0.508	–	G.I SHEET	7	7	29
1	ISSH 55 x 20 x 0.508	–	G.I SHEET	7	6	29
1	ISSH 60 x 20 x 0.508	–	G.I SHEET	7	5	29
1	ISSH 155 x 60 x 0.508	–	G.I SHEET	7	4	29
1	ISSH 140 x 120 x 0.508	–	G.I SHEET	7	3	29
1	ISSH 140 x 120 x 0.508	–	G.I SHEET	7	2	29
1	ISSH 350 x 60 x 0.508	–	G.I SHEET	7	1	29

SCALE 1:2

MAKE AN OIL CAN
(BY HAND PROCESS)

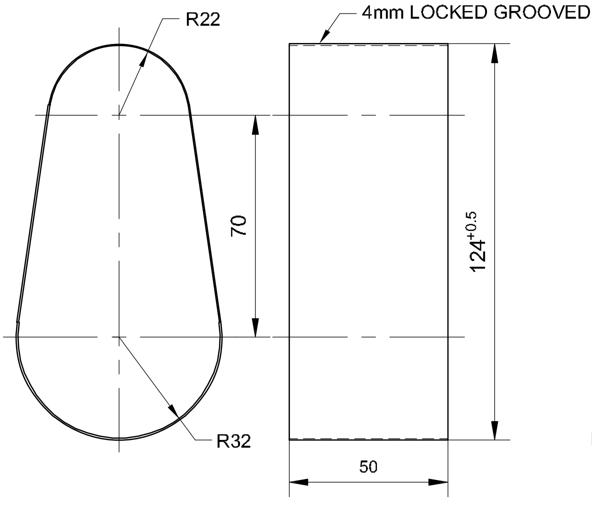
DEVIATIONS ±1

TIME 25h

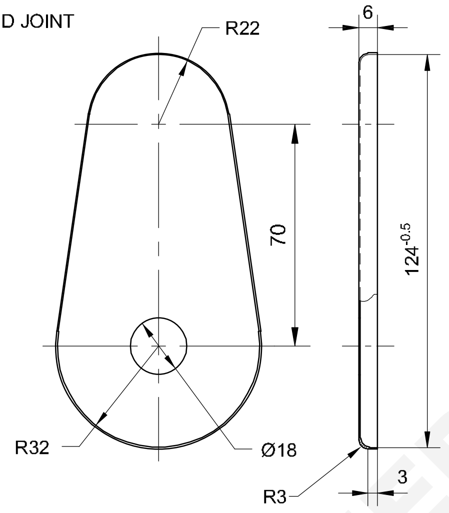
PROJECT: OIL CAN

PART: **1, 2, 3, 4, 5, 6, 7 & 8**

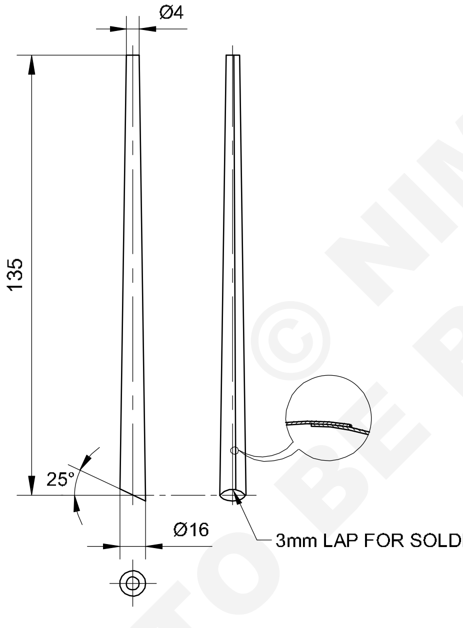
CODE NO. SM20N1429E1



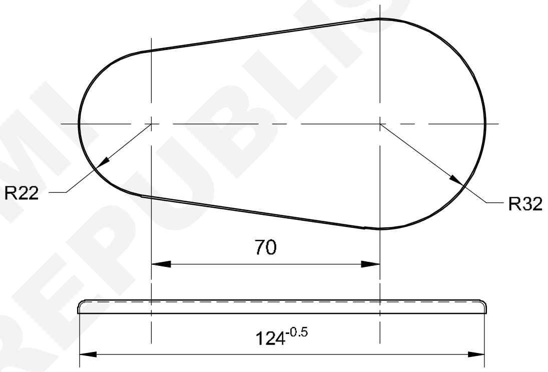
1. BODY



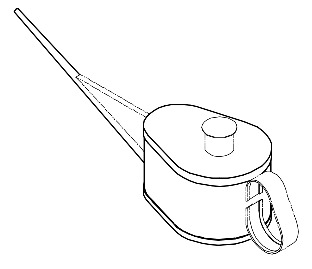
2. COVER



4. SPOUT



3. BOTTOM



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
1	ISSH 155 x 60 x 0.508	–	G.I SHEET	7	4	29
1	ISSH 140 x 120 x 0.508	–	G.I SHEET	7	3	29
1	ISSH 140 x 120 x 0.508	–	G.I SHEET	7	2	29
1	ISSH 350 x 60 x 0.508	–	G.I SHEET	7	1	29

SCALE 1:2

MAKE AN OIL CAN

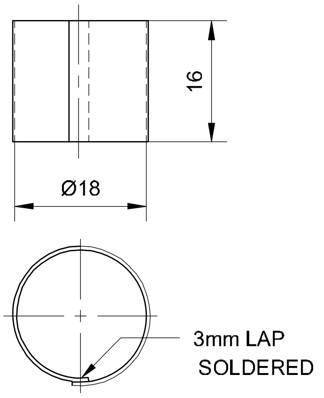
PART: 1. BODY 3. BOTTOM

PROJECT: OIL CAN 2. COVER 4. SPOUT

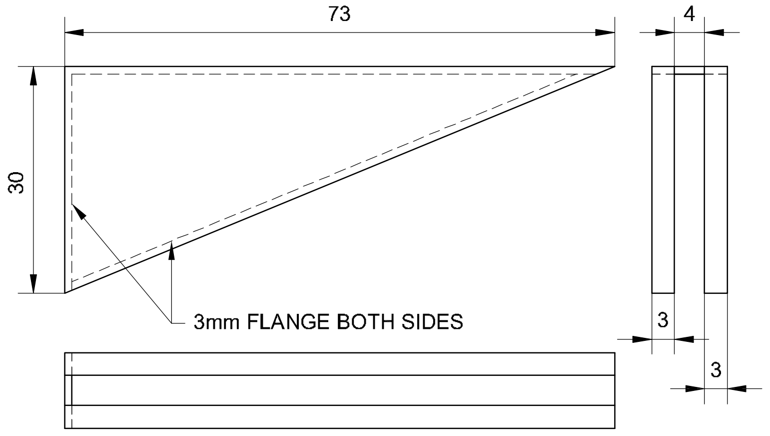
DEVIATIONS ±1

TIME

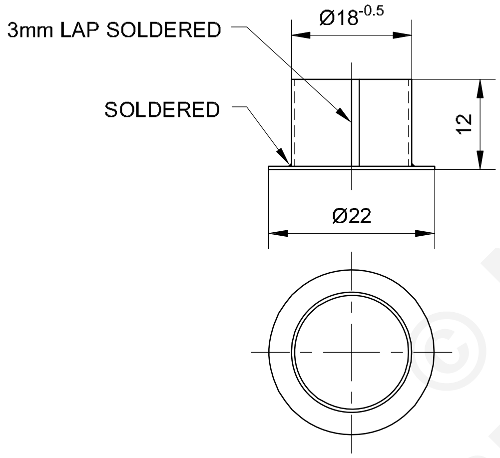
CODE NO. SM20N1429E2



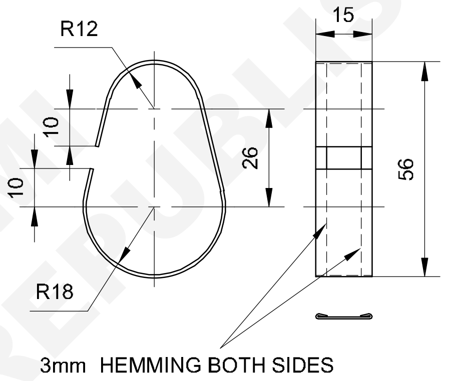
5. OIL PORT



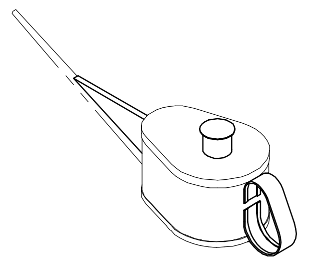
8. SUPPORT PIECE



6. CAP



7. HANDLE



1	--	--	SOFT SOLDER 60:40	7	--	29
1	ISSH 80 x 65 x 0.508	--	GI SHEET	7	8	29
1	ISSH 160 x 25 x 0.508	--	GI SHEET	7	7	29
1	ISSH 55 x 20 x 0.508	--	GI SHEET	7	6	29
1	ISSH 60 x 20 x 0.508	--	GI SHEET	7	5	29
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2

MAKE A OIL CAN

PART: 5. OIL PORT 7. HANDLE
PROJECT: OIL CAN 6. CAP 8. SUPPORT PIECE

DEVIATIONS ±1

TIME

CODE NO. SM20N1429E3

Job sequence

Part 1

Body: Cut the material to size, develop and layout the pattern by geometrical construction method. (Refer Skill sequence)

Layout the pattern for cutout, for fixing the spout, on this pattern by geometrical construction method. (Refer skill sequence for pattern)

Form the pattern to the shape as per job drawing, using a round mandrel stake and a mallet.

Make a locked grooved joint.

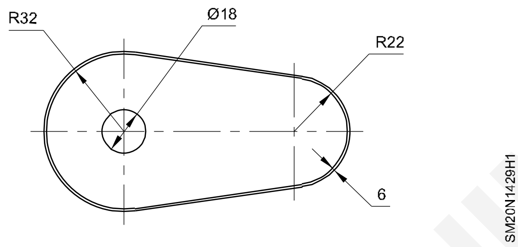
Check the dimensions and rectify, if required.

Finish the part by deburring, polishing etc.

Part 2

Cover: Develop and layout the pattern for the cover (part 3) as in Fig 1.

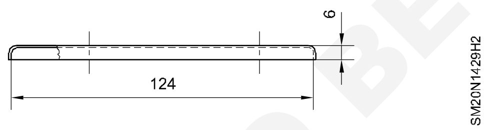
Fig 1



Make a ø 18 mm. Cut out for oil port using a chisel and a hammer.

Make a 6 mm flange making 3 mm corner radius on the edges of the cover. (Fig 2)

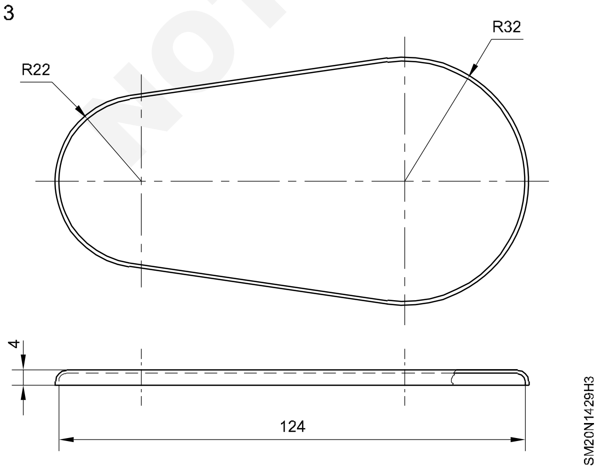
Fig 2



Part 3

Bottom: Make the bottom similar to the cover plate except 4 mm flange and without hole as per the drawing. (Fig 3)

Fig 3



Part 4

Spout: Develop and layout the pattern for spout by radial line development method. (Refer Skill sequence)

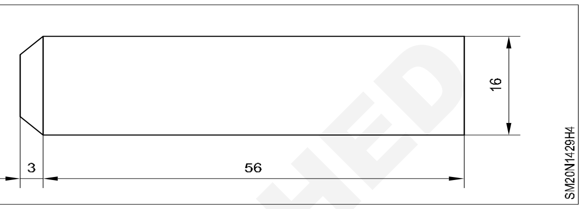
Form the pattern to the shape as per the job drawing and soft solder the lap joint.

Part 5

Oil port: Develope and layout the pattern. (Fig 4)

Form to cylindrical shape and lap the solder joint as per job drawing.

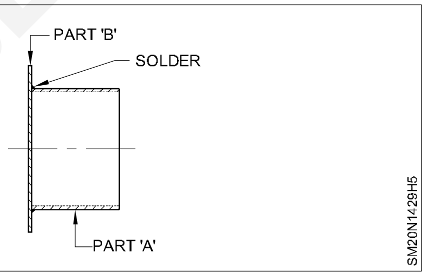
Fig 4



Part 6

Cap: Make the Part 'A' and Part 'B' as per job drawing and join by soldering as shown in Fig 5.

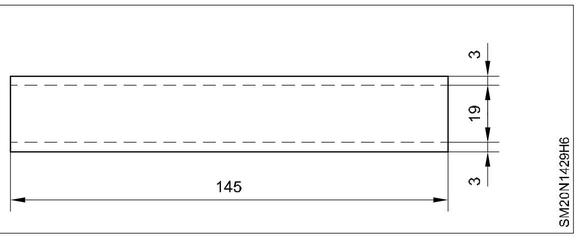
Fig 5



Part 7

Handle: Develop and layout the pattern for the handle (part 7) as in Fig 6.

Fig 6



Hem the edge and form as per the job drawing.

Part 8

Support piece: Develop and layout the pattern for the support piece. (Fig 7)

Cut the pattern and deburr.

Make the 3 mm flange on the component as per marking.

From the part to shape as per job drawing and finishthe part.

Assembly: Check all the parts 1 to 8 for shape and dimensions.

Flare the larger diameter end of the spout and set it into the body from inside and tack solder to the body in position as per the assembly drawing.

Place the body into the flanged portion of the bottom (Part 2) and join by tack soldering.

Set the support piece (Part 8) inbetween the body and the spout to position and tack solder to the body and spout.

Place the oil port (Part 5) in position on the cover (Part 2) and solder to the cover.Place the cover (Part 2) over the body (Part 1) in position and tack solder.

Set the handle in position and tack solder to the body.

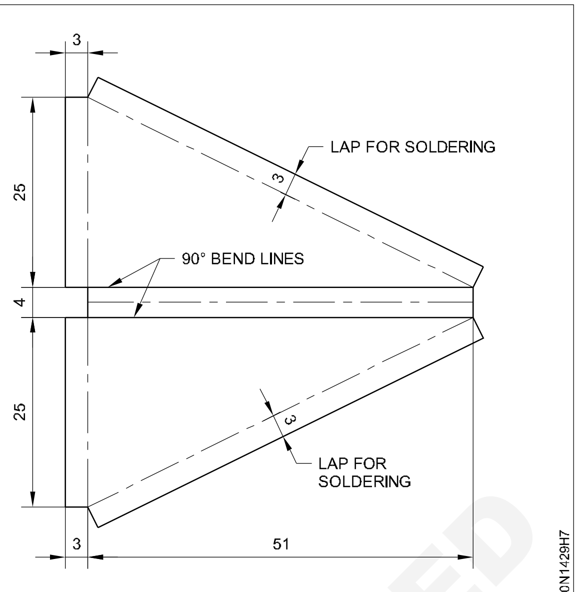
Check the assembly of all parts as per the assembly drawing and soft solder all the joints making a leak proof sheet metal article.

Check the oil can for leakage, and rectify, if required.

Clean the article with cold water.

Finish the article.

Fig 7



PATTERN FOR PART - 8

Skill Sequence

Develop and layout the pattern for oval shaped article by geometrical construction method and form to shape by hand process

Objectives: This shall help you to

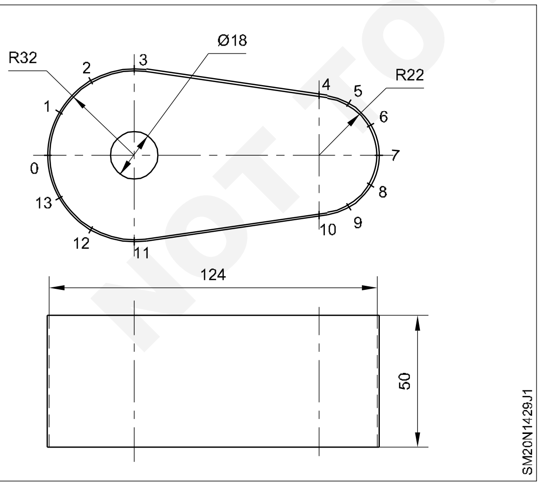
- **develop and layout the pattern for an oval shaped article by geometrical construction method**
- **form the article having different radius using a round mandrel stake and a mallet.**

Take the body of an oil can as an example for better illustration in this skill sequence.

Draw the plan and elevation of the body of the oil can as in Fig 1.

Divide the semi-circles R32 and R22 into 6 equal parts in the plan as in Fig 1.

Fig 1



Name the divisions 0 to 13 as in Fig 1. (Plan)

Draw a horizontal line of approximately 450 mm length.

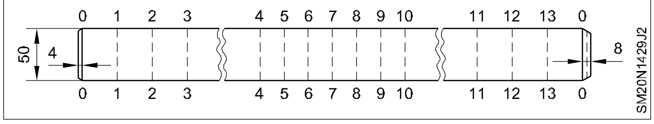
Draw a vertical line of 50 mm height at “00^1” as in Fig 2.

Transfer the points 0" to 13' from the plan to the horizontal line as in Fig 2. Add joining allowances.

Form the pattern to the shape as per the drawing using a round mandrel stake and a mallet.

Cut as per the marking using straight the snips. Deburr the part.

Fig 2



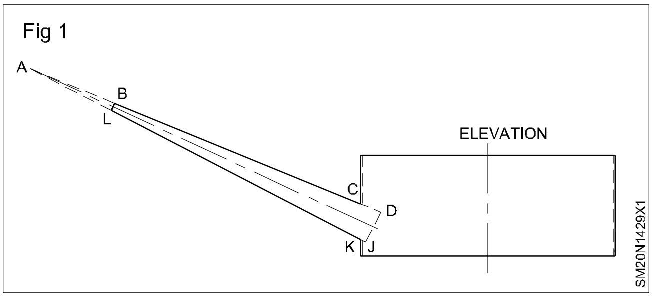
Develop and layout the pattern for conical spout fixed on a cylindrical body at an angle (using radial line method) and its cutout on the cylindrical body (using parallel line method).

Objectives: This shall help you to

- develop pattern for a conical spout

Draw the elevation of the sub-assembly of body and spout and complete the full cone ADJ by producing the sides BC and LK upwards to meet at 'A' the apex and downwards to a convenient position to form the base. (Fig 1)

Fig 1



The distance AD must be equal to AJ.

Describe a semi-circle on the base DJ and divide it into six equal parts and name them as D,E,F,G, H,I,J.

Draw perpendicular lines from these points to the base DJ and join these points so obtained on the base, to Apex 'A' Fig 2.

Draw a horizontal centre line in the plan. (Fig 2)

Project the base of the cone on to the plan by drawing vertical lines from the points on DJ to cross the horizontal line in the plan.

Mark off on the corresponding lines above and below the horizontal line JD, distances equal to these from the base JD to the semi-circle.

Draw the ellipse (isometric circle) to represent the base and joint the points D', E',F',G',H',I',J' to the Apex A'. (Fig 2)

From the points where these lines cut the circle representing the cylindrical body, project lines vertically upwards to meet the corresponding lines in the elevation.

Points should be obtained through which the line of intersection is to be drawn.

Project lines at right angles to the centre line AO from all the points on the line of intersection to the slant side AJ.

With Apex 'A' as centre and AJ as radius draw an arc.

Take one equal division from the semi-circle as DE or DF, from a convenient point. On the arc, step off twelve spaces which will represent the base of the full cone in the pattern.

Six divisions D', E', F', G', H', I',J' are shown in Fig 2.

Join these twelve points to the Apex 'A'.

Draw arcs from all the points on the slant side AJ to cut the radial lines of the pattern.

Join the points of intersection on the radial line and arcs with a smooth curve as in Fig 2.

MNOP represents the pattern of the spout.

(B)Pattern development for cutout on the body

After developing the pattern for spout let us develop the pattern for its cutout on the body. See Fig 2

Locate the points of intersection a,b,c,d,e,f,g.

Extend the lines QB and TS on the right side and name UV and WX. Length of UV and WX is equal to the circumference of the body.

Draw parallel lines from the points of intersection.

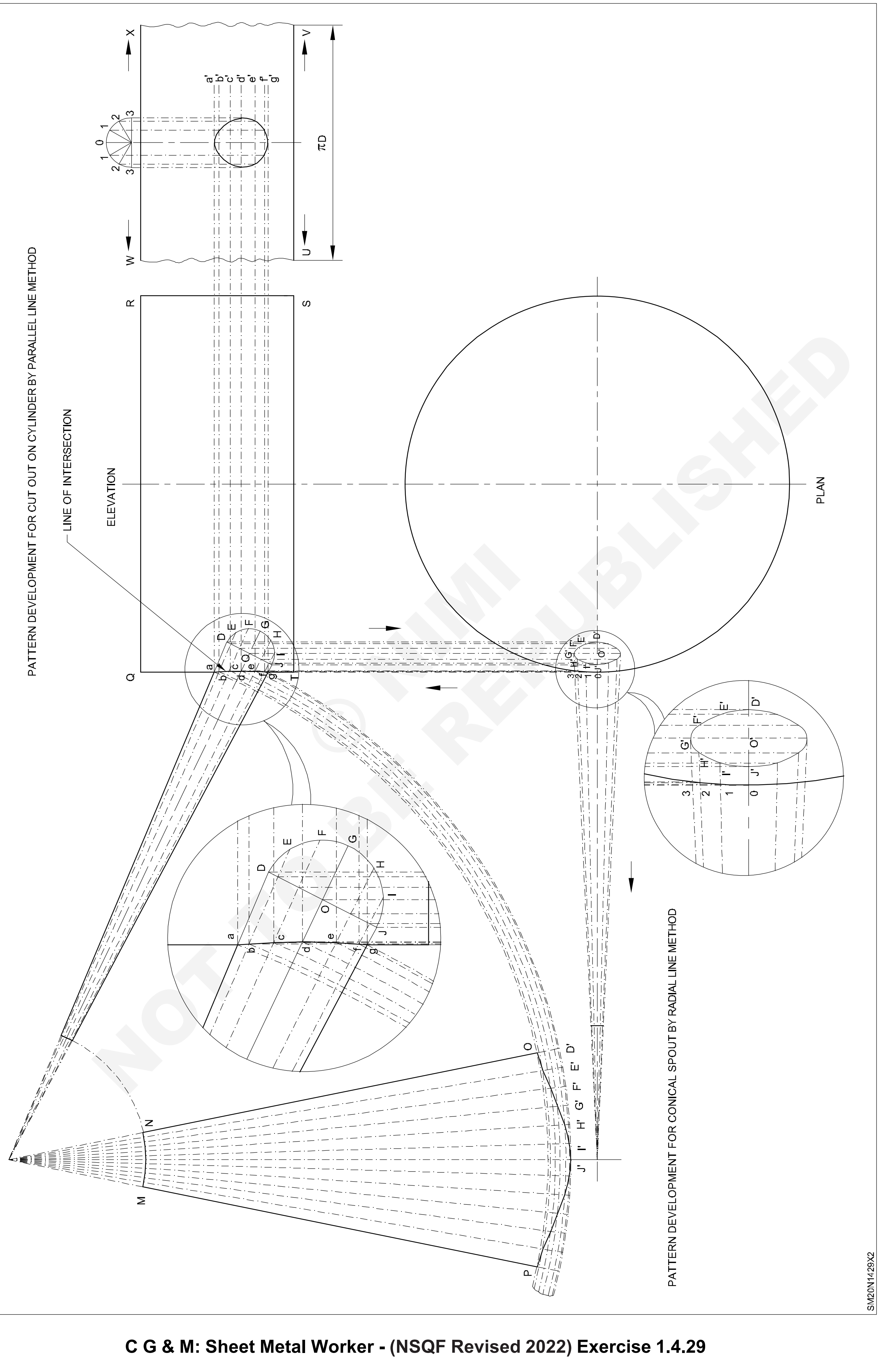
Take point '0' at the centre of the line UV and transfer the points from the plan 123 on both sides.

These lines intersect the horizontal lines.

Join the corresponding points of intersection by a smooth curve.

This is the pattern developed for the cutout to fix the spout on to the body.

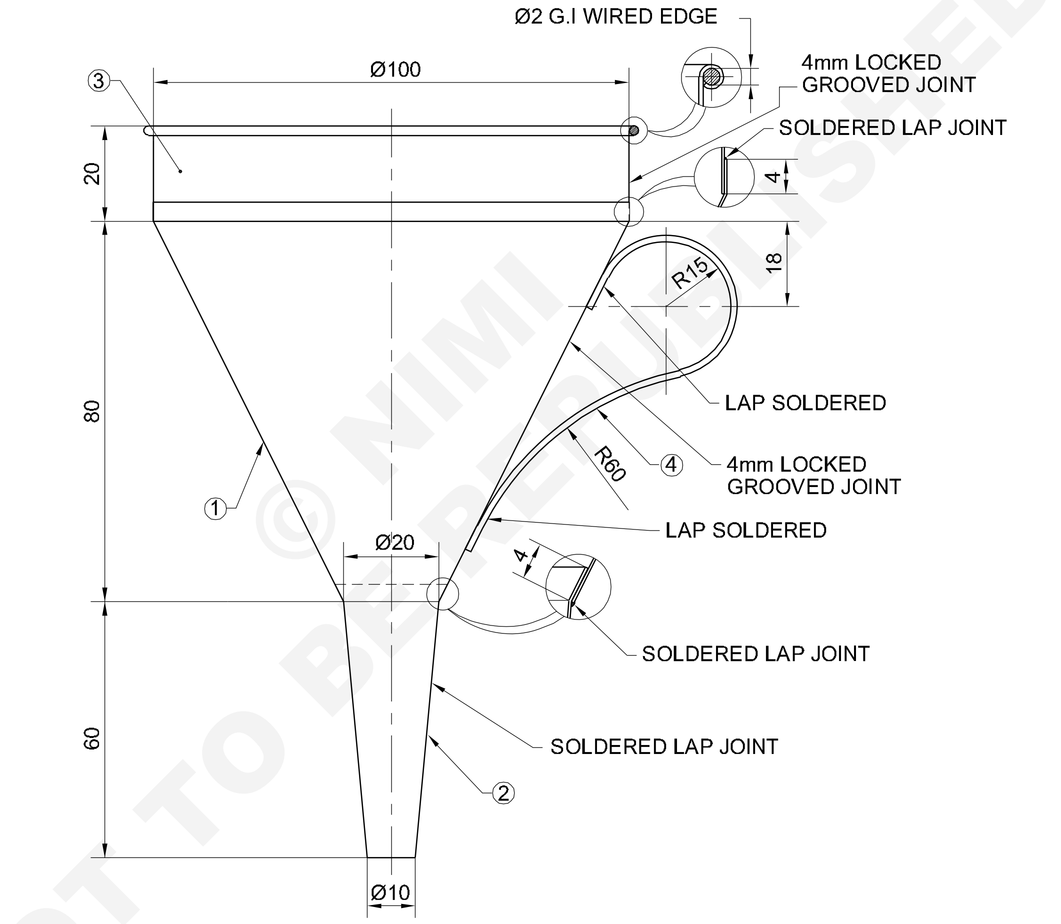
Fig 2


PATTERN DEVELOPMENT FOR CUT OUT ON CYLINDER BY PARALLEL LINE METHOD
LINE OF INTERSECTION
ELEVATION
PLAN
PATTERN DEVELOPMENT FOR CONICAL SPOUT BY RADIAL LINE METHOD
X
W
V
U
πD
0 1 2 3
a' b' c' d' e' f' g'
R
S
Q
T
a b c d e f g
D E F G H I J O
D' E' F' G' H' I' J' O'
M
N
O
P
SM20N1429X2

Make a funnel by soldering process

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

- **develop and layout the pattern for the frustrum of a cone by radial line method.**
- **to make frustrum of cone by locked grooved joint using hand tools**
- **to make frustrum cone by lap joint using hand tools**
- **to make a topring with grooved joint and wored edge**
- **mark the wiring allowance at the curved edge**
- **make a wired edge along a curved surface by hand process**
- **make a handle having different curvatures as per job drawing using funnel stake and wooden mallet**
- **assemble cylindrical shaped parts by soft soldering, as per drawing and finish the article.**

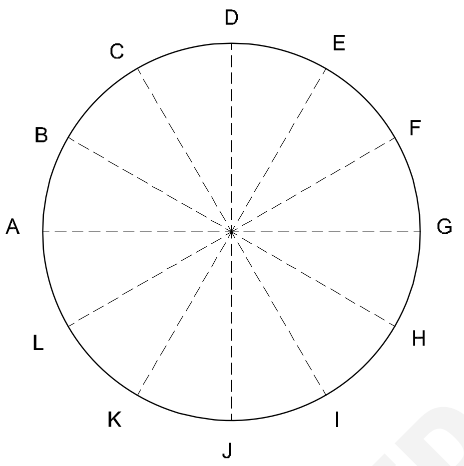


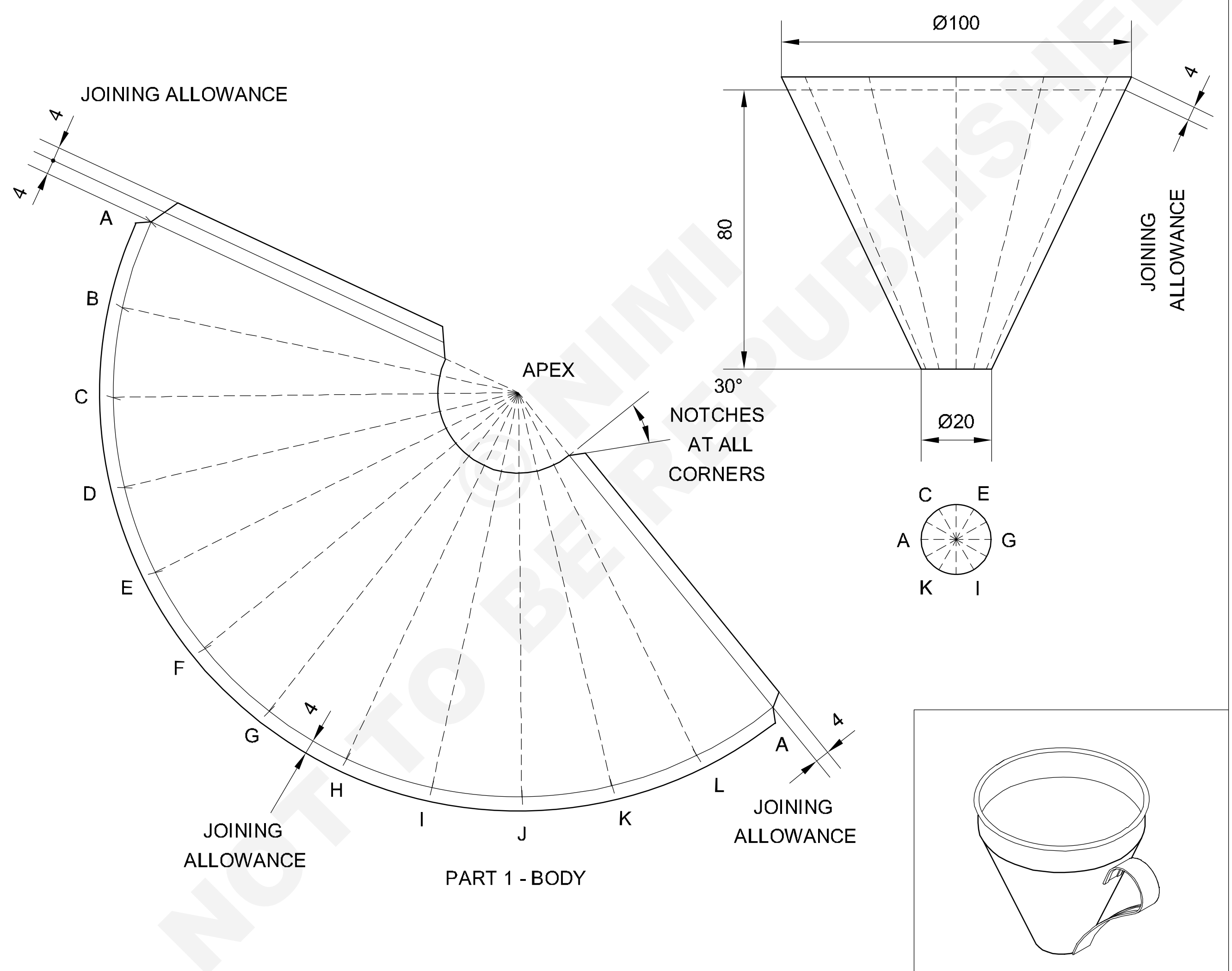
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
–	–	–	SOFT SOLDER 60:40	-	–	-
1	Ø2 - 360	–	G.I WIRE	-	–	-
1	ISSH 160 x 25 x 0.5	–	G.I SHEET	-	4	-
1	ISSH 335 x 30 x 0.5		–	-	3	-
1	ISSH 125 x 80 x 0.5		TINNED SHEET	-	2	-
1	ISSH 250 x 140 x 0.5		TINNED SHEET	-	1	1.353

SCALE: NTS	**MAKE A FUNNEL** (BY SOLDERING)	DEVIATIONS ±1	TIME :
	PROJECT: FUNNEL PART: **1, 2, 3 & 4**	CODE NO. SM20N1430E1	

Job Sequence

- Develop and layout the pattern for the body of a furnel frustrum of a cone) on a plain drawing paper using a geometry box (instrument box).
- Cut the layout pattern using scissors and paste it on the given raw material using fevicol/gum.
- Cut the Sheet metal on the outlines of the layout pattern of the paper so pasted, using a straight and bend snips.





-	ISSH 250 x 140 x 0.5	-	THINNED - SHEET	8	1	1.4.30
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2

MAKING A FUNNEL
(BODY PATTERN CUTTING)

PROJECT: FUNNEL PART: **BODY**

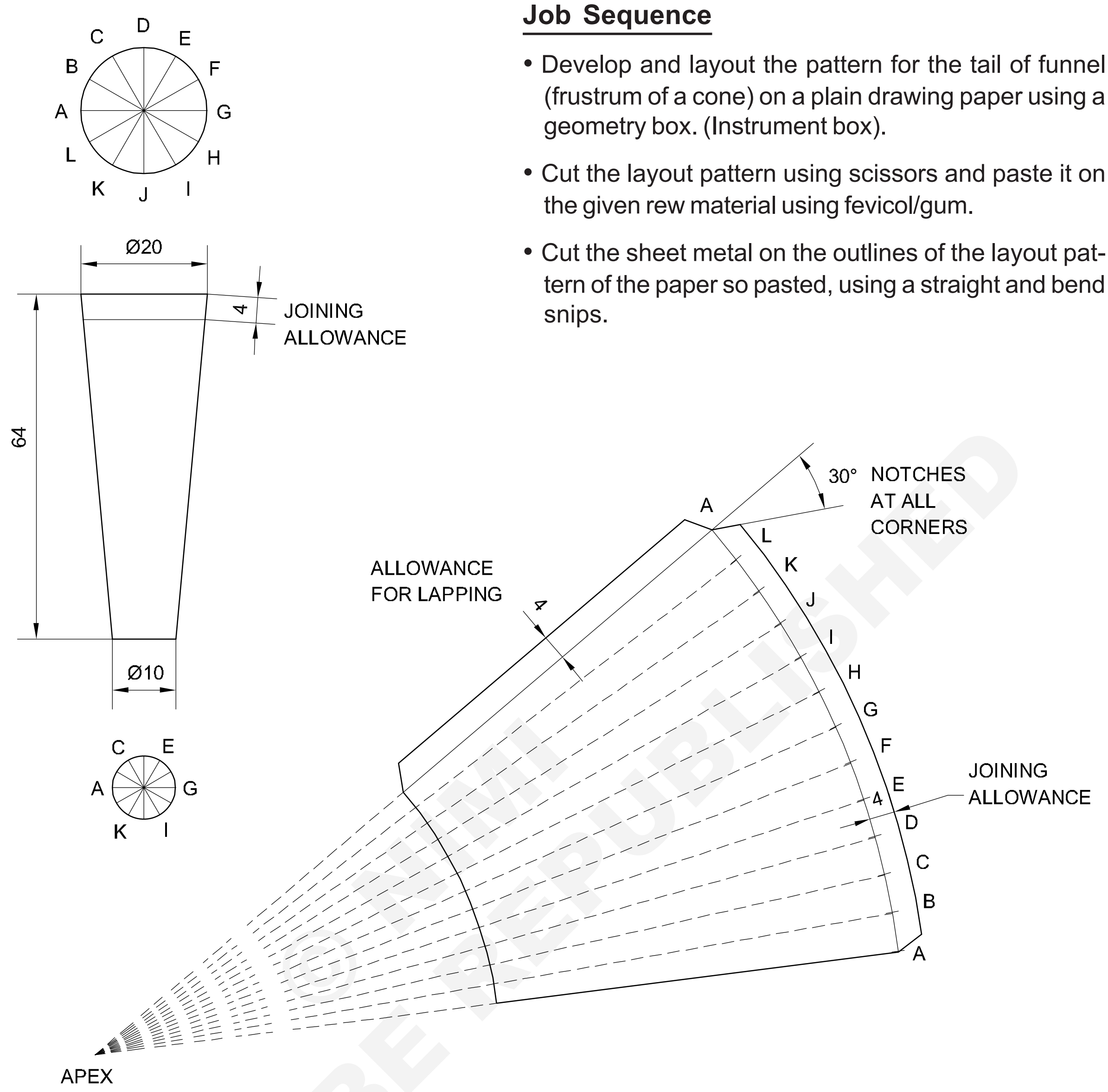
DEVIATIONS ±1

TIME

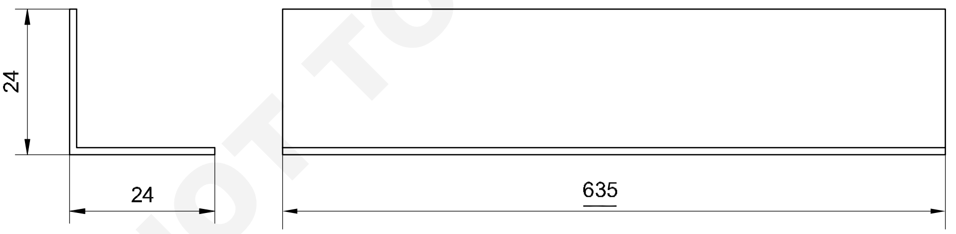
CODE NO. SM20N1430E2

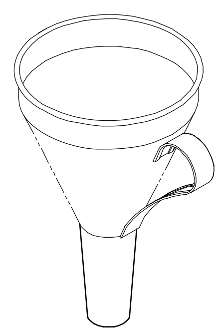
Job Sequence

- Develop and layout the pattern for the tail of funnel (frustrum of a cone) on a plain drawing paper using a geometry box. (Instrument box).
- Cut the layout pattern using scissors and paste it on the given rew material using fevicol/gum.
- Cut the sheet metal on the outlines of the layout pattern of the paper so pasted, using a straight and bend snips.



TASK-5





1	ISSH 125 x 80 x 0.5		TINNED - SHEET	-	-	1.4.30
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1

MAKING A FUNNEL

(TAIL PATTERN CUTTING)

DEVIATIONS ±1

TIME :

CODE NO. SM20N1430E3

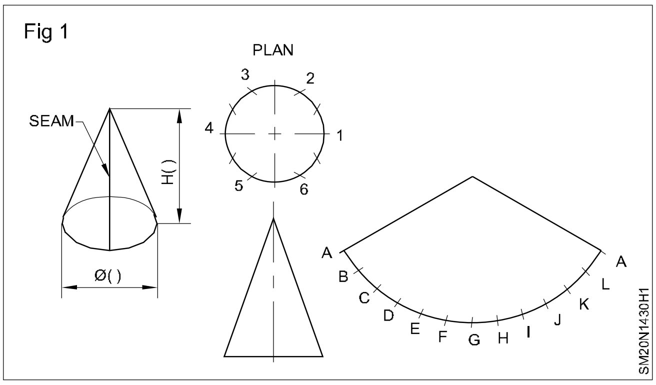
Skill Sequence

Development for a circular cone

Objectives: This shall help you to
- **develop a cicular cone by the radial line**

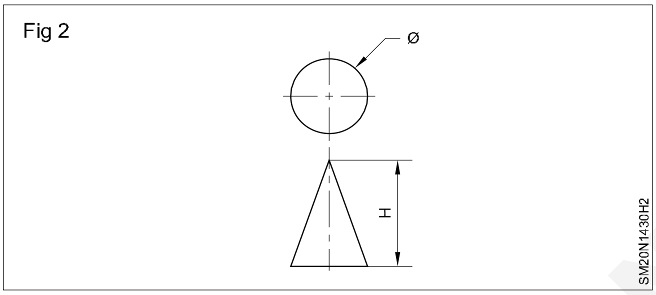
Develop a cicular cone by the radial line development (Fig 1)

Fig 1



Circular cone: Draw the front elevation and the plan. (Fig 2)

Fig 2

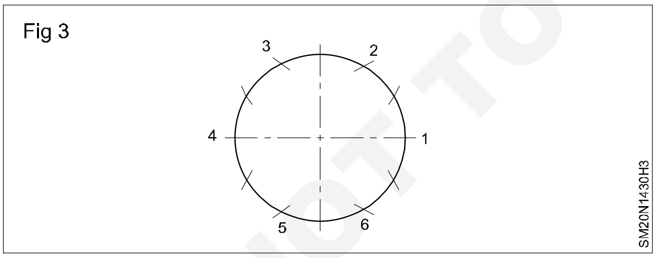


While drawing the plan, the neutral plane (outer diameter plate thickness) of the base circle is taken as the diameter.

The neutral plane size is negligible, if the plate thickness is less than 0.5 mm.

Divide accurately the circumference of the plan into 12 equal parts. (Fig 3)

Fig 3

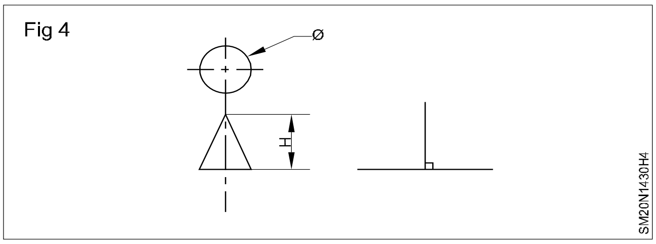


With the radius of the circle, first divide the circumference into 6 equal parts.

Then divide each part into two.

Draw a perpendicular line on the material. (Fig 4)

Fig 4

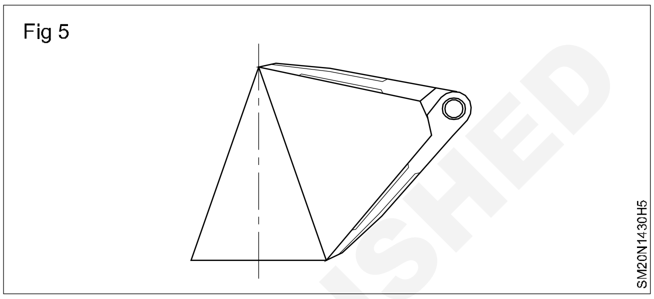


Draw the base line at about 5 mm from the end of the material.

Draw a perpendicular line to the centre of the material blank space.

Transfer the length of the edge line (slant height) to the compass. (Fig 5)

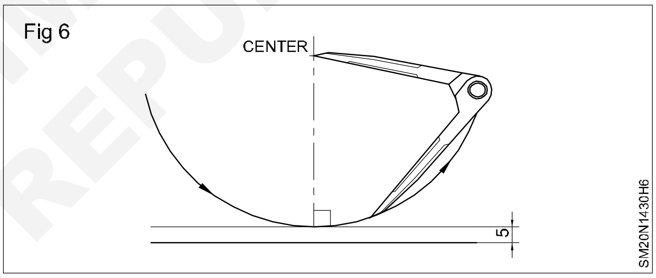
Fig 5



Transfer it accurately.

Draw an arc with the centre at a point on the perpendicular line (Fig 6) and the slant height as the radius.

Fig 6



Check the opening of the compass with each equally divided points, to minimise errors.

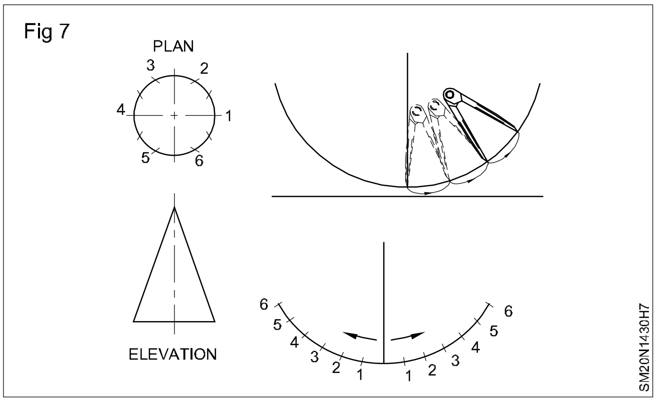
Open the compass points to one of the 12 equally divided parts of the circumferential length.

Open the compass by checking each equally divided point to minimise errors.

Scribe 12 opening points of the compass on the arc.

Scribe six points on both the right and left sides of the perpendicular respectively. (Fig 7)

Fig 7

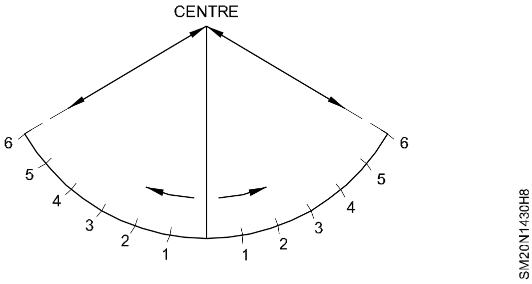


Use the compass points alternately while scribing points, without removing the compass from the arc at a time.

Connect the right and left ends of the arc to the centre. (Fig 8)

Fig 8 shows the development for the given cone.

Fig 8



Develop and layout the pattern for the frustrum of a cone by radial line method

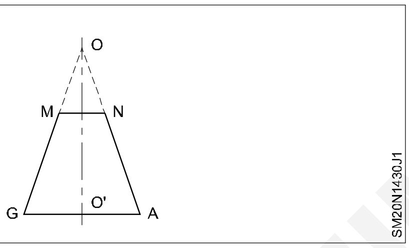
Objectives: This shall help you to

- **develop and layout the pattern for the frustrum of a cone by radial line method**

Get a plain drawing paper large enough to make the flat pattern layout.

Draw the elevation of the frustrum of a cone in full size ‘AGMN’ in Fig 1.

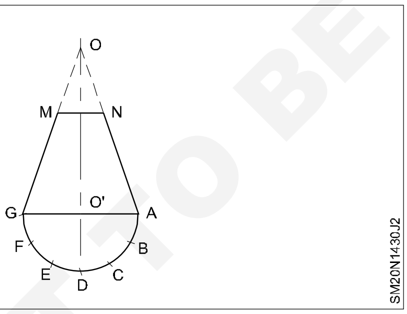
Fig 1



Continue the lines showing taper sides of the body till they intersect at a point ‘O’. ‘O’ is called as an ‘Apex’. (Fig 1)

Taking O’ as the centre and O’A as radius, draw an arc AG and divide it into six equal parts A-B-C-D-E-F-G. (Fig 2)

Fig 2



With centre ‘O’ draw arcs AX and NY. X&Y are the points on the centre line of the frustrum of a cone. (Fig 3)

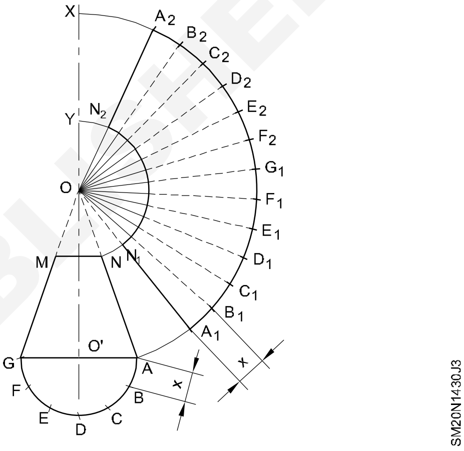
Take distance ‘X’ and mark off twelve lines along the arc AX to obtain A^1-B^1-C^1-D^1.... to D^2-C^2-B^2....A^2. (Fig 3)

Join the points A^1,B^1,C^1......C^2,B^2,A^2 to the point ‘O’.

The development required is then A^1 A^2 N^1 N^2.

This is the development of a frustrum of a cone without a joining allowance.

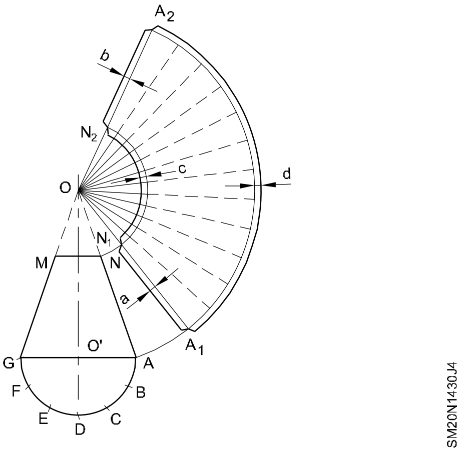
Fig 3



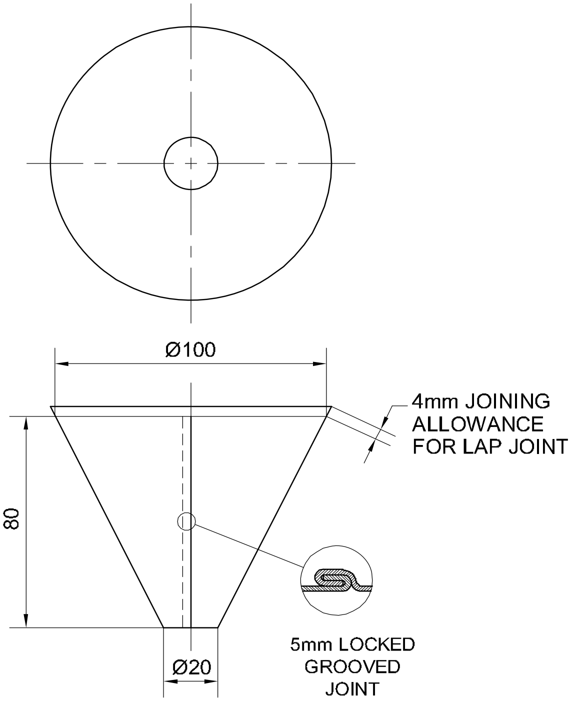
Now add joining allowances ‘a’ & ‘b’ by drawing lines parallel to A^1N^1 & A^2 N^2. (Fig 4)

Add hemming or wiring or joining allowance ‘c’ & ‘d’ by drawing arc inside the arc N^1 N^2 and outside the arc A^1 A^2. (Fig 4)

Fig 4



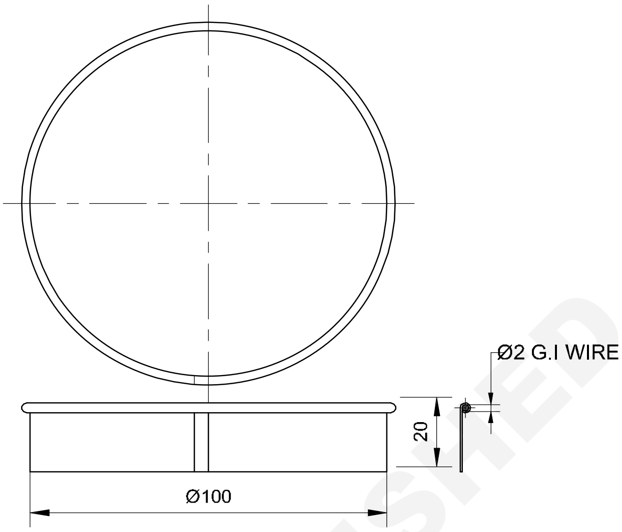
TASK-1



PART 1 - BODY

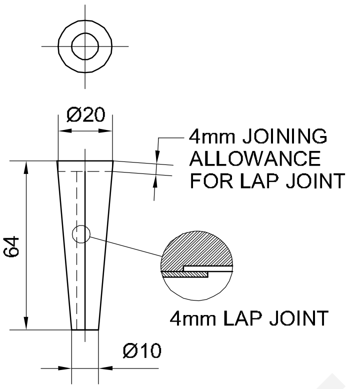
FUNNEL BODY

TASK-3



FUNNEL FERRULE

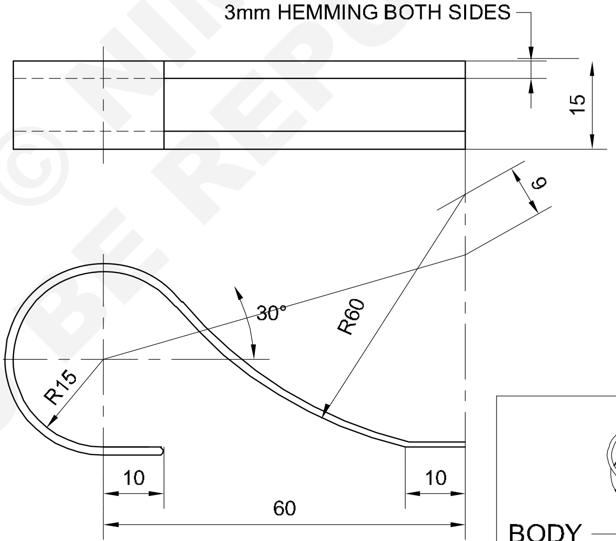
TASK-2



PART 2 - TAIL

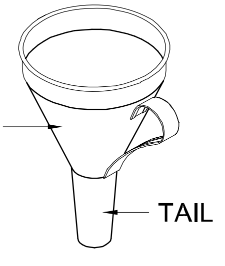
FUNNEL TAIL

TASK-4



FORMING THE HANDLE

FUNNEL HANDLE



-	–	–	-	-	-	1.4.30
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2

MAKE A FUNNEL
(SEAMING THE BODY AND THE TAIL)

PROJECT: FUNNEL PART: 1. BODY 2. TAIL

DEVIATIONS ±1

TIME

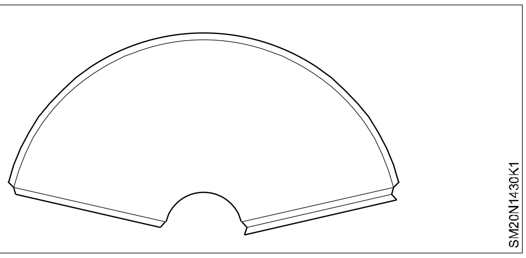
CODE NO. SM20N1430E4

Job Sequence

PART 1 (Body)

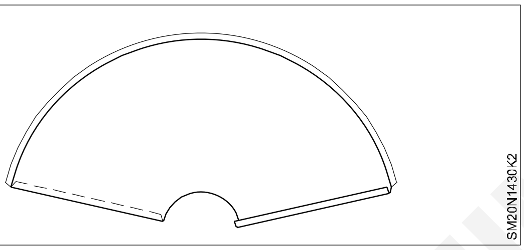
- Flatten the workpiece using a wooden mallet and a Tinmans anvil stake. Fig 1)

Fig 1



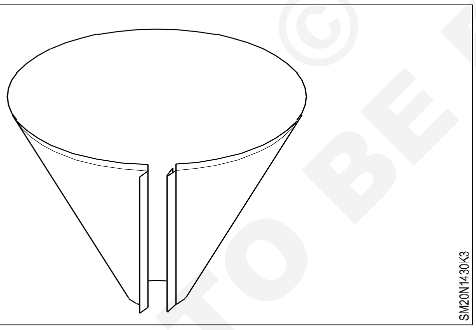
- Check the allowances for the locked grooved joint using a steel rule.
- From hooks on both the ends in opposite directions by using a hatchet stake, a wooden mallet and a 1/ 2 Ib ball pane hammer.

Fig 2



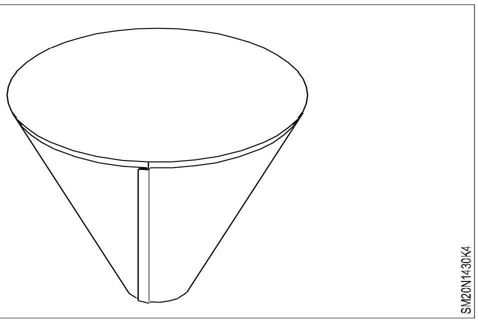
- From the workpiece to the frustum of cone by using a funnel stake. (Fig 3)

Fig 3



- Make a loced grooved joint by using a funnel stake, a hand groover and a 1 1/2 Ibs Ball pane hammer. (Fig 4)
- Finish the job using a wooden mallet.
- Check the dimensions of the job by using a steel rule.

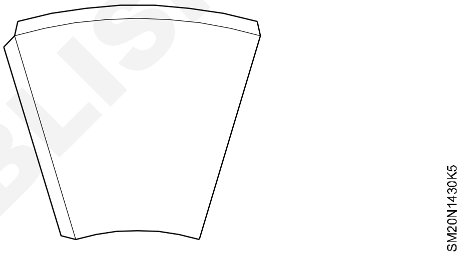
Fig 4



Part 2 (Tail)

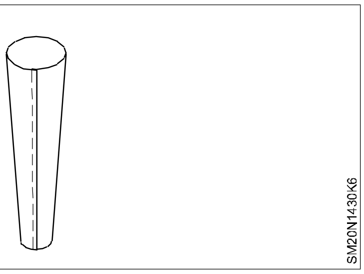
- Flatten the workpiece using a wooden mallet and a Toinmans anvil stake. (Fig 5).
- Check the allowance for the lap joint by using a steel rule.

Fig 5



- From the workpiece into frustum of cone using a long tapered beak houstum of cone using a long tapered beak horned iron stake. (Fig 6)

Fig 6



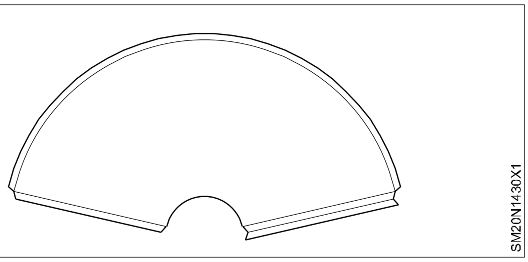
Skill Sequence

Forming a frustum of a cone with locked grooved joint

Objectives: This shall help you to
- **form a frustrum of cone using a funnel stake and a wooden mallet**
- **make locked grooved joint on tapered curved surface using a funnel stake, hand groover and a ball pane hammer.**

Check the pattern and ensure that all the required allowances are provided by using a steel rule as per the job drawing. (Fig 1)

Fig 1

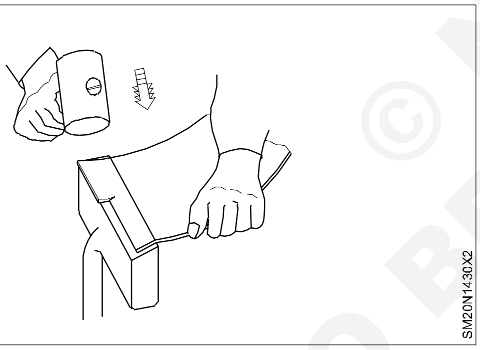


Remove burrs by using a flat file. Mount the hatchet stake on the bench plate.

Place the sheet horizontally on the hatchet stake edge at the line marked previously for folding.

With a wooden mallet strike the edge of the job on both ends. (Fig 2) Observe break or fold mark formed.

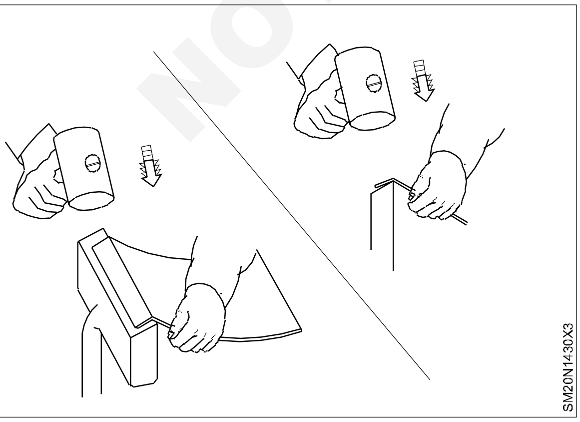
Fig 2



Lower the end of the work slightly using the same angle of striking, increasing the angle of turning.

Repeat the above operation till the edge is turned to the required angle. (Fig 3)

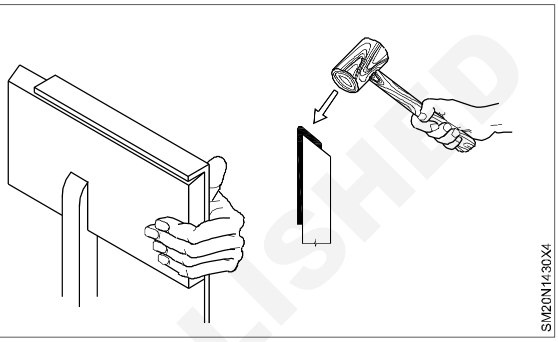
Fig 3



For turning more than 90^0, support the work flat against the face of the stake.

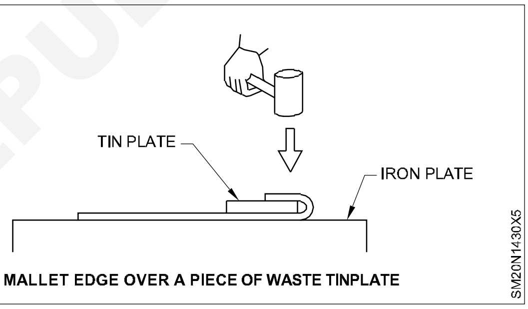
Grip the stake with fingers at 'A' and hold the work in position with the thumb. (Fig 4)

Fig 4



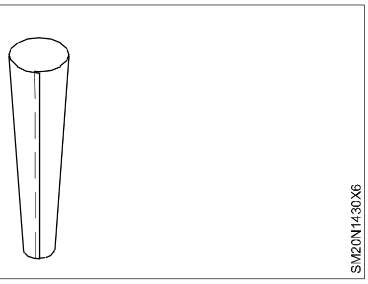
Mallet the edge over a piece of waste tin plate. (Fig 5)

Fig 5



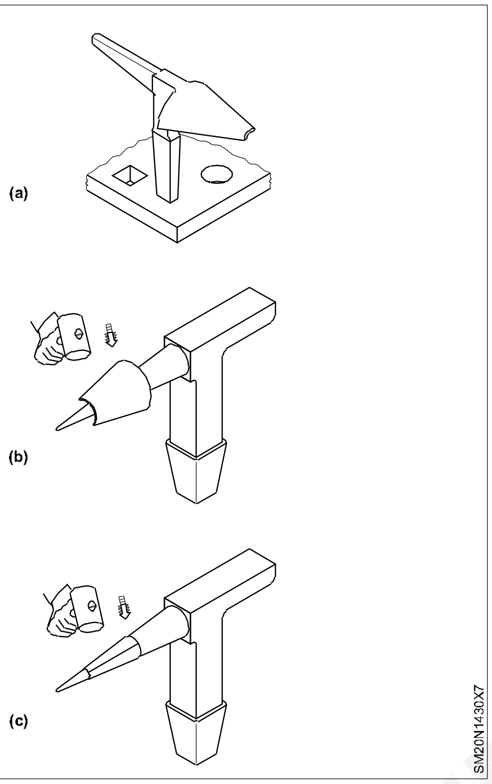
Repeat the same operation on the other edge of the sheet and form hooks. (Fig 6)

Fig 6



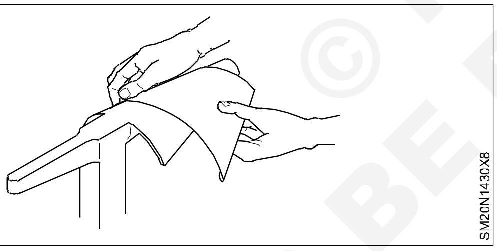
Mount the funnel stake on a bench plate. (Fig 7a) Use “long tapered beak horned iron stake” for the cones having small radius, plate. (Fig 7b & 7c)

Fig 7



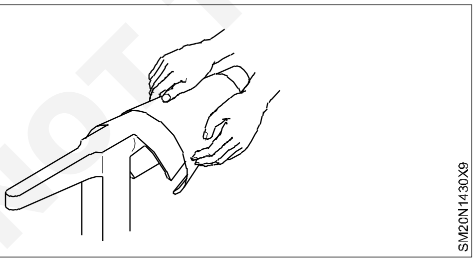
Place one end of the work piece on the funnel stake parallel to the axial line of the stake and bend as shown in Fig 8.

Fig 8



Repeat the same operation on the other end of the workpiece. Bend the workpiece evenly as shown in (Fig 9).

Fig 9



Check the turned up edge of the circular disc and curve it gradually and make both ends to meet together. (Fig 10)

Ensure that the folded edges of the workpiece are parallel, if not the edges will not match as shown in (Fig 11)

Fig 10

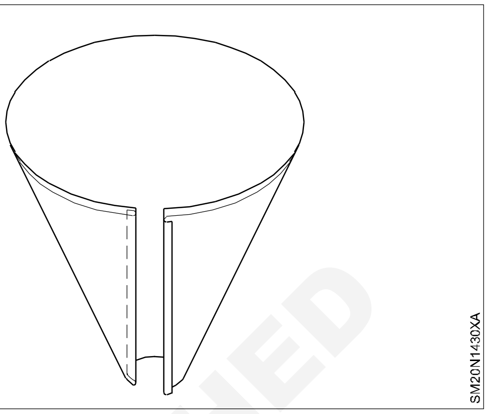
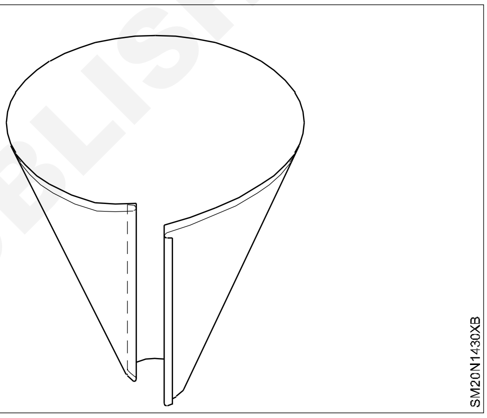
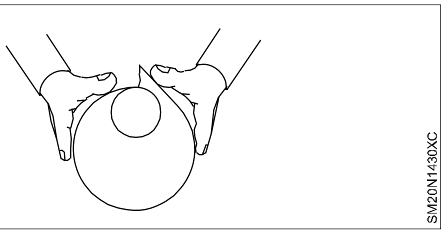


Fig 11



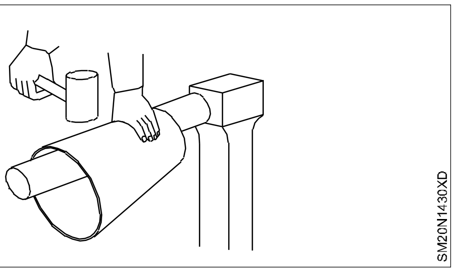
Hook the folded edges as shown in Fig 12.

Fig 12



Slowly lock the edges by light blows using a mallet as shown in (Fig 13) Start blows from one end of the joint to the other end to tighten the joint. (Now grooved seam is formed)

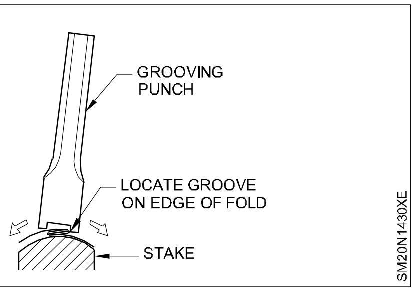
Fig 13



Select the correct size of the groover.

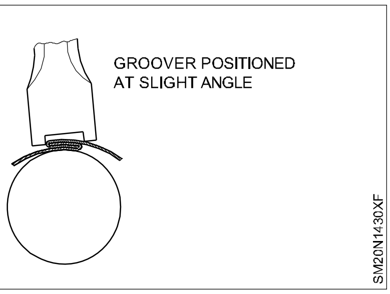
Place the groover over the grooved joint as shown in (Fig 14)

Fig 14



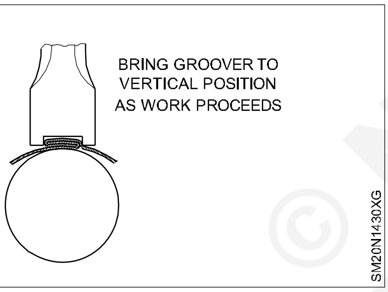
Position the groover at a very slight angle. The edge of joint acts as a guide to the groover. (Fig 15)

Fig 15



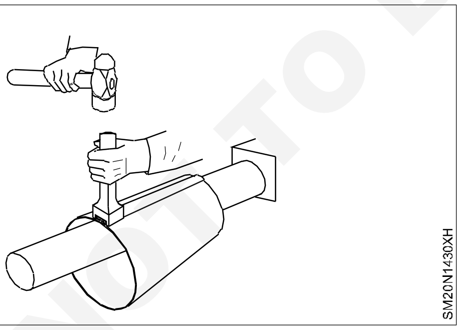
Bring the groover to vertical position. (Fig 16)

Fig 16



Strike the top of the groover firmly with Ball pane hammer and lock same on the other end. (Fig 17)

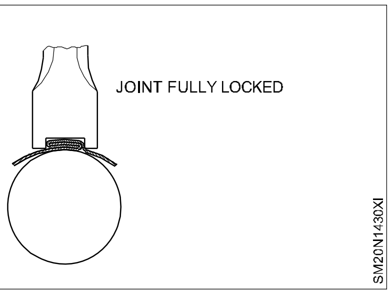
Fig 17



Check the ends again to ensure that they are in line. Continue to lock the seam along the line with the hand groover.

Now the joint is fully locked. (Fig 18)

Fig 18



Finally smoothen with a mallet all over the body and check the dimensions as per the job drawing by using a steel rule.

In order to get proper setting of seam of the required size, it is necessary to use the correct size of a groover. If not, the seam is set too wide or too narrow. See Fig 19, 20,21.

Fig 19

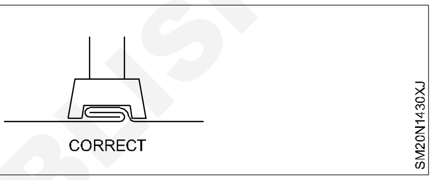


Fig 20

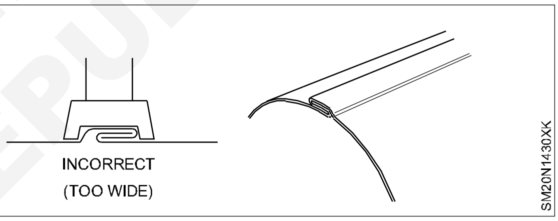
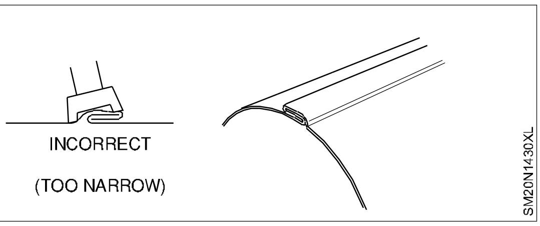


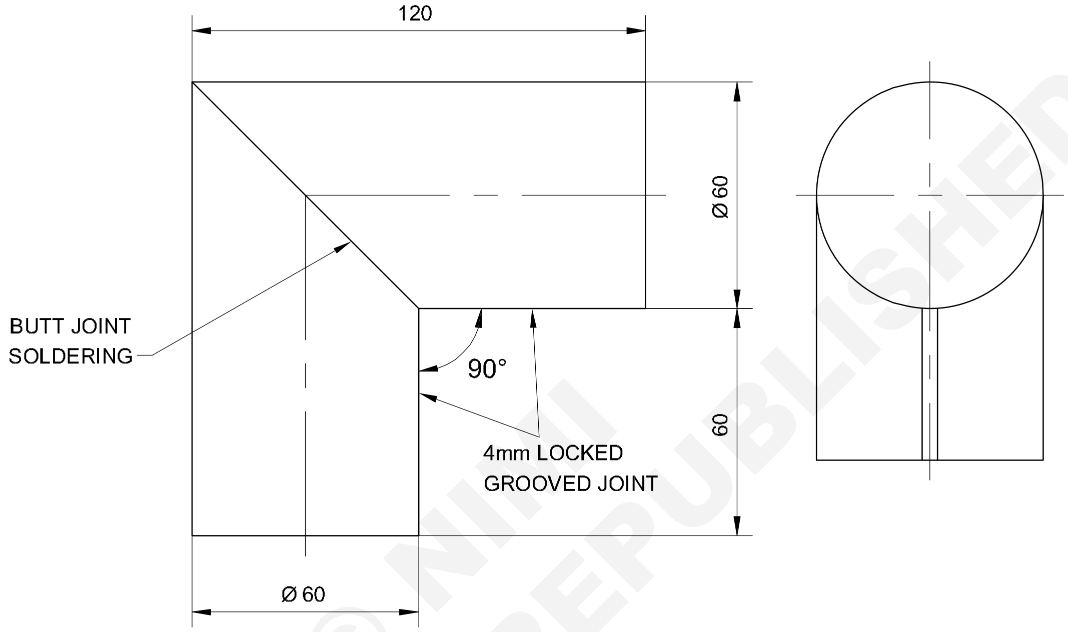
Fig 21



Make a joint 90º elbow joint two equal diameter pipes

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

- **to develop and layout the pattern for 90^0 cylindrical by parallel line method**
- **make two cylindrical pipes cut ablique at 45^0, joining withlocked grooved joint at throughout**
- **join two equal diameter pipes obliquely cut by soldered butt joint, to make 90^0 elbow, without mismatch & leak proof.**



Job Sequence

- Develop the pattern for a 90° elbow of equal diameter pipes, by parallel line method.
- Cut the patterns for both the pipes by using straight snips, bend snips.
- Form the patterns to cylindrical shape and join by locked grooved joint using a round mandrel, mallet, 4 mm groover and a ball pane hammer. Thus two pipes, cut obliquely are prepared.
- Assemble two pipes at an angle of 90^0 and make soldered butt joint by using a hand forge, soldering iron, a soft solder and a flux.

–	–	–	SOFT SOLDER 60:40	–	–	31
1	ISSH 210 x 260 x 0.6	–	G.I SHEET	–	–	31
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	MAKE A 90° ELBOW JOINING TWO EQUAL DIAMETER PIPES BY SOLDERING	DEVIATIONS ±1	TIME 5hr
		CODE NO. SM20N1431E1	

Skill Sequence

Making 90^0 elbow joining two equal diameter pipes by soldering

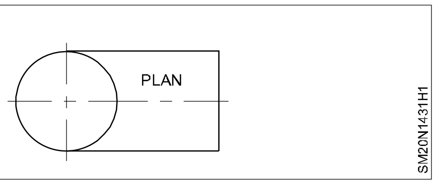
Objectives: This shall help you to

- **to develop and layout the pattern for 90° elbow joining two equal diameter pipe by parallel line method**
- **join two equal diameter pipes, obliquely cut, by soldered butt joint to make 90° elbow without mismatch and making it leak proof.**

Develop the pattern for a 90° elbow of equal diameter pipes by parallel line method:-

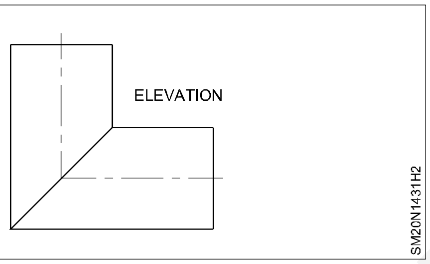
Draw plan as shown in Fig 1.

Fig 1



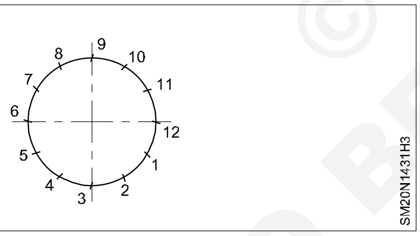
Below this, draw the front elevation as shown in Fig 2.

Fig 2



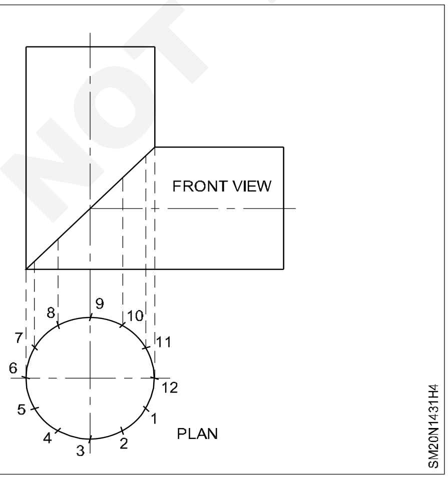
Divide the plan into twelve equal parts and number the points 0 to 12 as shown in Fig 3.

Fig 3



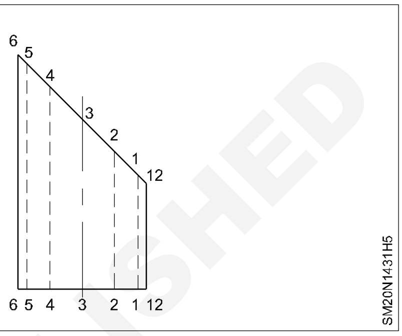
Draw the perpendicular line from these points towards the front view and number 1 to 12 as shown in Fig 4.

Fig 4



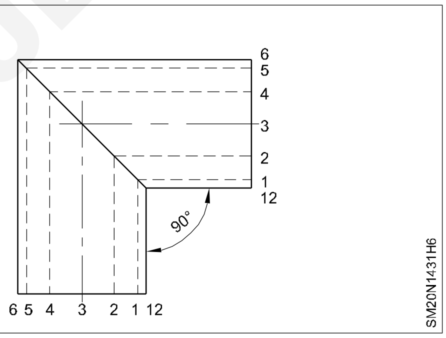
Now you find that the vertical lines are cutting at six different points top and bottom in the elevation line. Number them as shown in Fig 5.

Fig 5



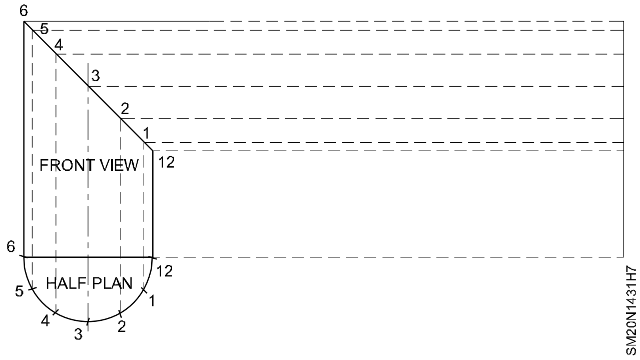
Draw horizontal parallel lines from each point and number them as shown in Fig 6.

Fig 6



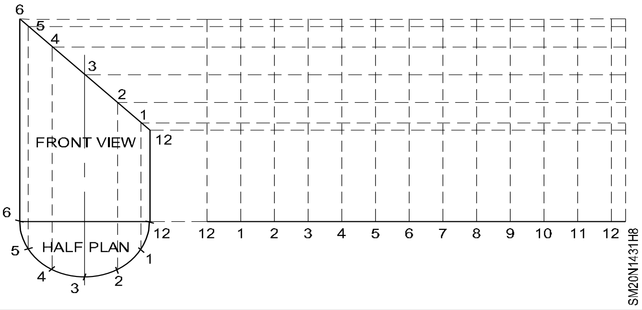
Extend the front elevation base line as shown in Fig 7.

Fig 7



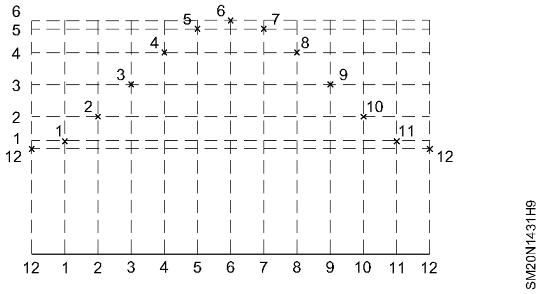
Take the distance equal to one division of plan and mark twelve times on base line by a compass and draw perpendicular lines from each point as shown in Fig 8.

Fig 8



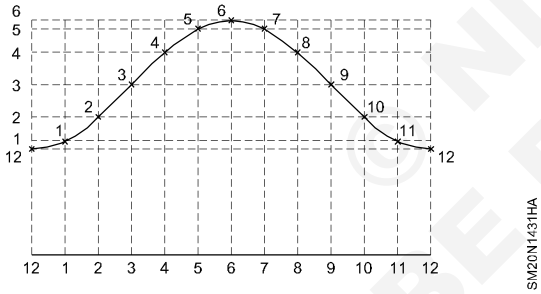
Now you find that each horizontal line and corresponding vertical line meet at a point. Number the points as 1 to 12 as shown in Fig 9.

Fig 9



Join these points by free hand curve as shown in Fig 10.

Fig 10

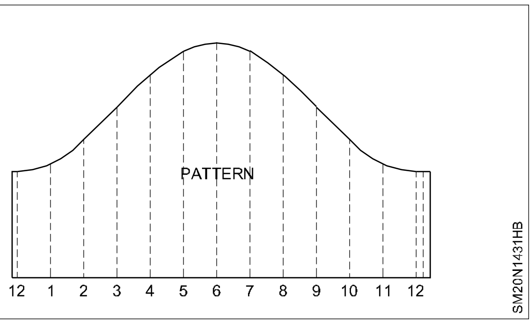


Provide locked grooved joint allowance as shown in Fig 11.

Check the pattern before cutting it.

Cut the pattern using straight and bend snips.

Fig 11

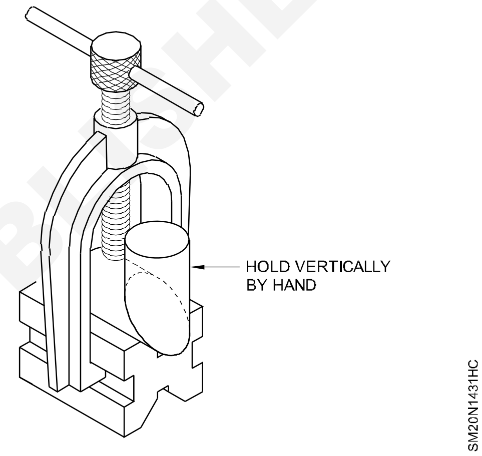


Place the pattern over another piece of metal, transfer the pattern on the other piece metal by marking and cut to get one more similar pattern.

Now form both the patterns to cylindrical shape and join by locked grooved joint.

Hold one pipe on 'V' block and clamp it as shown in Fig 12.

Fig 12



Hold another pipe on it, at 90° in one hand. Check for the perpendicularity by a trysquare with the other hand. Align it properly and tack solder at four different points.

Check the perpendicularity by trysquare before full run of soldering.

Complete soldering butt joint and clean the joint with cold water. Thus a 90° elbow, joining two equal diameter pipes is made.

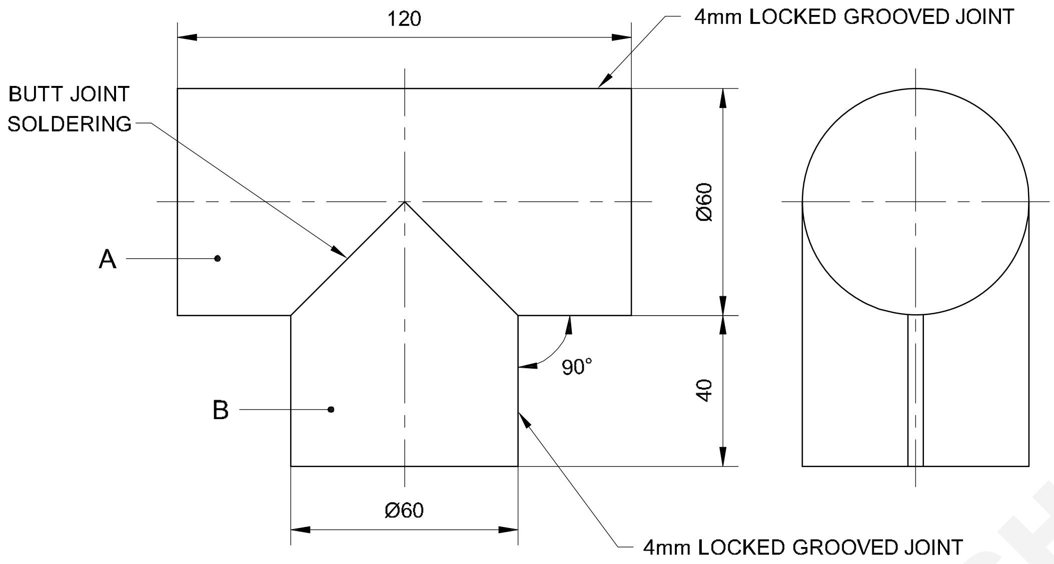
Make a 90º 'T' joining two equal diameter pipes

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

- **develop and layout the pattern for 90^0 "T" pipe of equal diameter by parallel line method**
- **form and join the main and branch pipe by using locked grooved joingt• join two pipes at an angle of 90^0 by soldered butt joint to make 90^0 'T' pipe of equal diameter.**

Job Sequence

- Develop and layout the pattern for the 90^0 "T" of equal diameter as per the job drawing, with locked grooved joint allowances, by parallel line method.
- Cut the patterns for main pipe and branch pipe by straight and bend snips and 6" flat cold Chisel.
- Form the patterns to cylindrical shape and join by locked grooved joint using a round mandrel, a mallet 4 mm. groover and a Ball Pane Hammer.
- Join the main pipe and branch pipe at an angle of 90^0 by soldered butt joint using a hand forge, a soldering iron, a soft solder and flux.



PART A - MAIN PIPE
PART B - BRANCH PIPE

–	–	–	SOFT SOLDER 60 x 40	–	–	–
1	ISSH 210 x 80 x 0.6	–	G.I SHEET	–	–	–
1	ISSH 210 x 130 x 0.6	–	G.I SHEET	–	–	31
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	**MAKE A 90° 'T' JOINING TWO EQUAL DIAMETER PIPES BY SOLDERING**	ANGULAR DEVIATIONS ±1°	TIME 10hrs
		CODE NO. SM20N1431E2	

Skill Sequence

Making 90^0 "T" pipe joint development and layout pattern

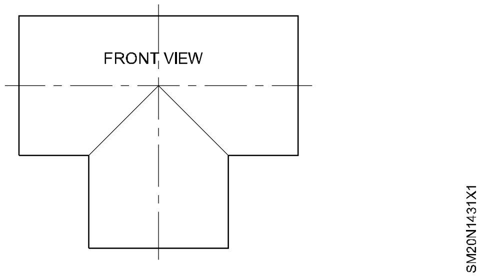
Objectives: This shall help you to

- **develop and layout the pattern for 90^0 "T" pipe of equal diameter by parallel line method**
- **join the main pipe and branch pipe of 90^0 'T' by soldered butt joint, making it leak proof.**

Develop the pattern for a 90^0 "T" pipe of equal diameter by parallel line method:-

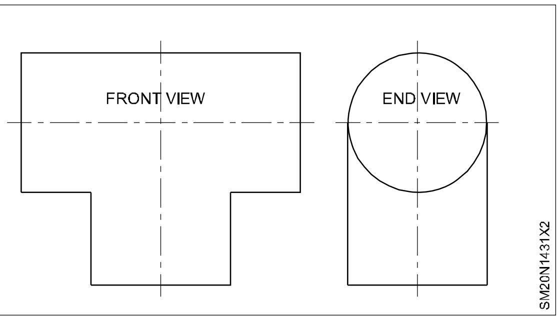
Draw the front view as shown in Fig 1.

Fig 1



Draw the side view as shown in Fig 2.

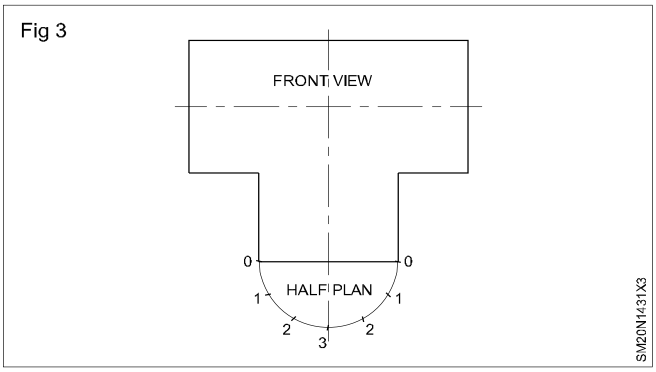
Fig 2



Draw a semi-circle on the base line of the front elevation. (Fig 3)

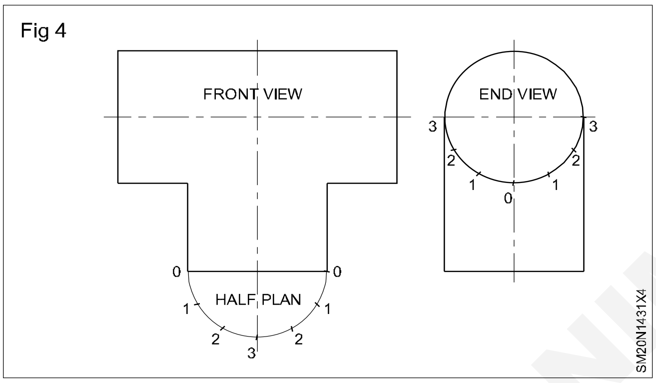
Divide the semi-circle into six equal parts and number them as 0,1,2,3,2,1,0. (Fig 3)

Fig 3



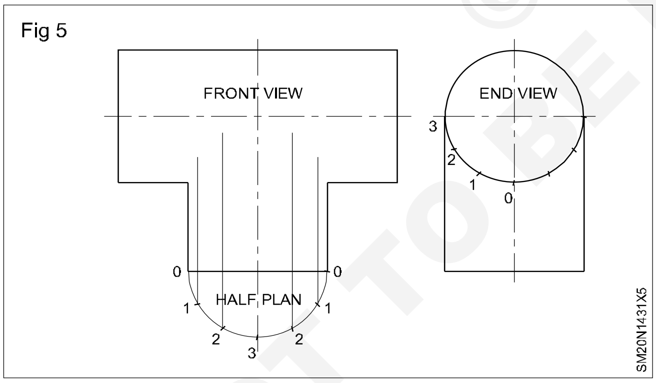
Divide a semi-circle in side view into six equal parts and number as 3,2,1,0,1,2,3 as shown in Fig 4.

Fig 4



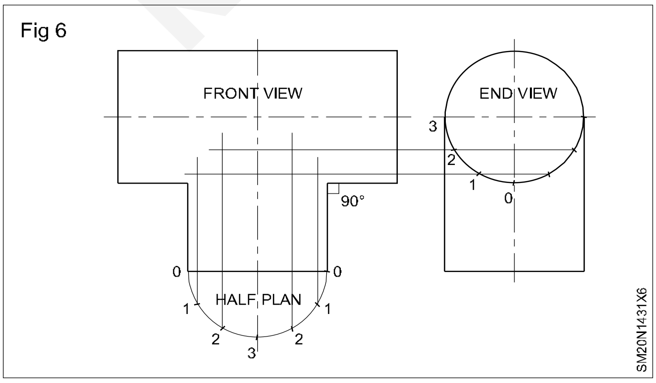
Draw the perpendicular lines from each point of the semi-circle of the front view as shown in (Fig 5).

Fig 5



Draw horizontal lines from the side view towards the front view as shown in (Fig 6).

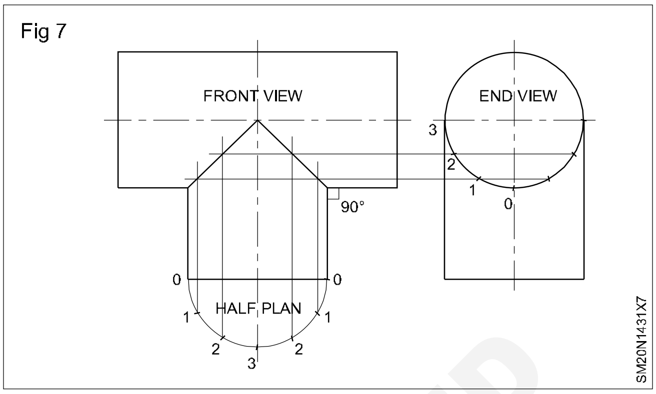
Fig 6



Now the vertical lines of the front view and the horizontal lines of side view meet at their respective points.

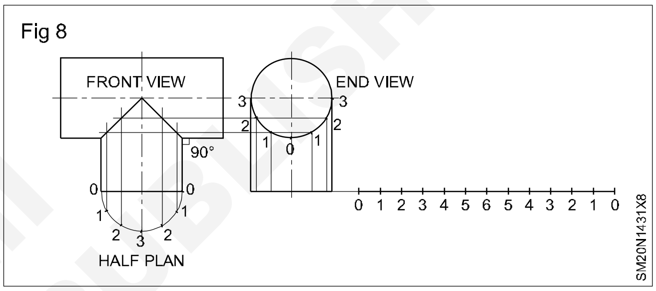
Join these points to get the line of intersection of "T" pipe as shown in Fig 7.

Fig 7



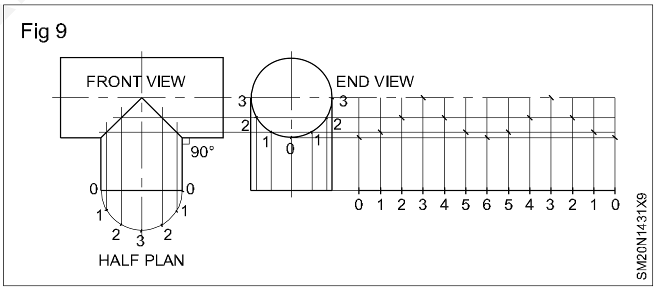
Extend the base line of the side view and mark the end point as 0. (Fig 8)

Fig 8



Take one division of the semi-circle inside view and transfer it 12 times on the base line starting from "0" and number as 0,1,2,3,2,1,0,1,2,3,2,1,0 as shown in Fig 9.

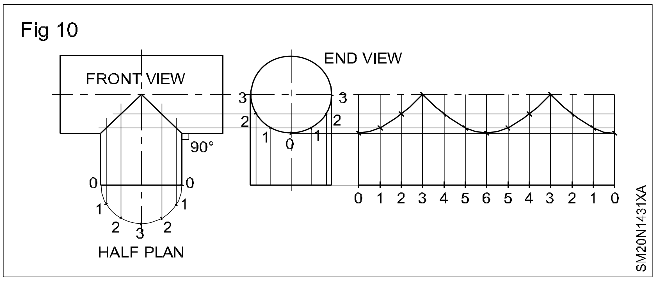
Fig 9



Draw perpendicular lines from these points and draw horizontal lines from the points on the line of intersection of 'T'. These lines meet at their respective points. (Fig 9)

Join these points by free hand curve. (Fig 10)

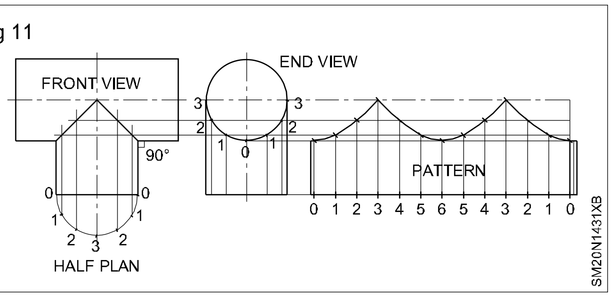
Fig 10



Provide locked grooved joint allowance as shown in (Fig 11).

Check the pattern once again and cut. Thus you get the pattern for branch pipe.

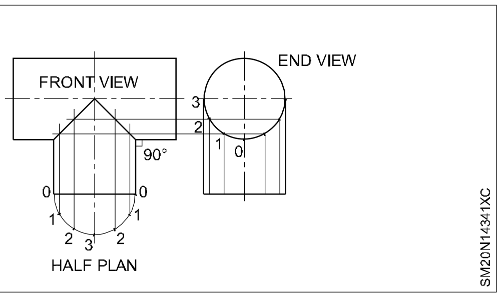
Fig 11



For main pipe, develop and layout the pattern as follows:-

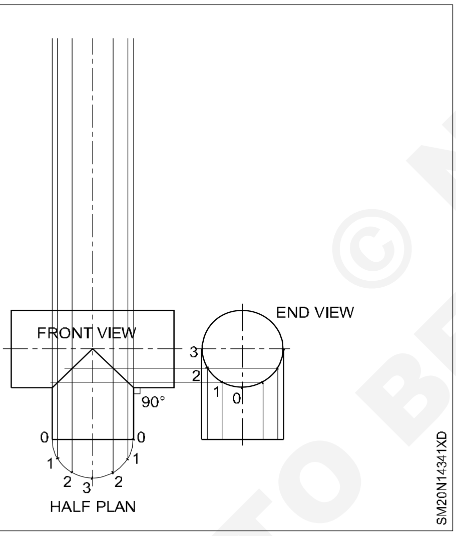
Draw the front view and end view. (Fig 12)

Fig 12



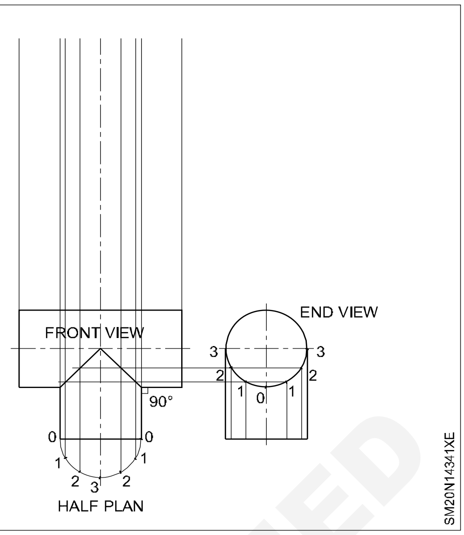
Extern the vertical lines 0,1,2,3,2,1,0 of branch pipe from the front view as shown in Fig 13.

Fig 13



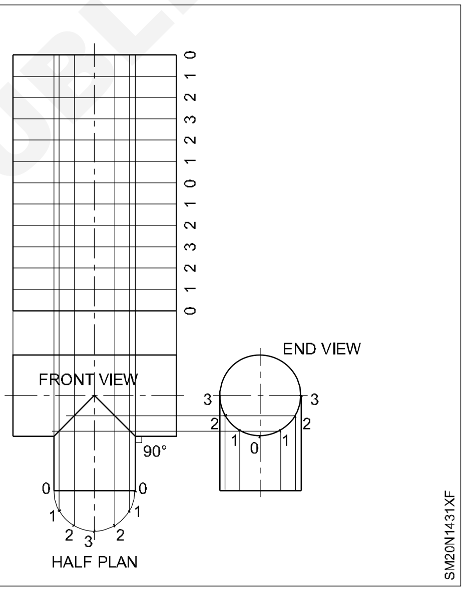
Extend the two extreme end vertical lines of the main pipe from the front view as shown in Fig 14.

Fig 14



On one of these lines, take point '0' as starting point and mark points 0,1,2,3,2,1,0,1,2,3,2,1,0 at equal distances equal to one division of the semi-circle and draw horizontal lines from these points. (Fig 15)

Fig 15

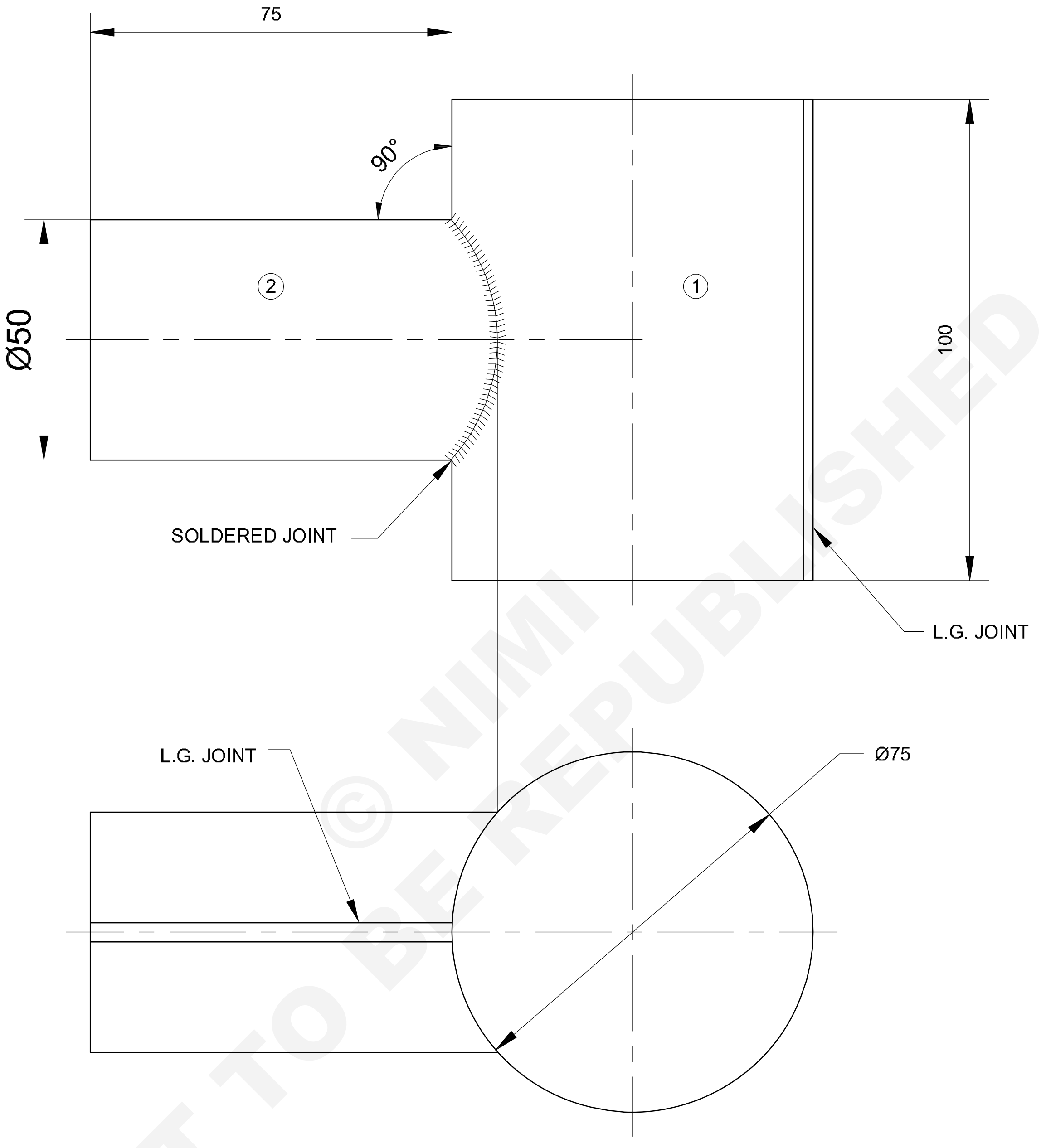


Make a 90º 'T' pipe joint of un-equal diameter pipes

Objectives: At the end of this exercise you shall be able to
- **develop and layout the pattern for a 90° Tee unequal dia pipes by parallel line development**
- **cut and prepare the pipes as per the job drawing**
- **check the pipes as per the job drawing**
- **clean the pipe end which is to be soldered**
- **tack the pipe by soldering, check the angle and solder the joint.**

Job Sequence

- Develop and layout the pattern for the 90° Tee pipes with cutout on the main pipe by parallel line development. (Fig 1)
- Cut, form and lock groove the joints of the pipe as per the job drawing.
- Check, set and align the two pipes as per job drawing.
- Tack the joint by soldering and check for perpendicularity using a trysquare.
- Complete the joint by soldering. (Fig 1)
- Wash the job to avoid corrosion.



–	60% x 40%	–	SOFT SOLDER	–	–	31
1	ISSH 175 x 0.6 - 100	–	G.I SHEET	–	2	31
1	ISSH 250 x 0.6 - 110	–	G.I SHEET	–	1	31
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2

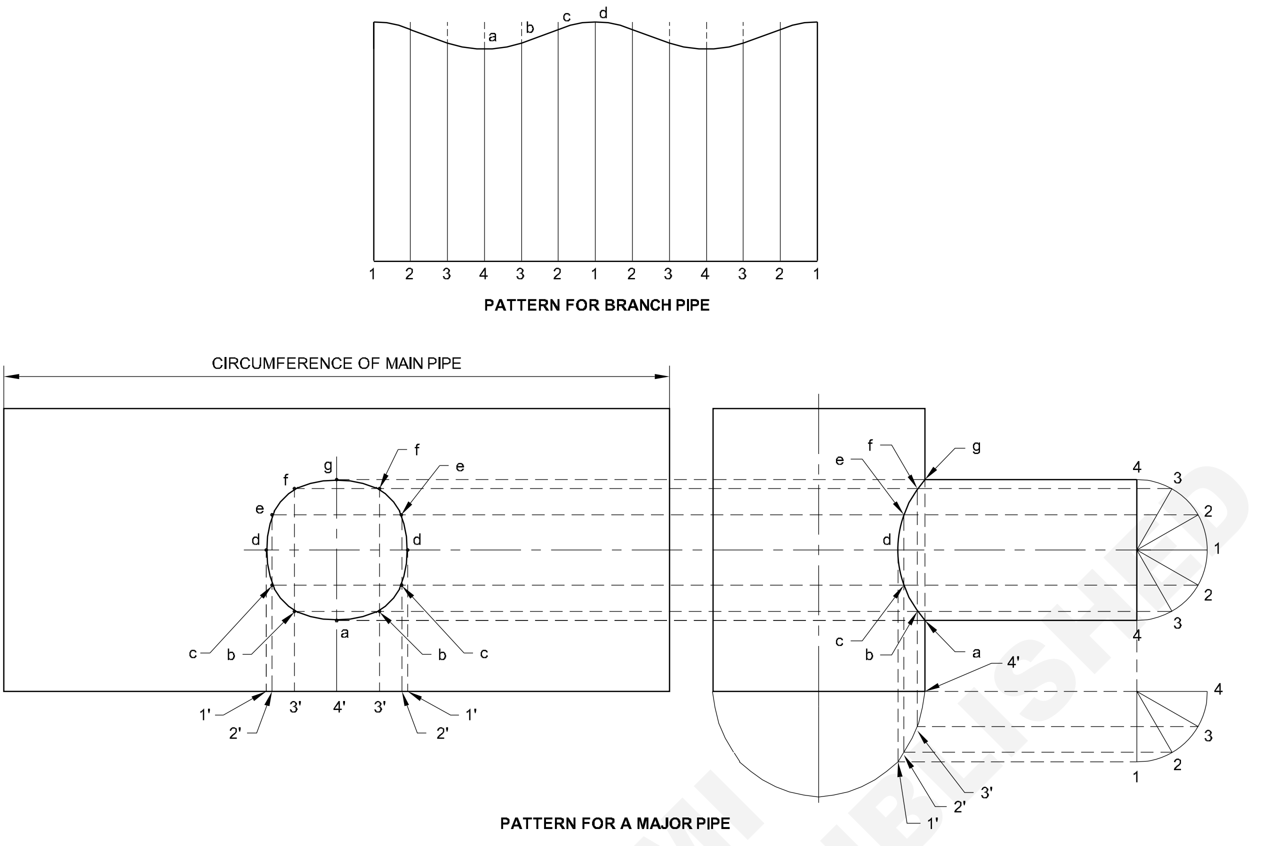
MAKE A 90° 'T' PIPE JOINT OF UN-EQUAL DIAMETER PIPES BY SOLDERING

DEVIATIONS ±1

TIME 5hrs

CODE NO. SM20N1431E3

Fig 1



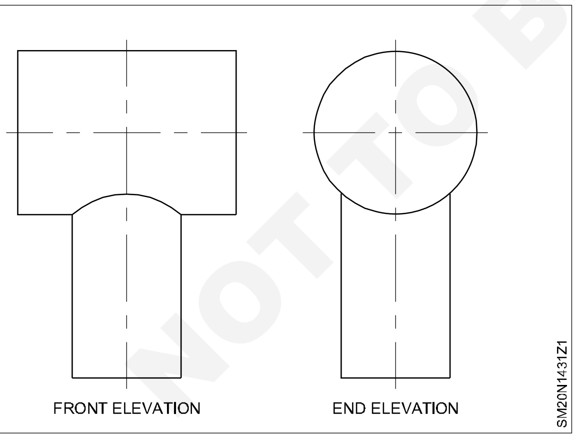
Skill sequence

90° Tee Pipe Joint (Unequal diameters)

Objectives: This shall help you to
- **layout the pattern development for main and branch pipe.**

Draw the front and end elevation. (Fig 1)

Fig 1

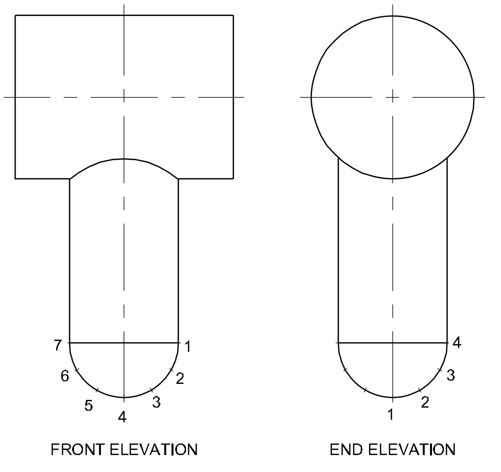


Describe semi-circles on the bases of the front and end elevation. (Fig 2)

Divide the semi-circles into 6 equal parts and number them 1 to 7 as in Fig 2.

Point 1 on the elevation becomes the middle point of the end elevation as in Fig 2.

Fig 2

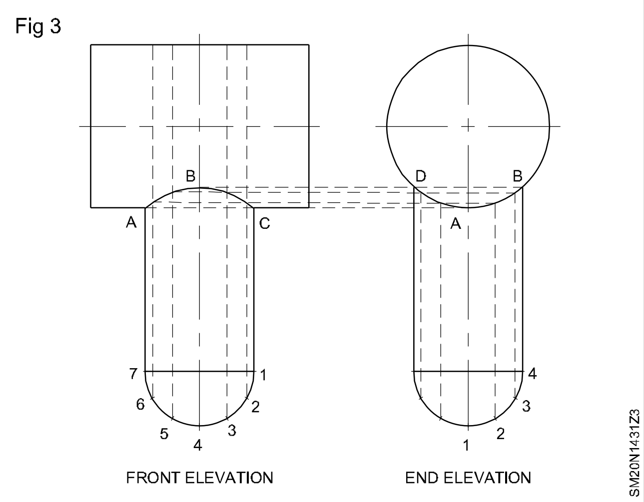


Draw perpendicular lines from these points to cut the major pipe.

From the points where these lines meet, cut the circle of the small major pipe (End elevation). Project lines horizontally to meet the corresponding vertical lines in the front elevation.

A curve drawn through the meeting points from A to B, B to C will give the line of intersection. (Fig 3)

Fig 3



To layout the pattern development for the branch pipe, project the base line horizontally and mark off 12 spaces 1^12^1 and so on upto 12^11^2 as in Fig 4.

From the points $1^12^1....12^11^2$ on the base line, erect perpendicular lines to meet those projected horizontally, from the major circle as in Fig 4.

A smooth curve drawn through the points of intersection $C^1B^1A^1D^1C^2$ will give the contour of the intersecting line in the pattern.

To develop the pattern layout with cutout, for the main pipe, divide the diameter of the main pipe into 12 equal parts. 3 equal parts are shown in Fig 4.

Produce the ends of the main pipe and step off 12 spaces and name them 1-1' as in Fig 4.

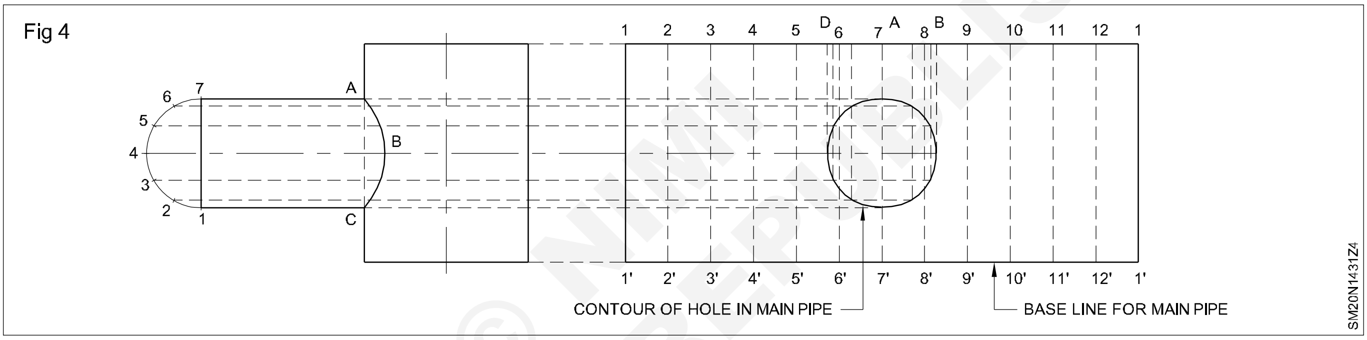
Take the divisions round the curve from D to B in the end elevation and mark them off above and below the centre line point 7 as shown in Fig 4.

Through these points, draw horizontal lines to meet the perpendicular lines projected from the front elevation.

Draw a smooth curve through the points of intersections which will give the contour of the hole in the main pipe.

The hole will be slightly elliptical in this case.

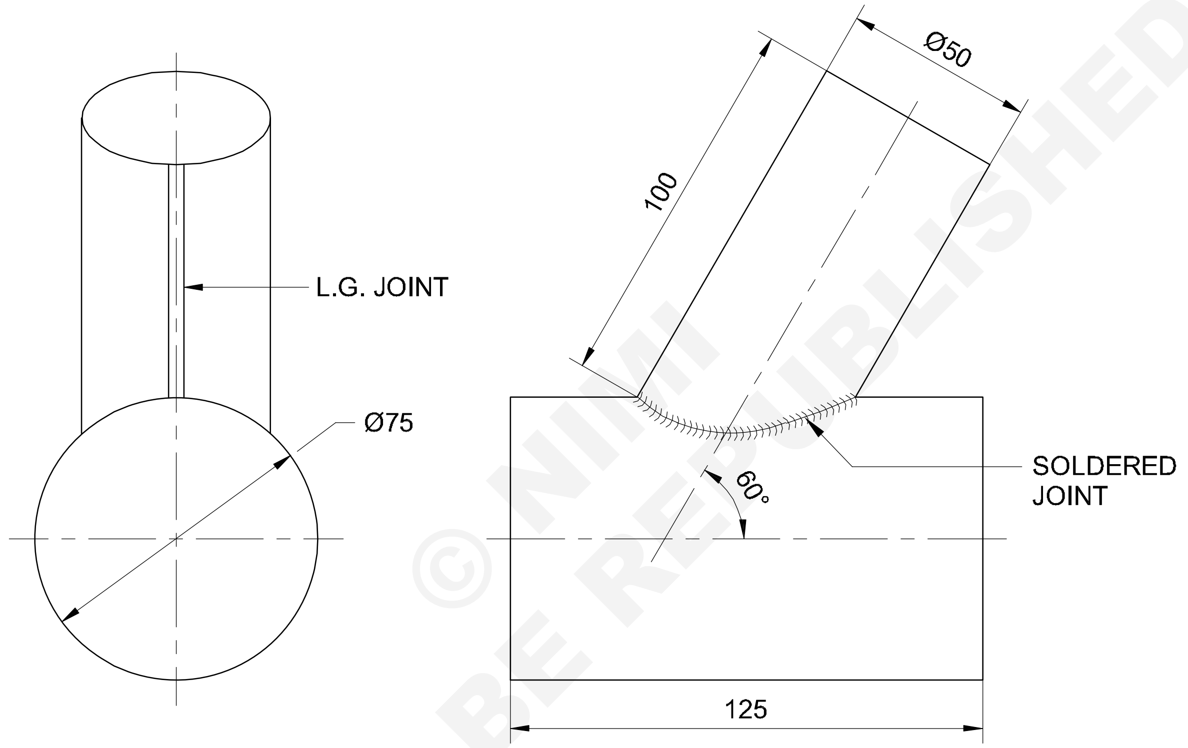
Fig 4



Make a 60º offset 'T' pipe joint of un-equal diameter pipes

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

- **develop and layout the pattern for a 60° Tee unequal dia pipes by parallel line method**
- **cut and prepare the main pipe as per the job drawing**
- **cut the branch pipe 60°**
- **cut and prepare the pipes as per the job drawing**
- **set the pipe end to be soldered using protractor**
- **set and tack the pipes by soldering, check the angle and solder the joint.**



Job Sequence

- Develop and layout the pattern for the 60° branch pipe of 50 mm dia and the main pipe of 75 mm dia with cutout for the branch pipe with joining allowances.
- Cut and form the pattern, of branch pipe and main pipe as per job drawing.
- Set the two pipes and align to an angle of 60°.
- Tack the joint by soldering and check the angle using a protractor.
- After rechecking, complete the joint by soldering.
- Clean and inspect the joint.

–	60% x 40%	–	SOFT SOLDER	–	–	–
1	ISSH 175 x 0.61 - 120	–	G.I SHEET	–	2	–
1	ISSH 420 x 0.61 - 140	–	G.I SHEET	–	1	32
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	**MAKE A 60° OFFSET TEE PIPE JOINT UN-EQUAL DIAMETER PIPES BY SOLDERING**	DEVIATIONS ±1	TIME 5h
		CODE NO. SM20N1432E1	

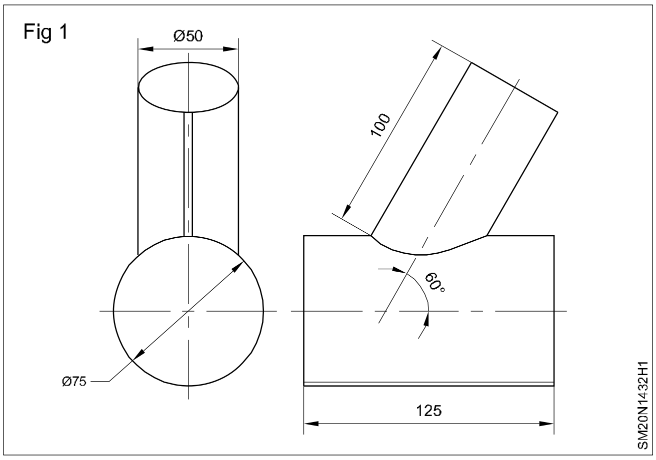
Skill sequence

60° Tee pipe (Unequal diameter)

Objectives: This shall help you to
- **make tee pipe joint of unequal diameter by parallel line method.**

Draw the front and end elevation. (Fig 1)

Fig 1



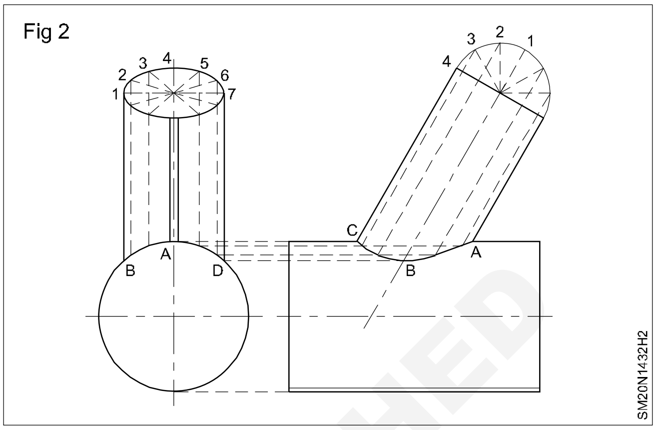
Describe semi-circles on the basis of the front and end elevation. (Fig 2)

Divide the semi-circles into 6 equal parts and number them 1 to 7 as in Fig 2.

Point 1 on the elevation becomes the middle point on the end elevation on as in Fig 2.

Draw perpendicular lines from these points to cut the major pipe.

Fig 2



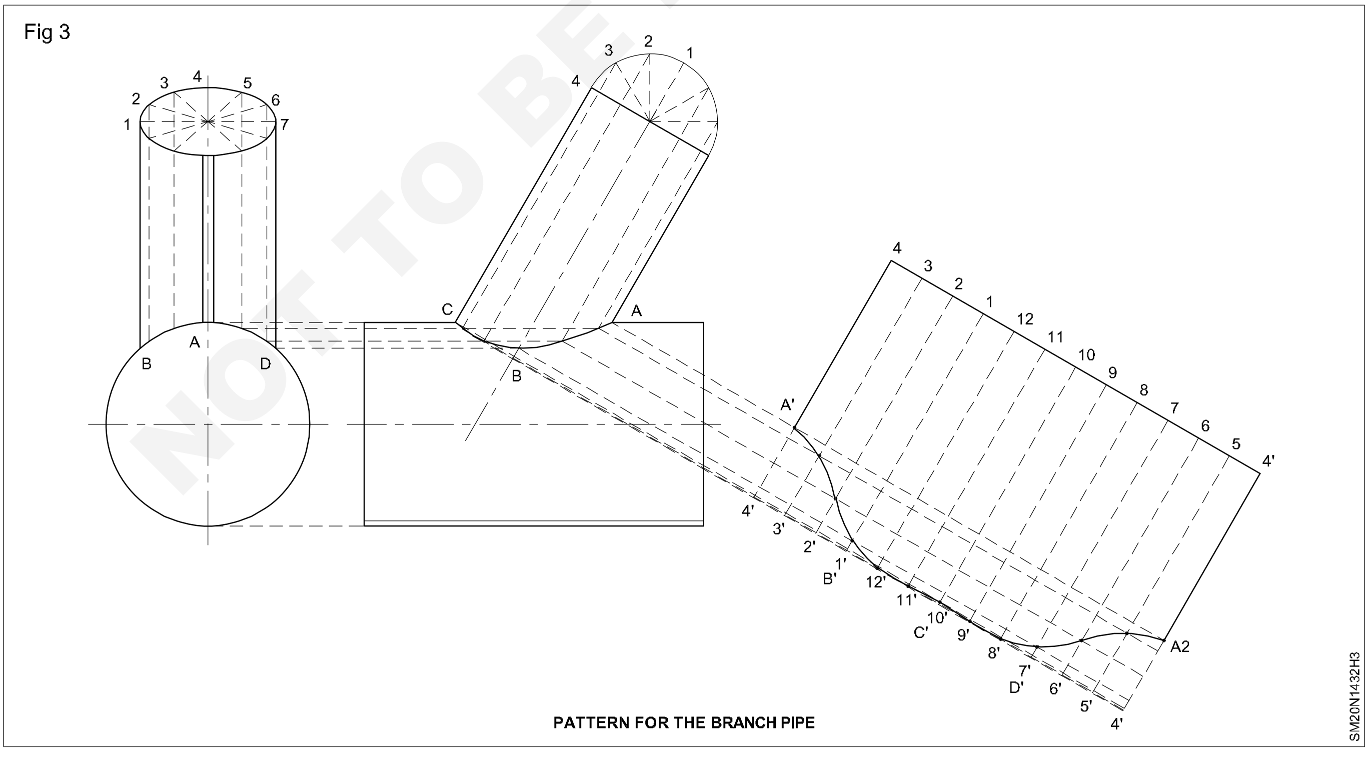
From the points where these lines cut the circle of the main pipe (End Elevation) project lines horizontally to meet the corresponding vertical lines in the front elevation.

A curve drawn through the meeting points from A to B, B to C will give the line of intersection.

To layout the pattern development for the branch pipe project the baseline and mark off 12 spaces $4^1 3^1$ and so on upto 3^1,4^1 as in Fig 3.

Erect perpendiculars from these points to meet these projected lines from the major circle as in figure.

Fig 3



A smooth curve drawn through the points of intersection C^{1}B^{1}A^{1}D^{1}C^2 will give the intersection line in the pattern.

To develop the pattern layout with cutout for the main pipe. divide the diameter of the main pipe into 12 equal parts. 3 equal parts are shown in Fig 4.

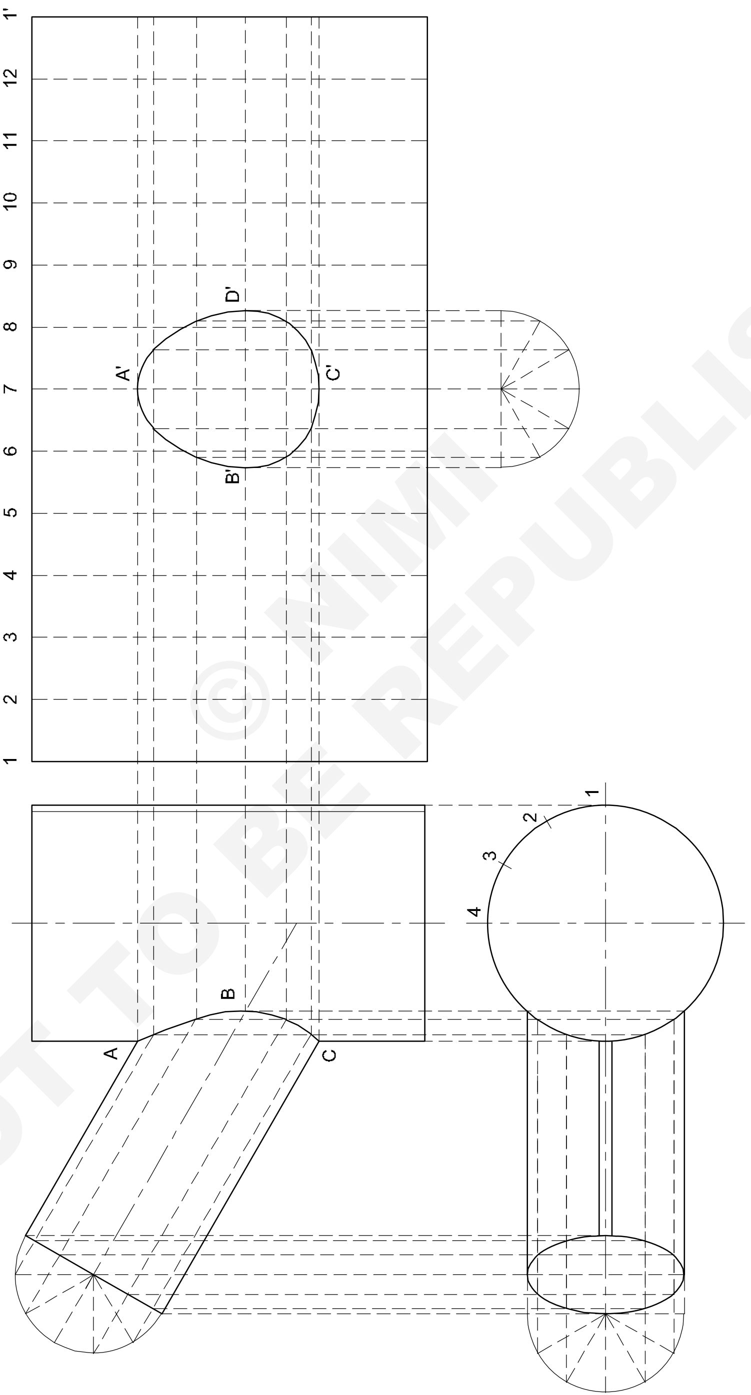
Produce the ends of the main pipe and step off 6 to 12 spaces and number them 1 to 1^1 as in Fig 4.

Take the divisions round the curve from D to B in the end elevation and mark them off above and below centre line point 7 as in Fig 4.

Through these points, draw horizontal lines to meet the perpendicular lines projected from the front elevation.

Draw a smooth curve through the points of intersections which will give the contour of the hole in the main pipe. (Fig 4)

Fig 4

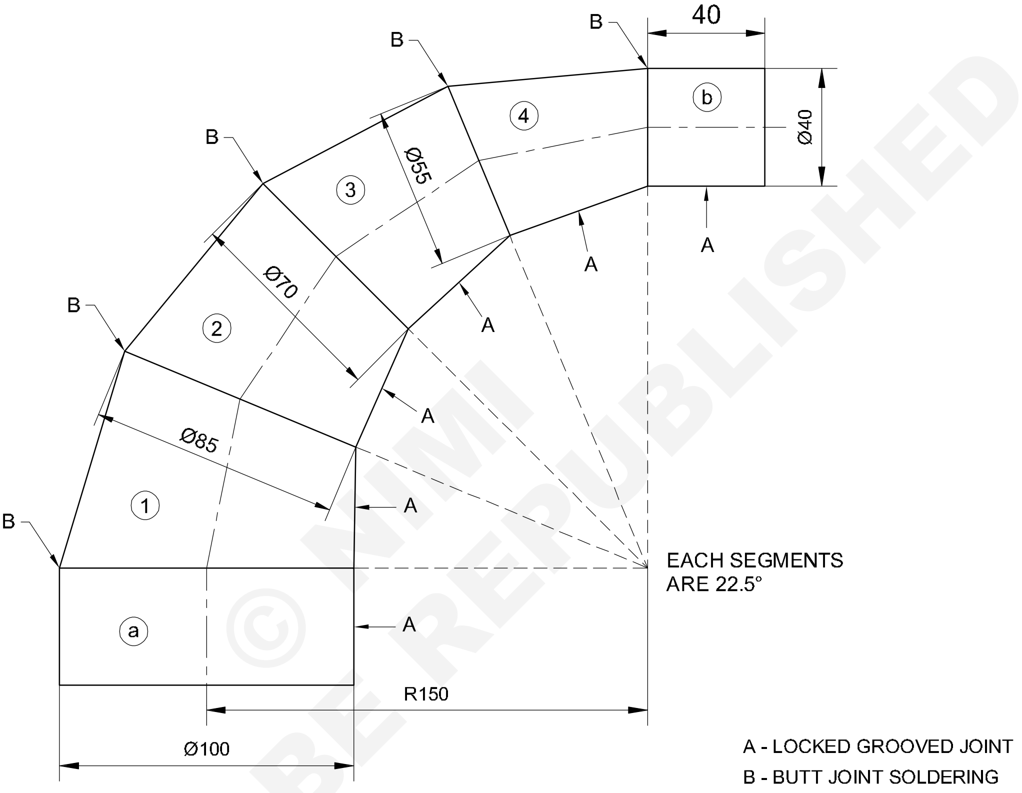


PATTERN FOR THE MAIN PIPE

Make a tapered lobster back bend 90º from oblique coneby solder

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.**



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.

–	60% x 40%	–	SOFT SOLDER	–	–	33
1	ISSH 330 x 0.61 - 200		G.I. SHEET	21	1	33
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	MAKE A TAPERED LOBSTER BACK BEND 90° FROM OBLIQUE CONE	DEVIATIONS ±1	TIME 20h
		CODE NO. SM20N1433E1	

Skill sequence

Develop a pattern for a tapered Lobster back from oblique cone by radial line method

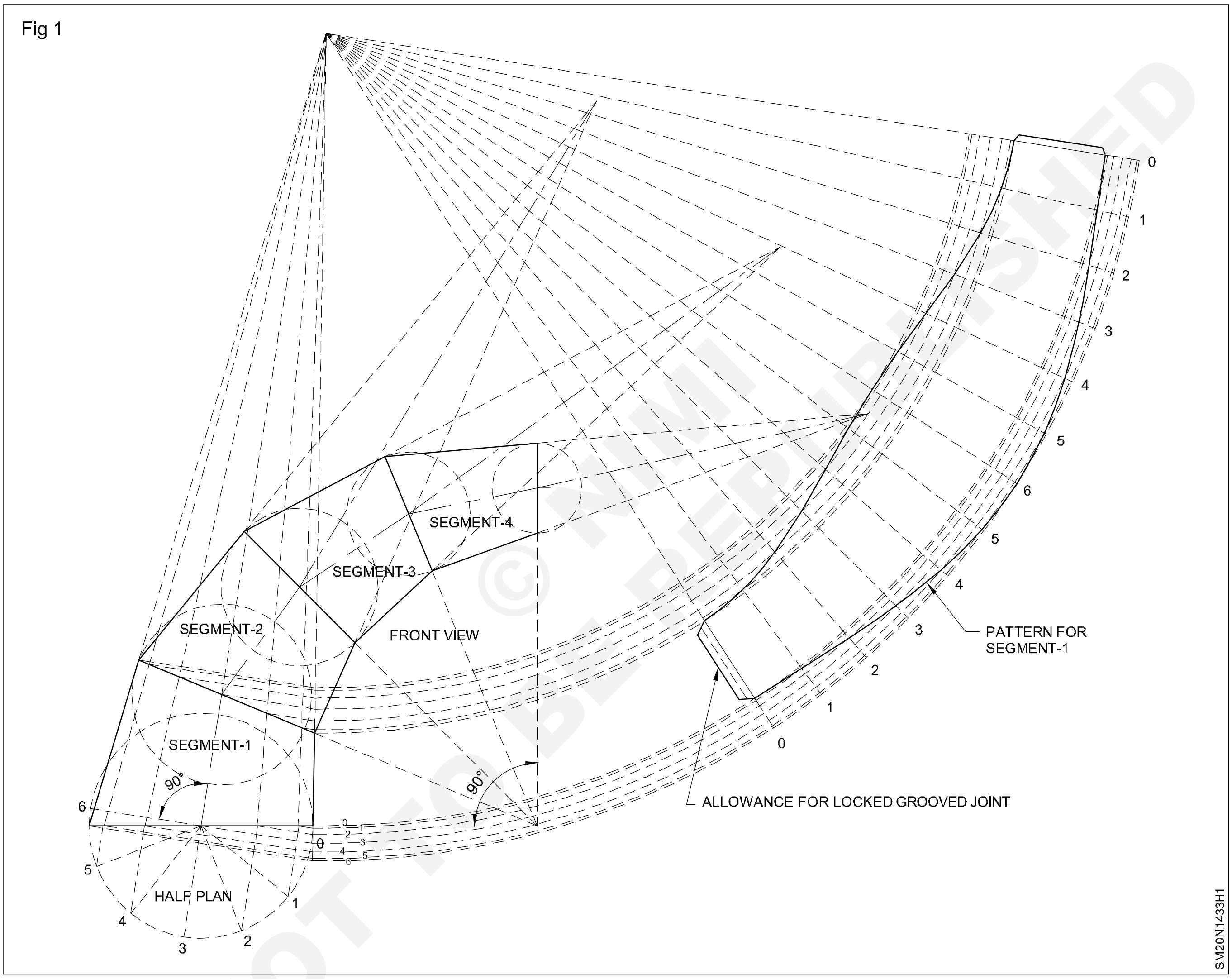
Objectives: This shall help you to

- **develop the pattern for a tapered lobster back from oblique cone in four segments by radial line method.**

In Exercise 23, the Skill Sequence of development of pattern for square section segmental quarter bend is given.

In the same manner, develop the pattern for each segment of the tapered lobster back by radial line method as it is done previously for the frustrum of a cone as shown in Fig 1.

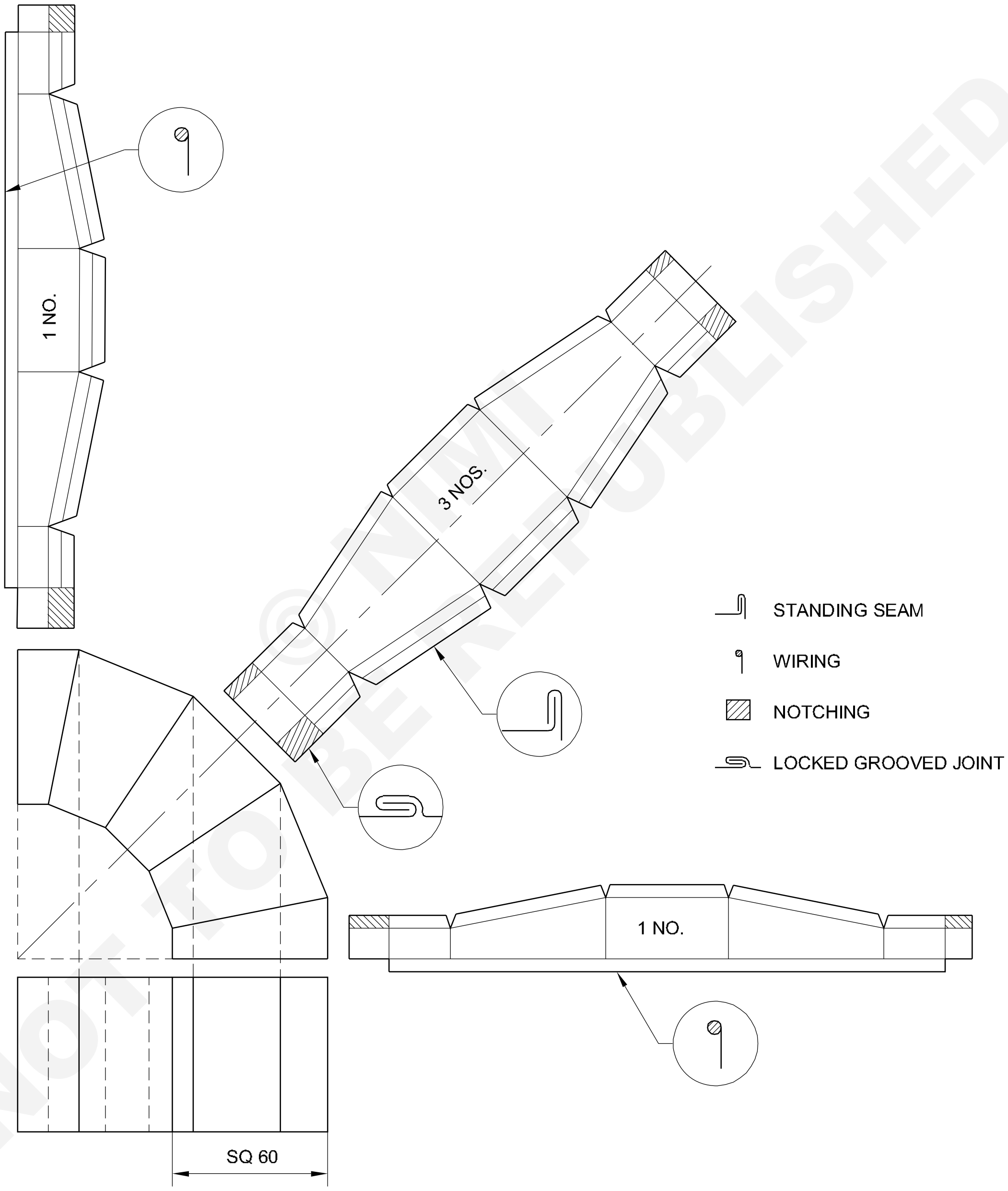
Fig 1



Make a square section segmental quarter bend pipe

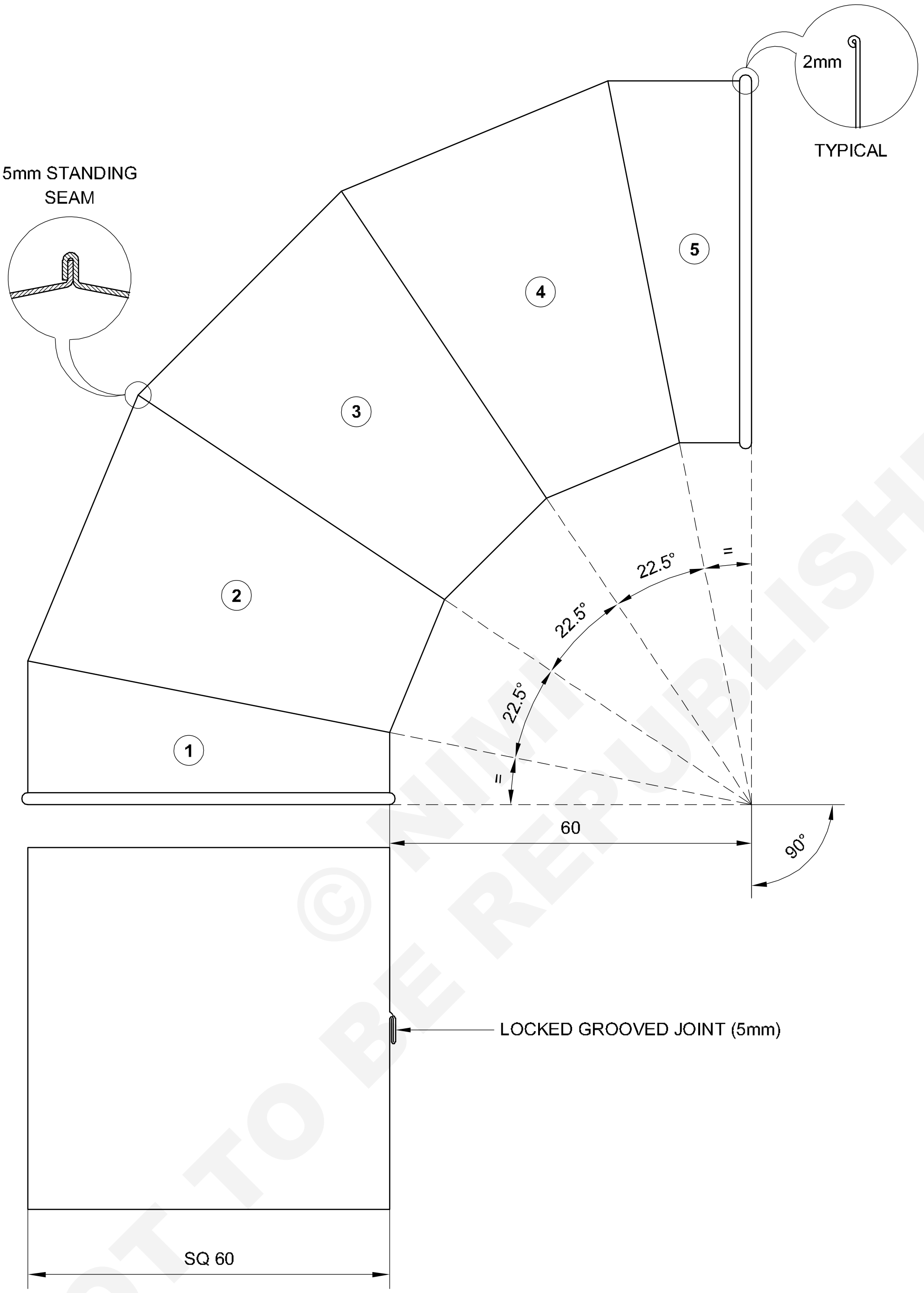
Objectives: At the end of this exercise you shall be able to

- **develop and layout the pattern for square section segmental quarter bend pipe by parallel line method**
- **join the segments of square section by standing seams using beak iron stake and setting hammer to make segmental quarter bend pipe.**



2	Ø2 - 250	–	Fe310 (G.I. WIRE)	–	–	34
1	ISSH 280 x 0.71 - 280	–	G.I. SHEET	–	–	34
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**MAKE A SQUARE SECTION SEGMENTAL QUARTER BEND PIPE**	DEVIATIONS ±1	TIME 15h
		CODE NO. SM20N1434E1	



2	Ø2 - 250	–	Fe310 (G.I. WIRE)	–	–	34
1	ISSH 280 x 0.71 - 280	–	G.I. SHEET	–	–	34
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS

DEVIATIONS ±1

TIME

MAKE A SQUARE SECTION SEGMENTAL QUARTER BEND PIPE

CODE NO. SM20N1434E2

Job sequence

- Cut the material to the required size.
- Develop and layout the pattern for segment 1 adding allowances for wiring, standing ream and locked grooved joint by parallel line method and cut it.
- Segment 5 is identical to segment 1, thus reproduce it.
- Now develop and layout the pattern for segment 2, adding allowances for standing ream and locked grooved joint by parallel line method and cut it.
- Segment 3 and 4 are identical to segments 2, thus reproduce.
- Fold the pattern of all segments and make square sections as per drawing, using hatchet stake and mallet.
- Join the square sections by locked grooved joint using hand groover, hatchet stake and ball peen hammer.
- Join the five segments of the square section in sequence as per drawing by standing seam using beak iron stake, anvil stake and setting hammer.
- Make wire edge on both ends.

Skill sequence

Developing and joining by standing seams

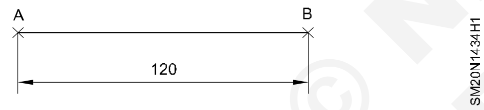
Objectives: This shall help you to

- **develop and layout the pattern for a square section segmental quarter bend pipe by parallel line method**
- **make a square section segmental quarter bend pipe first by making square section segments and then joining them in sequence by standing seams.**

For better illustration of the skill, let us take the example of this exercise.

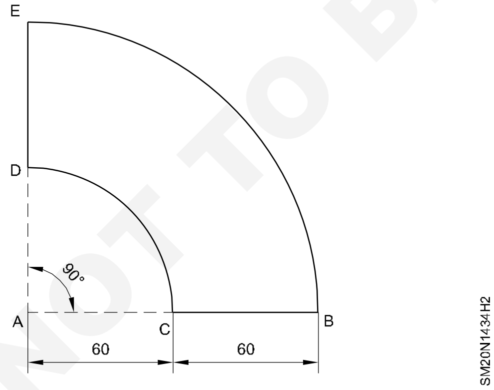
Draw a straight line to 120 mm, (Fig No.1) from a point 'A' draw a quarter bend circle of radius 60 and 120 mm to meet at 90° as shown in the Fig 2 (CD and BE).

Fig 1



Keep the protractor over a point 'A' and mark to 11.25° at either ends and join as shown in the Fig 3.

Fig 2



Take twice the length of BG or EF and CM or DJ.

Draw an arc from 'G' to 'H' M to L, similarly H to I, L to K and I to F, K to J. Thus you get 5 segments. (Fig 4)

Develop the pattern for segment 1 by parallel line development method adding allowances for wiring single fold for standing seam and locked grooved joint as shown in the Fig 5 and 6.

Fig 3

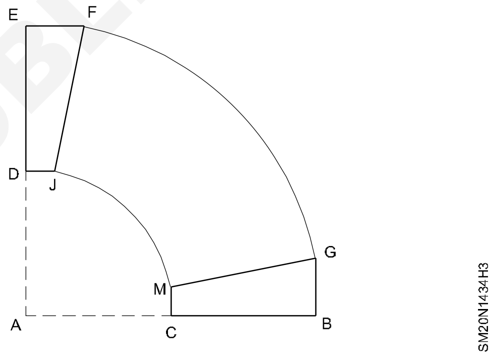


Fig 4

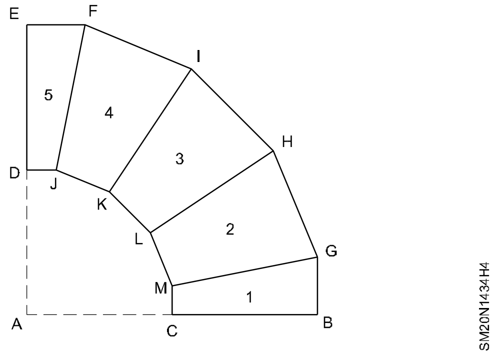
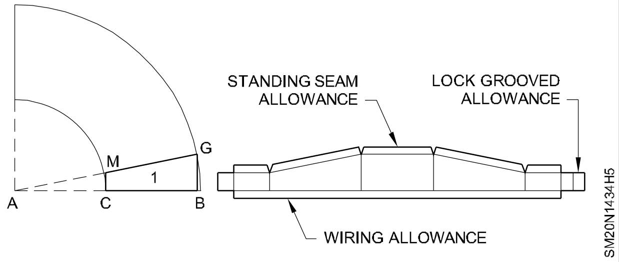


Fig 5

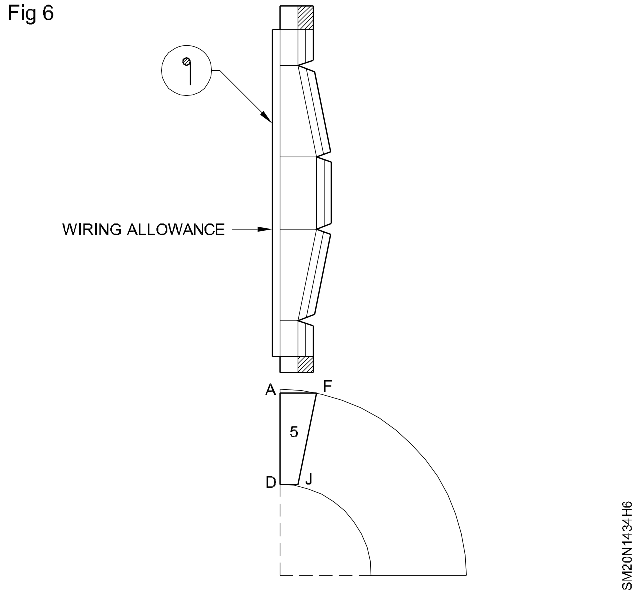


Bisect the length HI to get centre line and project the lines from KL and IH to get the pattern for segment 3 allowance for single fold of the standing seam on one side and double fold of the standing seam on the other side and locked grooved joint as shown in Fig 7.

Segment 1 & 5 are identical and 2,3,4 are identical.

Make all five square section segments by folding and making locked grooved joints.

Fig 6



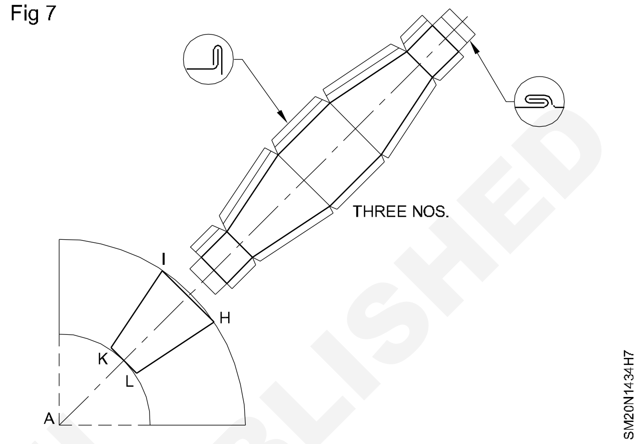
Segment 1&5 are wired at one end and folded for standing seam at other end.

Segment 2,3,4 are single folded at one end and double folded at other end to make standing seam.

Finally, join square section segments 1 to 5, in sequence by standing seam using beak iron stake, anvil stake and setting hammer.

Check the segment quarter bend pipe as per job drawing.

Fig 7

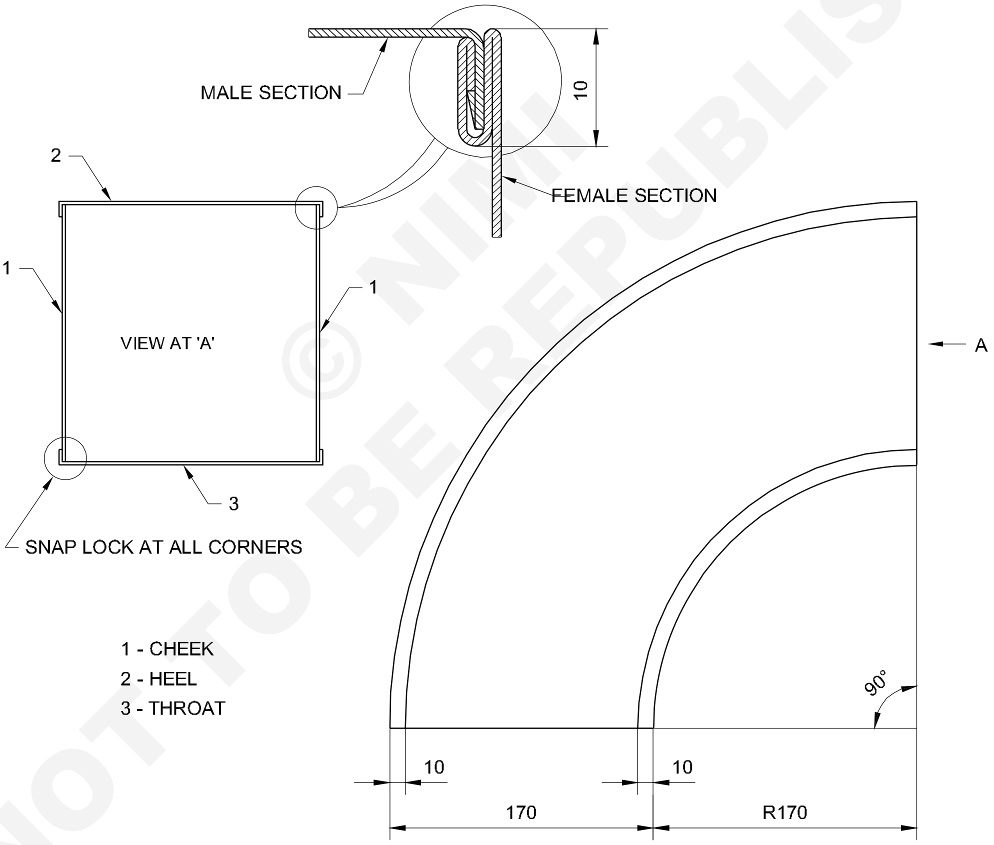


Make a square duct elbow

Objectives: At the end of this exercise you shall be able to
- **cut sheets as per drawing**
- **layout the pattern for cheek, heel and throat**
- **form square duct elbow with snap lock.**

Job sequence

- Cut four pieces to the required sizes using tradle shear.
- Layout the patterns for check (2 Nos.) heel and throat of the square duct elbow, including allowance for snap lock.
- Make a square duct elbow with snap lock using portable shear for cutting, slip roll forming machine for rolling bar folder for bending, chisel for wedge shaped projection, dolly copper smith stake and setting hammer for lock seam.
- Check the square duct elbow for size and squareness.



1	ISSH 580 x 0.61 - 170	–	G.I. SHEET	–	3	35
1	ISSH 800 x 0.61 - 170	–	G.I. SHEET	–	2	35
2	ISSH 2400 x 0.61 - 2400	–	G.I. SHEET	–	1	35
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:4	MAKE A SQUARE DUCT ELBOW	DEVIATIONS ±1	TIME 10h
		CODE NO. SM20N1535E1	

Skill sequence

Make a square duct elbow with snap lock

Objectives: This shall help you to

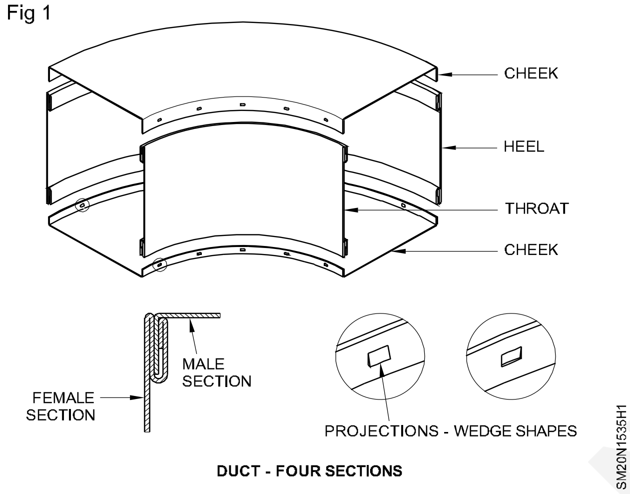
- **make a square duct elbow with snap lock using portable shear, slip roll forming machine, bar folder, copper smith stake, dolly, setting hammer and chisel.**

For better illustration let us take the job drawing of this exercise as example.

Fig 1 shows parts of the square duct elbow, wedge shaped projections on check and section of lock seam.

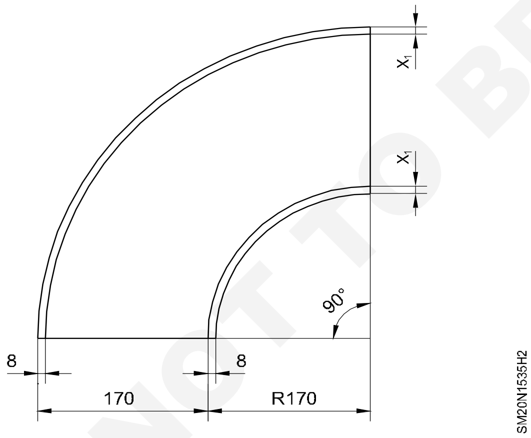
Layout the pattern for check, considering allowance for lock seam. (Fig 1)

Fig 1



Layout the pattern for heel considering allowance for lock seam. (Fig 2)

Fig 2



X_1 = allowance for lock seam.

= Width of the lock – 2 x thickness of sheet

(width of the lock = 10 mm, thickness of sheet= 1 mm)

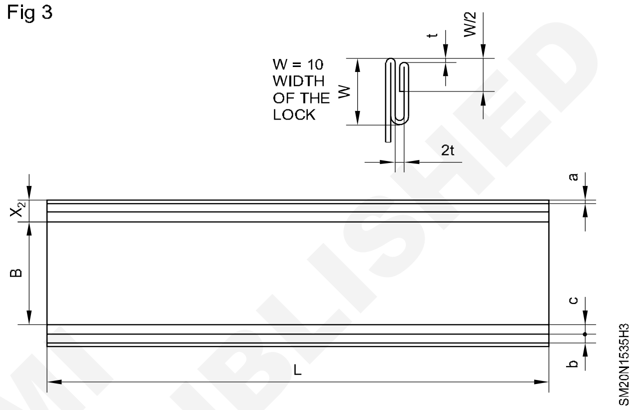
Therefore Allowance X_1 = 10mm – 2 mm = 8 mm

The pattern for throat is similar to that of heel except the length. Here the length of the pattern is 267.

First flange the 8 mm edges of check (2 Nos.) to 90° on the burring machine.

For making the edges of heel and throat for lock seam as per section shown in Fig 2, fold the edges to make pocket for lock seam as shown in Fig 3 in sequence on bar folder.

Fig 3



a = w/2-t = 4 mm

b = w = 10 mm

c = w + t = 11 mm

X_2 = a+b+c = 25 mm

B = 170 – 2t = 168 mm

L = 1/4 x $2\pi R$ = 534 mm

Form the curved shape on the slip roll forming machine using 4 mm spacer sheet between two folded edges.

Make wedge shaped cuts like tabs on flanges of both checks approximately at a distance of 40 mm. See that the section should lie above half the length of the edge towards the edge using chisel and ball pane hammer. (Fig 4)

Project these taps inside slightly as shown in Fig 5 by screw driver.

Now place the cheek on a flat steel plate and insert throat at the inner radius of cheek by pressing against the wedge shaped projection.

Similarly insert the heel at the outer radius of cheek.

Now, place the other cheek at the top and press the flanges on both sides in pockets of snap lock at the upper edges of throat cheek and insert it till the inside surface of the cheek rests on the pocket.

Fig 4

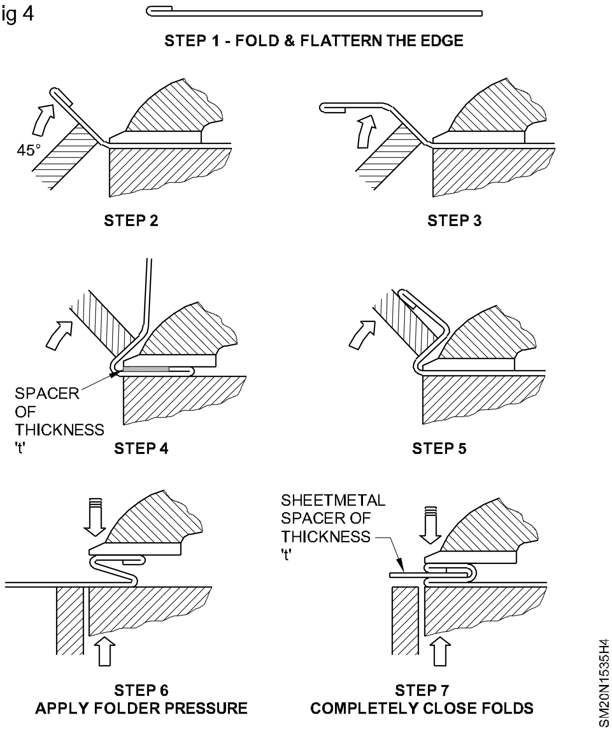
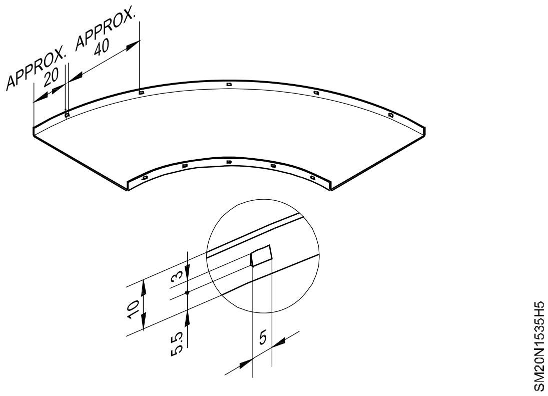

STEP 1 - FOLD & FLATTERN THE EDGE
45°
STEP 2
STEP 3
SPACER
OF
THICKNESS
't'
STEP 4
STEP 5
SHEETMETAL
SPACER OF
THICKNESS
't'
STEP 6
APPLY FOLDER PRESSURE
STEP 7
COMPLETELY CLOSE FOLDS
SM20N1535H4

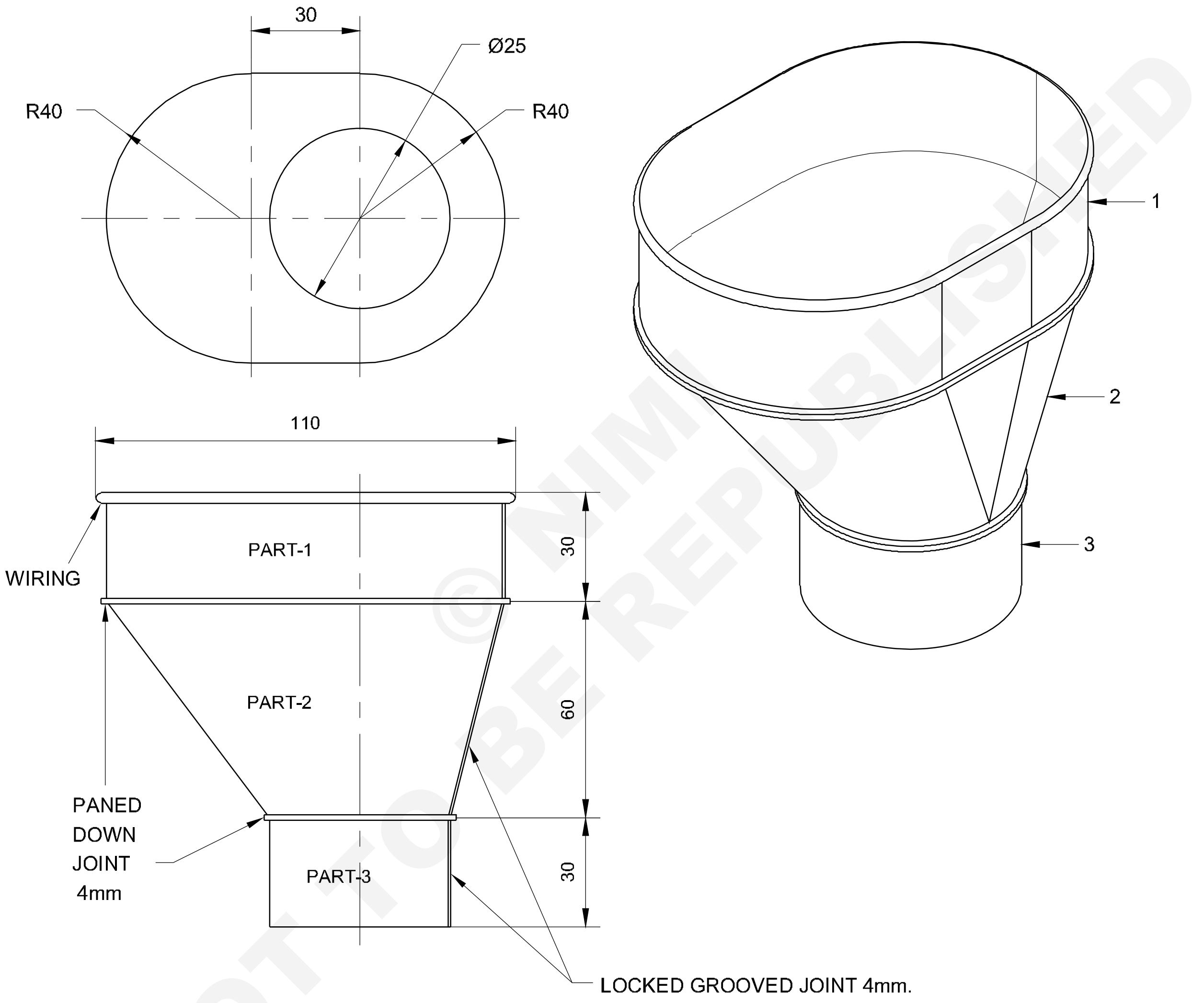
Fig 5


APPROX.
20
APPROX.
40
3
10
5.5
5
SM20N1535H5

Make a conical hopper by soldering

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

- **develop the pattern for conical hopper out of centre (part I & III by parallel line method, for part II by triangulation method)**
- **cut, form assemble part I, II & III by paned down joint as per job drawing.**



1	Ø3 - 350	–	G.I WIRE	09	–	36
1	ISSH 330 x 0.6 - 55	–	G.I SHEET	09	3	36
1	ISSH 175 x 0.6 - 50	–	G.I SHEET	09	2	36
1	ISSH 360 x 0.6 - 220	–	G.I SHEET	09	1	36
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2

MAKE A CONICAL HOPPER

DEVIATIONS ±2

TIME 10h

PROJECT: CONICAL HOPPER

PART: 1,2,3

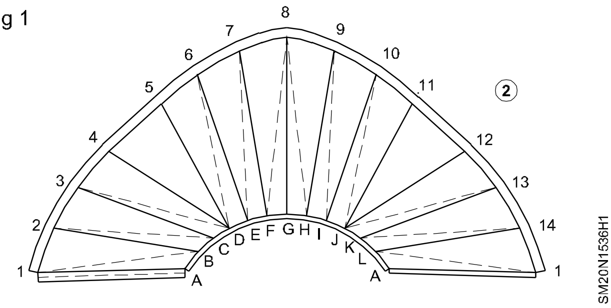
CODE NO. SM20N1536E1

Job sequence

Conical Hopper

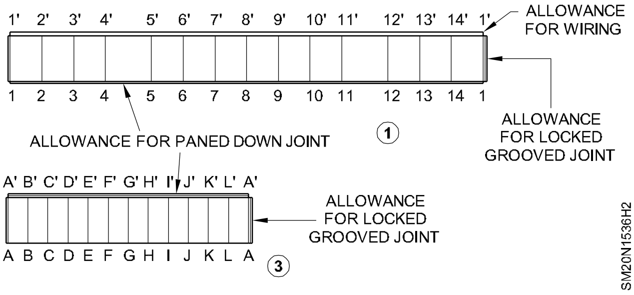
- Develop and layout the pattern for the conical hopper with, out of centre (Part 2) as per the job drawing with joining allowances by triangulation method. (Fig 1)

Fig 1



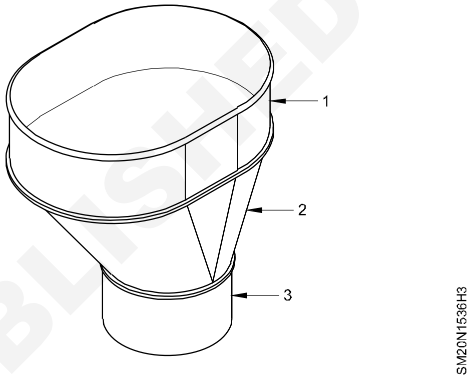
- Develop and layout the pattern for Part I & 3 by parallel line method with wiring paned down joint and locked grooved joint allowances. (Fig 2)
- Cut the pattern by using straight snips and bend snips.
- Form the shape of Part I, 2 & 3 and make locked grooved joint using round mandrel, wooden mallet, 4 mm. Groover and 1 1/2 lbs Ball Pane Hammer. Make wiring on straight, and curved edge of Part I.

Fig 2



- Assemble the Part I, 2 & 3 by Paned down joint using Hatchet stake, anvil stake and setting hammer. (Fig 3)

Fig 3



Skill Sequence

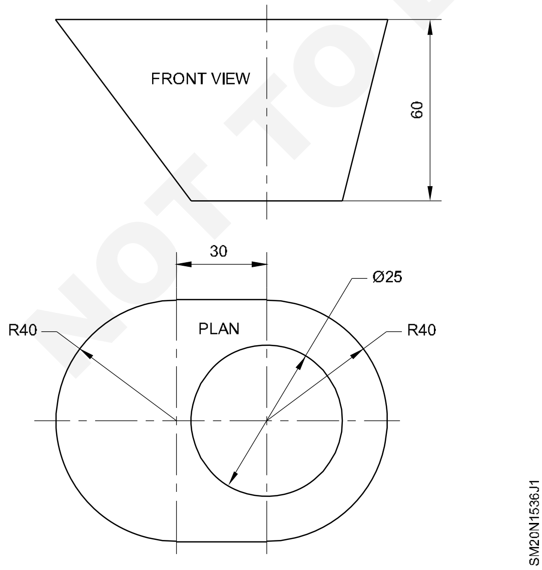
Form the conical hopper with out of centre

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

- **draw the development for the conical hopper with out of centre by triangulation method development.**

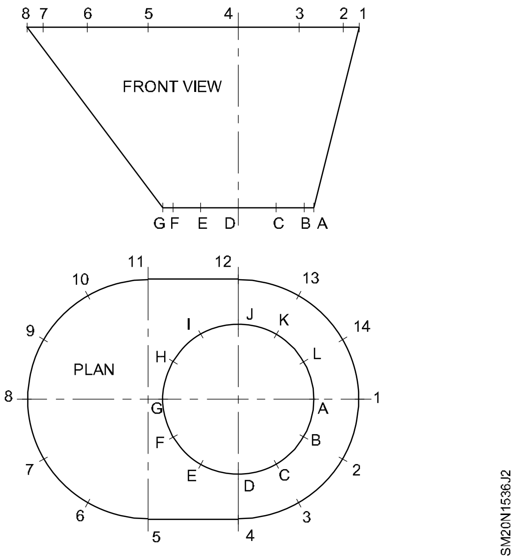
Draw the front view and plan as shown in the Fig 1.

Fig 1



Divide the plan of the circle into twelve equal parts and number it A to L as shown in plan. Then divide the oblong circle into fourteen parts and number it as shown in Fig 2.

Fig 2



Setting up of oxy acetylene plant

Objectives: At the end of this exercise you shall be able to
- **identify the flow pipe injector and non-injector type**
- **distinguish the difference between both blow pipes.**

PROCEDURE

TASK 1: **Identifying the type of blow pipe.**

The blow pipe is used for producing flame for welding as well as for cutting of sheet metal. These are two types of blow pipe viz high pressure and low pressure.

Table - 1

Distinguish the low pressure & high press blow pipe.

High Pressure	**Low Pressure**
It is also called non-injector type blow pipe	It is called as Injector type blow pipe
The Pressure of both gases are set at same pressure of 0.15ksc	The Oxygen passes through its injector, with high pressure Acelelyene is at low pressure
Back firing is controlled only by closing gas valve.	Injector prevents back firing in the nozzle.
Nozzles have varying sizes and nozzle no. is based on gas consumpition in litres/hr.	Whole head has to be interchanged for each nozzle and injector
This blow pipe should not be used on a lowpressure. system	LP blow pipe more expensive but it can be used for HP system also
Used for gas welding , brazing and gas cutting	Ferrous & non ferrous welding, preheating/post heating purposes. Removal of dent & distertion. For gas cutting use cutting use cutting blow pipe.

— — — — — — — —

TASK 2: **The Instructor will explain about the care & maintenance of blow pipe.**

The important & vital element in gas welding is the blow pipe, which has to be handled carefully and propsly maintained. Identify the following statements relating to care and safety for its correctness or not

S.No.	Statement	State true or False
1	HP blow pipe should not be used for LP system	
2	LP blow pipe can be used for HP system,	
3	HP blow pipe has an injector in O_2 contol	
4	The pressure of O_2 and Acetelyne are set at same pressure of 0.15ksc	
5	Blow pipes made of copper gets damaged if handled roughly	
6	Nozzle seat and threads should be free from dust & foreign matter.	
7	Nozzle orifice should be cleaned periodically only with Tip cleaner	
8	Nozzle tip may be filed to remove any damage to the tip.	
9	Inlet for Acctylene has LH thread.	
10	Inlet for Oxygen has RH thread.	
11	The hose protector with a groove at the corners are fixed in Oxygen cylinder	

Get your answers checked by your instructor for its correctness.

Types of Oxy-acetylene flames

Objectives: At the end of this exercise you shall be able to
- **identify type of flame used for different metals.**

PROCEDURE

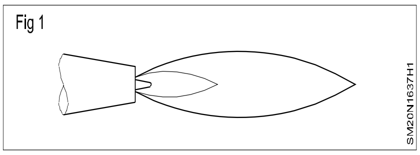
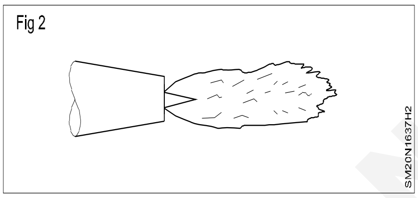
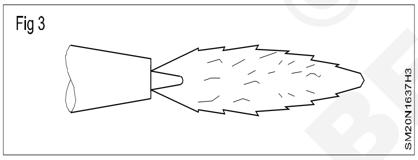
TASK 1: **Identifying type of flame for welding different metals**

1 The Instructor will explain characterishes of flames and its utility.

2 The Oxy-acetylene flame is used for gas welding because it prodeces controlled flame with high temperature The flame can be easily manipulated and flame does not change chemical composition.

Table 1

Identify the following flame and state its characteristic.

S.No.	Type of flame	Name of flame	Characteristic
1.	Fig 1 		
2.	Fig 2 		
3.	Fig 3 		

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TASK 2: **Identifying flame for following metals**

Though neutral flames in commonly used the other type of lames are also used for center purposes. The Table 1 indicates the metal to be welded. Fill up the type of flame to be selected against each metal.

Table - 1
Flame for metals

S.No.	Metal to be welded	Indicate flame type
1	Mild steel, stainless steel	
2	Stellite	
3	Copper	
4	Cast Iron	
5	Pure Aluminium	
6	Brass	

Get your answers checked by your Instructor for its correctness.

TASK 3 : **Identifying flame temperature and uses of different combinations of gases**

The Instructor will explain about the various gas combinations and their special uses.

1 The flame for gas welding is obtained by the combination of different gases such as acetylene, Hydrogen, Coal gas, LPG etc., These combination produces varyfying temperature, based on which its application is decided.

2 Identify the flame temperature and the application and fill it up in the table against column shown temperature. uses,

3 Check your answers checked by your instrutor for its correctness.

Table - 1
Flame for metals

S.No.	Fuel gas	Supporter	Flame temp	Application/uses
1	Acetylene	O_2		
2	Hydrogen	O_2		
3	Coalgas	O_2		
4	LPG	O_2		
5	Acetyle	Ari		

— — — — — — — —

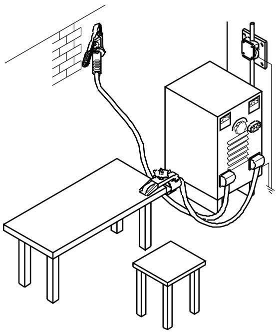
Setting up of arc welding plant

Objectives: At the end of this exercise you shall be able to
- **operate the controls of arc welding machines safely and in sequence**
- **select the cables, electrode-holders and earth clamps of the right capacity**
- **connect the cables with the welding machine and the job**
- **start and stop the arc welding plants.**
- **name the diffeent type of arc welding machines**
- **identify arc different types of arc welding machines**

PROCEDURE

TASK 1: **Identify the parts in Fig 1**

Fig 1



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TASK 2: **Identify the machine shown in the Fig 1, 2, 3 & 4.**

Fig 1

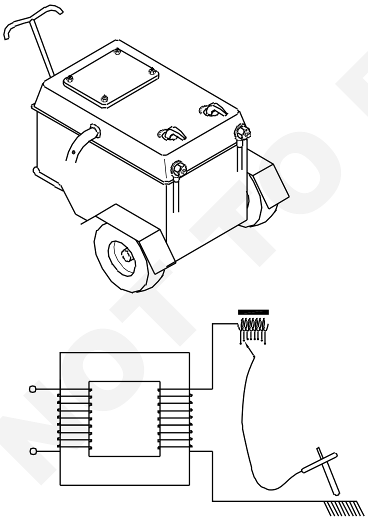


Fig 2

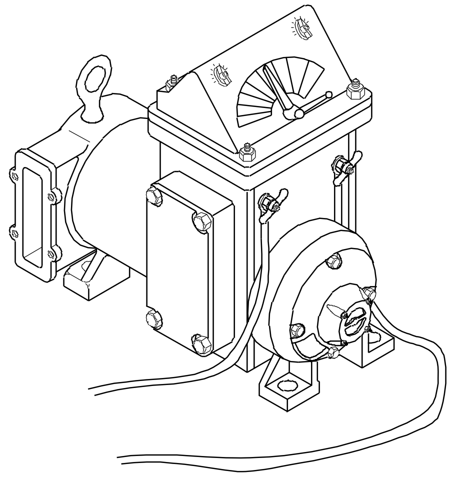


Fig 3

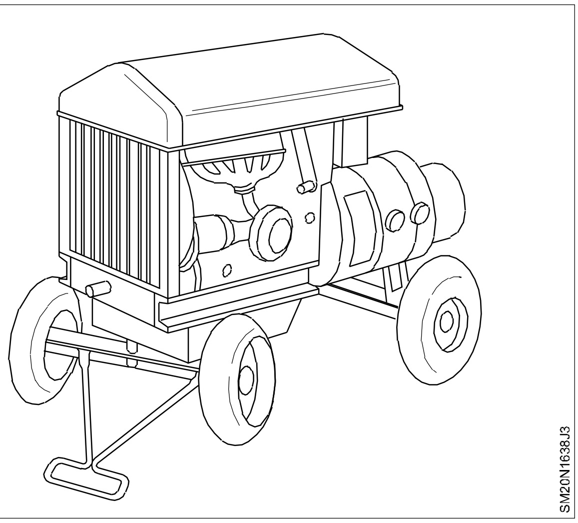
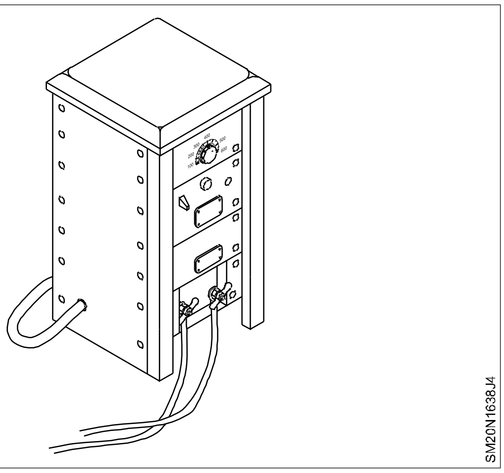


Fig 4



1 **Identify current range against the shade numbers mentioned below.**

Shade No. of coloured glass	**Range of welding current in amperes.**
8 - 9	
10 - 11	
12 - 14	

Arc Welding Accessories

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

- **identify the arc welding accessories**
- **select the correct shade of glass for welding a seam according to current range.**

TASK 1 : **Identify the Accessories.**

Fig 1

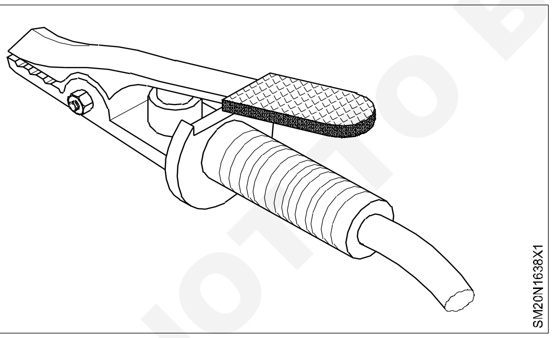


Fig 2

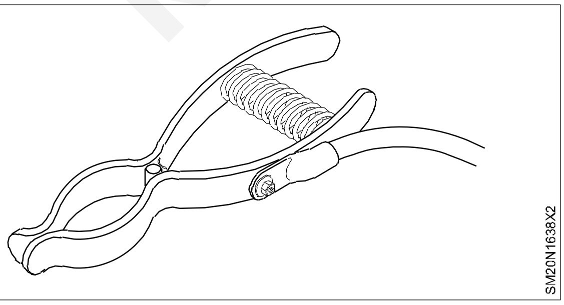


Fig 3

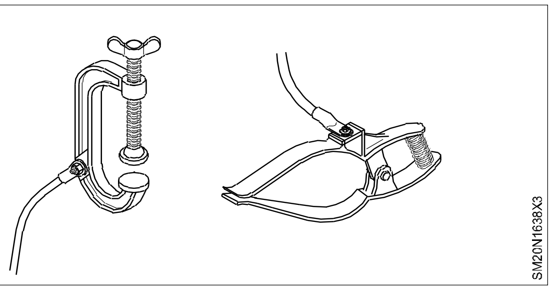


Fig 4

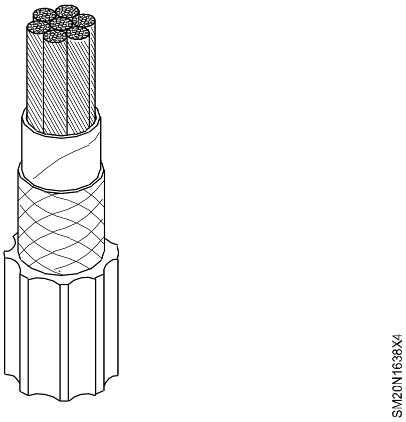


Fig 5

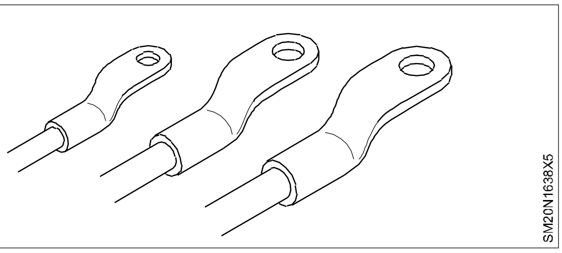


Fig 6

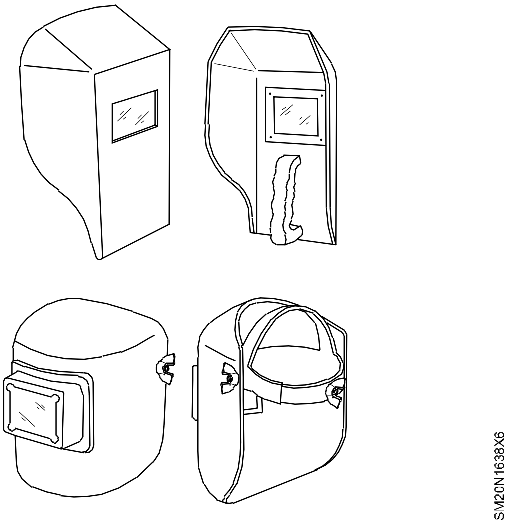


Fig 7

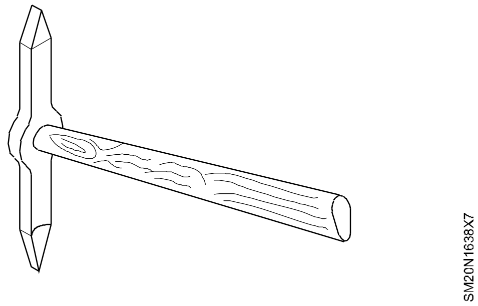


Fig 8

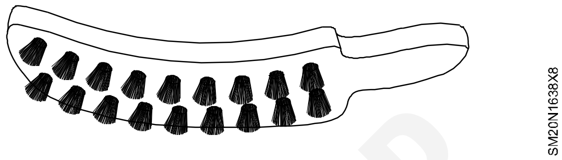
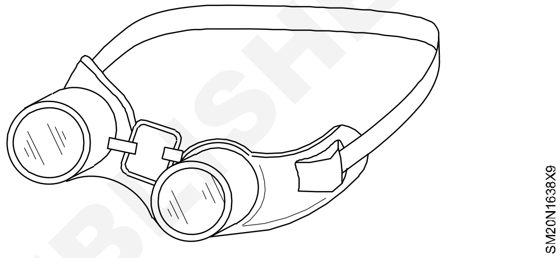


Fig 9



Striking, maintaining of arc and laying short beads

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

- **prepare M.S. plate pieces to size**
- **select and fix electrode in the electrode-holder at the required angle**
- **set the welding current on the welding machine as per the electrode and job requirements**
- **strike and maintain electric arc without freezing the electrode**
- **lay short beads on the plate by manipulating the electrode in the correct angle**
- **de-slag and clean the weld bead**
- **identify the weld defects.**

Job Sequence

Striking of arc and laying short beads on M.S. plate in flat position

- Cut the M.S. plate to size (as per drawing) by shearing.

Keep your fingers away from the blades of the shearing machine.

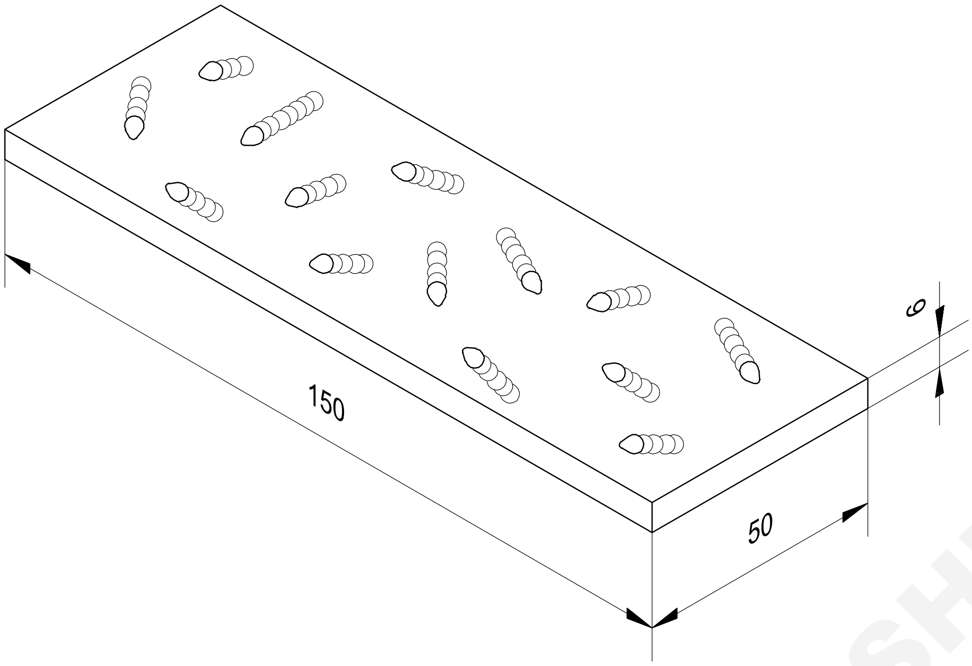
- File the cut edges to square.
- Clean the plate (workpiece) surface with a steel wire brush, and clean the oil or grease, if any.

Improper cleaning makes poor electrical ontacts and weak welds.

- Set the workpiece on the welding table in a flat position.
- Wear safety apparels (protective clothing).
- Connect the welding cables with the machine and work.
- If the welding machine is DC connect the electrode to Negative.
- Check the cables for damage and loose connections.

Loose cable connections cause spark, heat and unstable arc.

- Fix a 3.15 mm ø/4.00 mm ø M.S. electrode in the holder.
- Ensure the electrode is firmly held in the holder at the bare end.



- Set the welding current (amperage).

  100 - 125 amps for the 3.15 ø electrode.

  140 - 150 amps for the 4.00 ø electrode.

- Switch `on' the input supply and start the welding machine.
- Strike the arc by the scratching method and tapping method.

  Look at the arc through the filter glass only fitted in the welding screen.

- Deposit short beads of 20 - 25 mm length by maintaining correct arc length and electrode angles.
- Stop at the end of every short bead for a while and break the arc by quickly withdrawing the electrode up.
- Remove the slag from the short beads by using a chipping hammer, and clean with a wire brush.

Use chipping goggle or chipping screen, while de-slagging weldMs.

Use tongs to hold a hot job.

- Repeat this exercise until the arc can be struck every time without the electrode freezing.

If the electrode freezes (sticks) to the plate, it should be immediately freed to avoid its overheating or spoiling by a quick twist of the wrist motion or if it fails by releasing the grip of the holder.

2	50 ISF 6-150	–	FE310-W	–	–	38
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

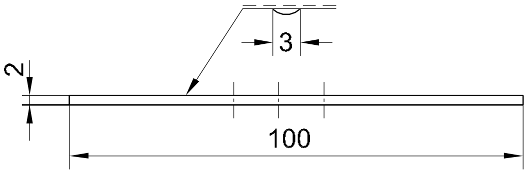
SCALE NTS	**STRIKING, MAINTAINING OF ARC AND LAYING SHORT BEADS**	DEVIATIONS	TIME 10h
		CODE NO. SM20N1638E1	

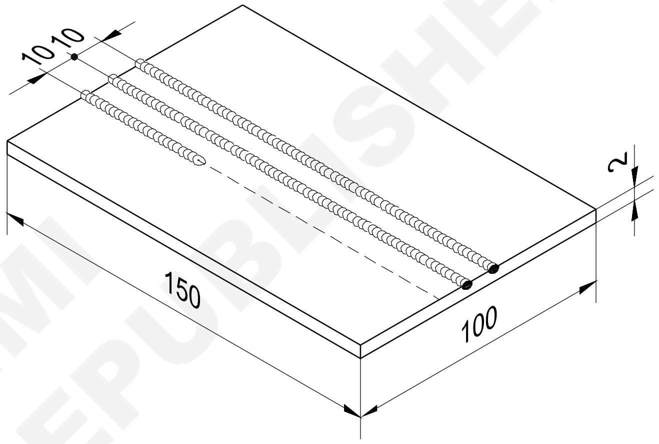
Capital Goods & Manufacturing
Sheet Metal Worker- Welding

Exercise 1.6.39

Fusion runing with filler rod

Objectives: At the end of this exercise you shall be able to
- **shear a sheet to given size**
- **file the edges of the sheet in right angle to the correct measurement**
- **mark straight and punch parallel lines on sheet surfaces as per drawing**
- **adjust the neutral flame using recommended nozzle size and gas pressure**
- **produce a molten pool by manipulating the blowpipe and flame on the sheet surface**
- **maintain the molten pool to make fusion run without filler rod in flat position using leftward technique**
- **clean the fusion bead and inspect for weld defects**
- **take corrective steps to avoid defects during and after welding.**





Job Sequence

Fusion runs without filler rod in flat position

- Mark and cut the M.S. sheet pieces as per drawing using a shearing machine.

Care should be taken to keep the fingers off from the shearing blades. Wear gloves to avoid injury.

- Straighten the cut pieces by hammering on an anvil.
- File and finish the sheet to dimensions.
- Mark and punch parallel lines on the sheet surface as per drawing.
- Set the job piece on the welding table in flat position.
- Select and attach nozzle size 3 with the blowpipe.

Wear safety apparels.

- Set acetylene and oxygen pressure 0.15 kg/cm^2 on the regulators.
- Adjust the neutral flame.
- Hold the blowpipe on the job at its right end.
- Start heating the surface with slight circular motion to the blowpipe and produce a molten pool on the marked line.
- Move the blowpipe in the leftward direction maintaining a uniform speed.
- Avoid excessive concentration of heat at any one point.

If the metal becomes too hot, lift the blowpipe momentarily away from the molten pool.

Do not touch the inner cone with the molten pool, to avoid backfire and flashback.

1	ISST 100 x 2 - 150	–	Fe310-W	–	–	39
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**FUSION RUN WITH FILLER ROD (IN FLAT POSITION)**	DEVIATIONS	TIME 10h
		CODE NO. SM20N1639E1	

- Keep the molten pool in correct size by adjusting the rate of travel and giving slight circular motion to the blowpipe.
- Stop at the left end and lift the blowpipe quickly.
- Extinguish the flame and cool the blowpipe in water.
- Clean the fused surface with a steel wire brush and inspect for the uniformity of fusion runs.

If the speed of travel and blowpipe motion are correct, the fusion runs will appear with uniform width and even ripples.

Repeat the exercise till you achieve uniform fusion.

Skill Sequence

Fusion runs without filler rod in flat position by gas

Objectives: This shall help you to
- **hold the blowpipe and filler rod in correct position with respect to the job**
- **fuse the metal surface and the filler metal to deposit weld metal in straight line using leftward technique**
- **clean and inspect the weldment for defects.**

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

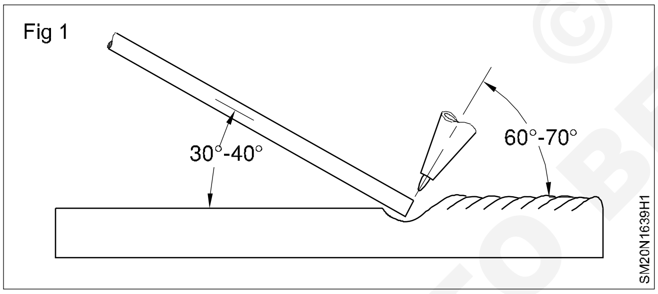
The feeding of filler metal in molten pool requires special skills.

Positioning and manipulation of blowpipe and filler rod to deposit beads

Hold the blowpipe and filler rod at correct position with respect to the job.

Blowpipe angle 60^0 - 70^0 with weld line (towards right). Filler rod angle 30^0 - 40^0 with weld line (towards left). (Fig 1)

Fig 1



This angle helps in moving the molten puddle along the line of weld and keeps the unwanted materials like scale, any dirt, etc. away from the molten pool. This also controls the depth of fusion (penetration) to the required extent. In addition the visibility of the melting region is better.

Keep the blowpipe and filler rod at 90^0 to the plate surface, so that the metal melts equally on both sides of the inner cone of the flame. (Fig 2)

Fuse the metal surface, maintain the molten pool and add filler metal with proper motion at the right hand end.

For the blowpipe, a slight circular motion is required and for the filler rod, a piston like motion (Fig 3) (up and down) is required.

Fig 2

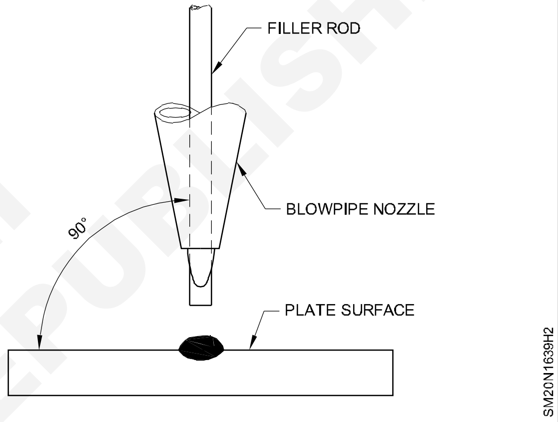
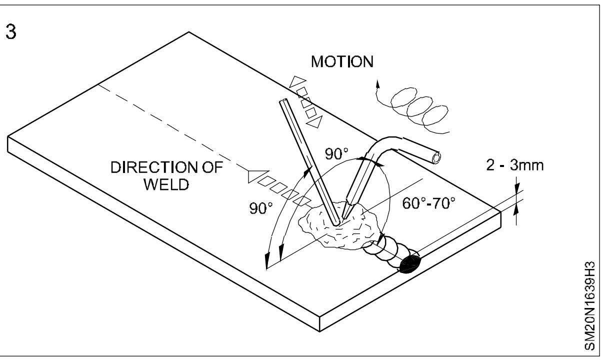


Fig 3



Maintain the flame cone distance to metal surface 2-3 mm.

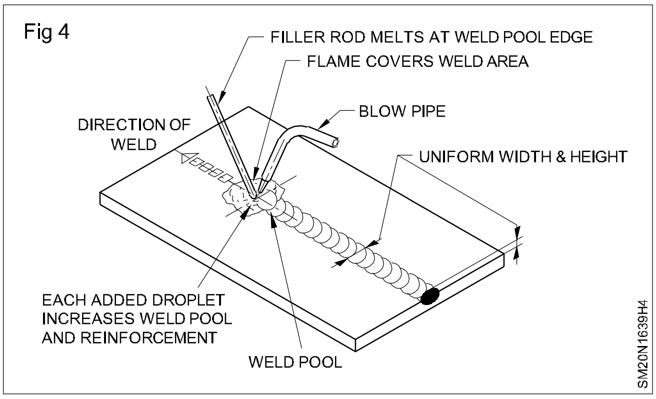
Depositing fusion runs with filler rod

Move the blowpipe and filler rod in leftward direction, along the punch-marked straight line, to progress the weld. (Fig 4)

Add filler rod in the weld pool to get 1.5 to 2 mm weld reinforcement above the sheet surface.

Maintain constant speed, angles and motion during welding for the blowpipe and the filler rod.

Fig 4

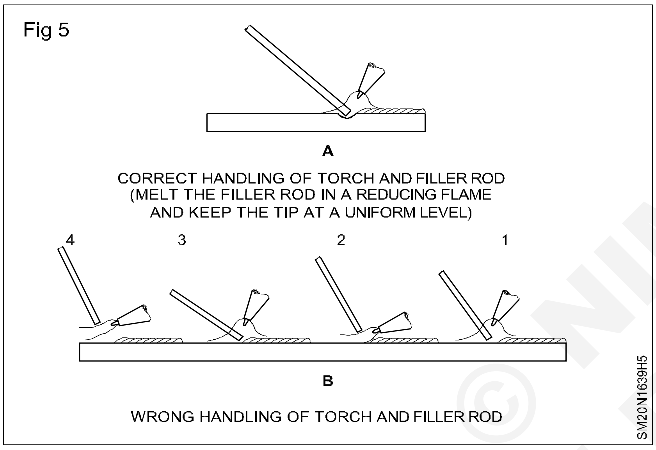


Keep the end of the filler rod within the flame to avoid its oxidation.

Restarting and stopping of weld

Restarting: Hold the blowpipe nozzle at 80° angle with the cone pointing on the last 3 mm of weld bead deposited i.e. the crater. (Fig 5A & 5B)

Fig 5



Re-melt the weld bead at crater to form a molten pool, add filler rod and proceed with the deposition.

Stopping: Reduce the angle of the blowpipe and filler rod as the weld pool reaches the left hand to control burn-through.

Build up the crater by adding enough filler metal, by dropping a few drops of molten metal at the crater.

Remove the flame slowly but cover the weld pool with the end of the flame's outer envelope to protect it from atmosphere.

Remove the filler rod end from the weld zone before the weld pool solidifies.

Inspection of the deposited run

Look for the following on the deposited bead.

Depreciation at various points on the bead. (This is due to variation in speed of travel of the blowpipe; improper feeding of the filler rod; wrong restarting; splashing of molten pool due to inner cone of flame touching the molten metal.)

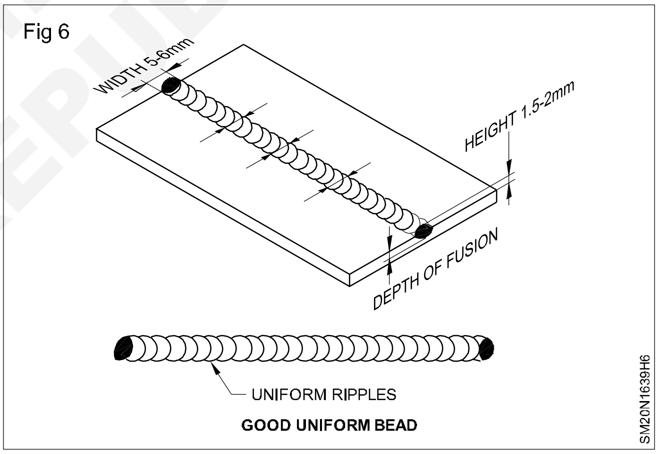
Undercut at the toes of the bead. (This is due to excessive pressure of gases and setting harsh flame; improper manipulation of the blowpipe; improper feeding of the filler rod.)

Concave bead surface. (This is due to harsh flame and excessive pressure of gases; inadequate feed of filler rod.

Porosity. (This is due to improper cleaning of the sheets; rusted filler rod.)

The correct bead is shown in Fig 6.

Fig 6



Fusion runs without filler rod in flat position

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

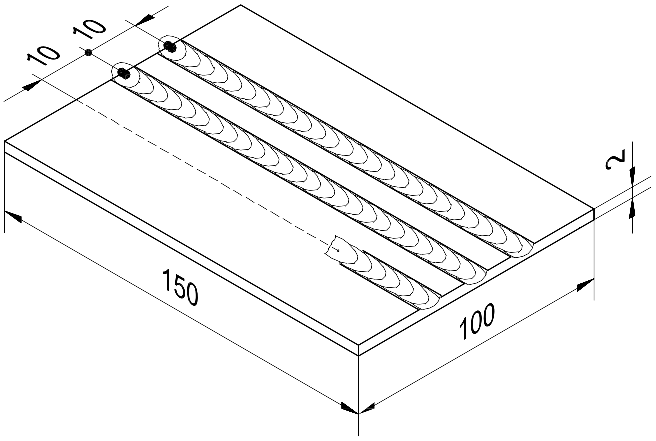
- **prepare the sheet pieces to the required size as per drawing**
- **produce molten pool of required size by the manipulation of the blowpipe and flame**
- **add filler metal at the required rate and place by manipulating the filler rod**
- **deposit fusion run with the filler rod in flat position using leftward technique**
- **clean and inspect the deposited beads for surface defects.**

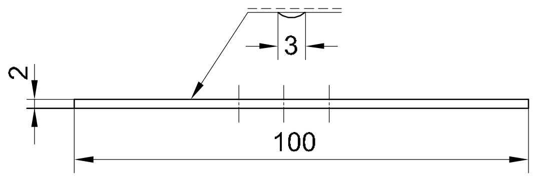
Job Sequence

- Mark and cut the M.S. sheet (job) pieces as per drawing using a shearing machine.
- Straighten the cut pieces of sheet by hammer and anvil.

Follow safety precautions to avoid injury to the fingers while shearing.

- Clean and finish the sheet pieces to dimensions using file and emery paper.
- Mark and punch straight parallel lines on the sheet surface as per drawing.
- Set the job piece on the welding table in flat position.





- Select and fix the nozzle size 3 and set acetylene / oxygen pressure 0.15 kg/cm$^{2.}$
- Select copper-coated, mild steel, (CCMS) filler rod of ϕ 1.6 mm.

Wear safety apparel.

- Adjust the neutral flame.
- Hold the blowpipe at an angle of 60° - 70° with the punched line of the job and make a small molten pool at the right hand edge of the line.
- Keep the flame cone distance 2.0 to 3.0 mm above the job surface.
- Hold the filler rod in the left hand, pointing near the molten pool with an angle of 30° - 40° with the line of weld.
- Fuse the end of the filler rod by dipping at the centre of the molten pool and add filler metal on the job surface to form a weld bead.
- Move towards left with uniform speed along the punched line with a slight circular motion to the blowpipe.
- Move the filler rod up and down (piston like motion) at a constant speed.
- Add enough rod into the molten pool to build up the bead evenly in height and width.
- Coordinate the rate of travel of the blowpipe with the filler rod to control the size of the bead and the required penetration.
- Keep the welding rod end within the flame to avoid oxidation.
- Stop at the left edge by filling the crater properly.
- Extinguish the flame and cool the nozzle.
- Clean the weld surface. Inspect for even ripples and uniform width/height of weld bead.

  (Refer to Skill Information.)

4	ISST 100 x 2 - 150	–	Fe310-W	–	–	39
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS

FUSION RUNS WITHOUT FILLER ROD IN FLAT POSITION

DEVIATIONS

TIME 10h

CODE NO. SM20N1639E2

Skill Sequence

Fusion runs without filler rod in flat position by gas

Objectives: This shall help you to

- **prepare the job to the required size**
- **hold the blowpipe and flame in correct position to obtain proper fusion of metal**
- **make fusion runs without the filler rod to produce uniform beads**
- **visually examine the fusion beads.**

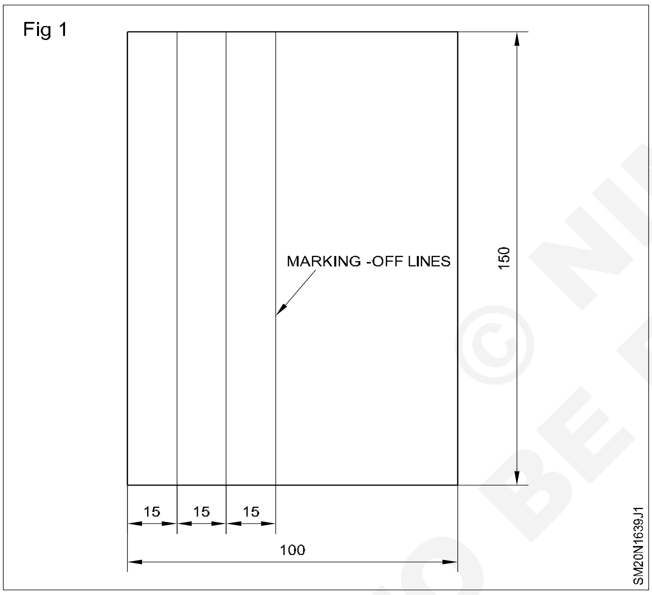
Homogeneous joints are produced in gas welding by melting and fusing the metal edges with the help of a gas flame.

The beginner for gas welding must practise:

- holding the blowpipe in the correct position
- fusing of the metal by using a proper gas flame
- deposit fusion run in a straight line using leftward technique.

Preparation of sheet for welding: Scribe lines at 15 mm from one edge of the given strip of 2 mm thick, 100 mm wide and 150 mm long. (Fig 1)

Fig 1



2 mm is the shearing allowance so that the finished size after filing will be 150 mm.

Use gloves while handling sheets.

Shear the strip to get job pieces 150 mm long x 100 mm wide x 2 mm thick size. (Fig 1)

Ensure your fingers are away from the shear blades while cutting.

Remove buckling of sheet due to shearing by hammer on the anvil.

File the irregular edges of the job to remove burrs and unevenness on the edge.

Cleaning and setting job piece

Remove rust if any using a wire brush and emery paper.

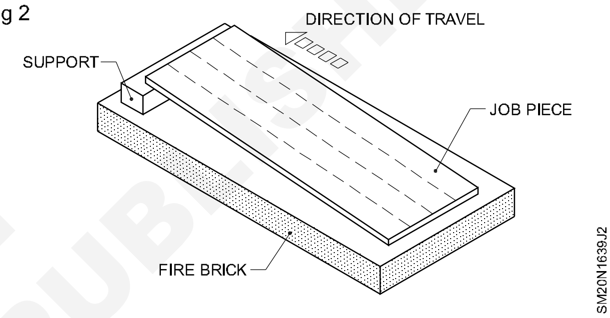
Do not rub with heavy pressure on the wire brush.

Use the emery paper rolled on a piece of wood while cleaning.

Remove paint, oil or grease by dipping the M.S. sheet in a solvent of dilute hydrochloric acid.

Keep the job 10 mm above the work table (Fig 2) to reduce the heat conduction and to position the job flat.

Fig 2



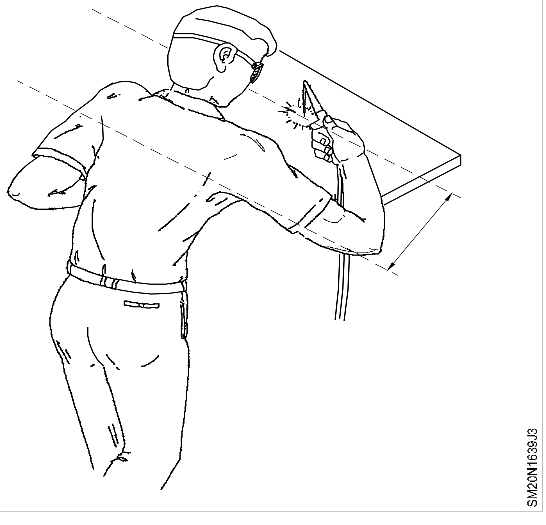
Draw lines parallel to the longer edge of the sheet and punch along the lines to serve as a guide.

Hold the blowpipe and flame in correct position for proper fusion (angle).

Position the blowpipe in such a way that:

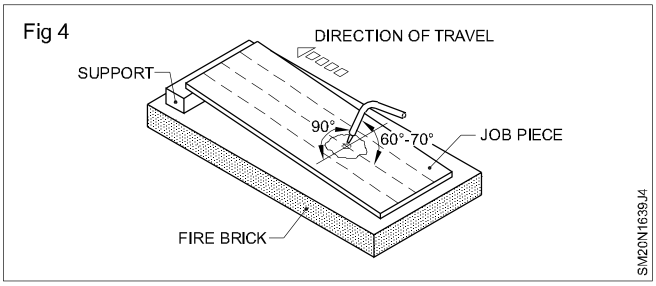
- the axis of the joint is parallel to the operator (Fig 3)
- there is less fatigue to the hand of the operator

Fig 3



- the angle of the nozzle with the welding line is between 60 - 70^0. (Fig 4)

Fig 4



Fuse the metal to form a small puddle of molten pool on the job surface at the right end.

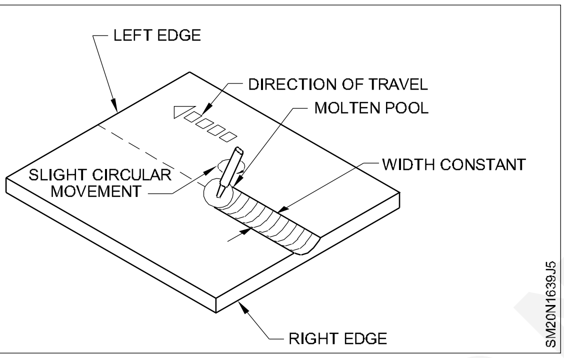
Give slight circular motion to the blowpipe.

Making fusion run without filler rod

Move the blowpipe in the leftward direction as local fusion is obtained.

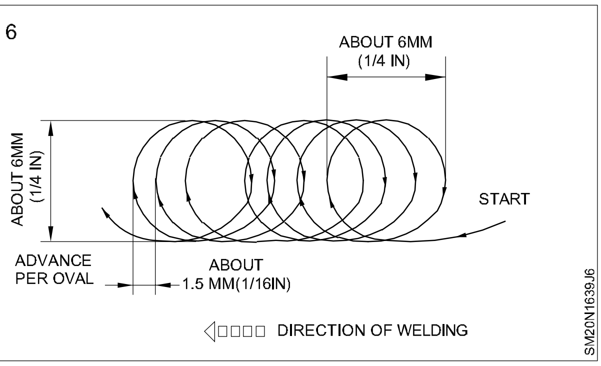
Keep the molten pool on the punch line. (Fig 5)

Fig 5



Maintain constant speed of travel with slight circular motion to the blowpipe. (Fig 6)

Fig 6

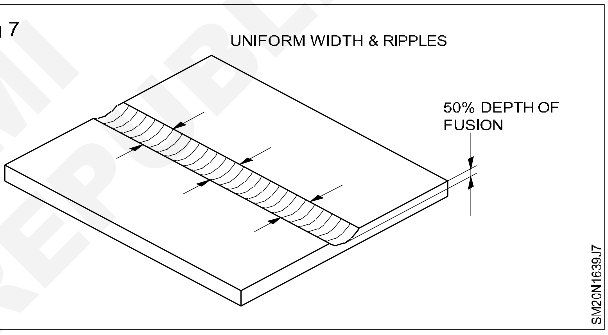


Reduce the blowpipe angle slightly near the left edge and slowly withdraw the flame to avoid burn through at the end.

Maintain 2-3 mm constant distance between the white cone of the flame and the sheet surface for proper heat input and to avoid backfire.

Visual inspection of fusion run: Visual examination can be done to ensure uniform width, ripples and proper depth of fusion (penetration) (Fig 7) for the bead after the welded job is cleaned thoroughly to remove the scales from its surface.

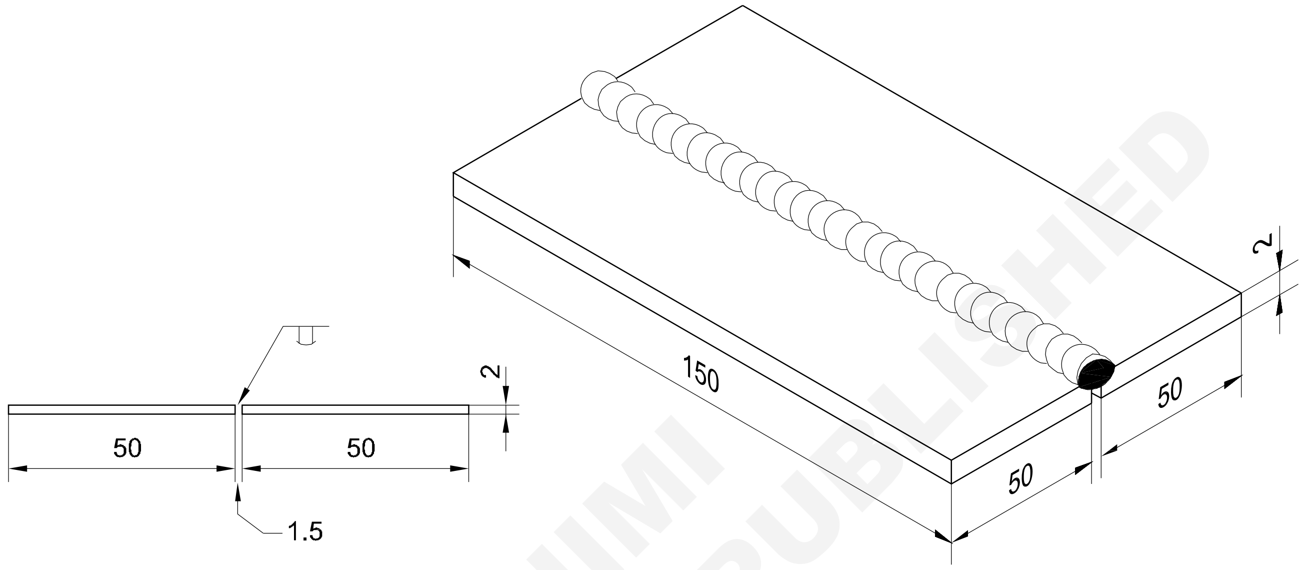
Fig 7



Use tongs while handling hot jobs.

Sqyare butt joint in flat position by gas welding

Objectives: At the end of this exercise you shall be able to
- **prepare the job to the given size as per drawing**
- **file the edges of the plate to square without burr**
- **tack-weld the square butt joint at specified intervls with correct alignment.**



Job Sequence

- Prepare the job pieces as per drawing.
- File the edges to square and ensure through cleaning.
- Set the job pieces on the weldign table to form a square butt joint (open) with a root gap of 1.5 mm.
- Set the gas welding plat, fix nozzle No. 3 and set the gas pressure of 0.15 Kg/cm^2 for both gases.
- Select C.C.M.S. filler rod ϕ 1.6 mm for tacking and welding.

Wear safety apparels.

- Set neutral flame.
- Tack the pieces at both ends and also at every 50 mm distance between ends, using ϕ 1.6 mm filler rod (keep a pre-set shrinkage allowance of 4^0).

Tacks should be well fused and penetrated and done on the bottom side of the joint.

- Check the alignment and root gap and reset if necesary.
- Clean the tacks and set the job on the welding table in a flat position.

Turn the tack-weld side down

- Start the weld at the right end of the job.
- Direct the flame at the beginning of the seam (welding line) with the blowpipe nozzle at an angle of 60^0 – 70^0 towards right.
- Hold the filler rod at an angle of 30^0 – 40^0 \with the seam towards left.
- Fuse the edges uniformly and add filler metal by up and down (piston like) motion and progress the weld towards left.
- Maintain a uniform speed of the blowpipe with slight circular motion.

8	ISST 50 x 2 - 150	–	Fe310- W	–	–	40
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**SQUARE BUTT JOINT (IN FLAT POSITION)**	DEVIATIONS	TIME 10h
		CODE NO. SM20N1640E1	

- Stop at the left end, fill the crater and complete the weld.
- Clean the welded joint and remove distortion.
- Extinguish the flame, cool the nozzle in water and keep it at a safe place.
- Inspect the joint by visual inspection for:
  - Slight convexity with uniform width and height of bead
  - uniform ripples
  - uniform peneration.
- Cut and prepare the sample pieces and perform free bend tests (root bend and face bend).
- Repeat the exercise till you et good results. (Refer to Skill Information)

Skill sequence

Square butt joint on M.S. Sheet in flat position

Objectives: This shall help you to

- **set and tack the job pieces with correct root gap and correct alignment for square butt joint**
- **weld a uniform and well penetrated bead on open square butt joint in flat position**
- **inspect the completed weld**
- **test the welded joint.**

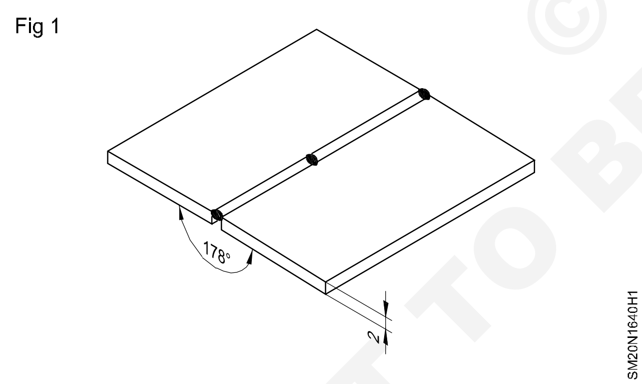
The requirements of a good welded joint are:

- the joint must be in correct alignment (distortion-free)
- the weld must be well fused, well penetrated, uniform in width and height, of correct size and free from internal and external faults.

Preparation: Prepare the join pieces of size 150 x 50 x 2 mm by cutting with a chisel and then by filing.

Setting and tacking: Set the prepared job pieces on the welding table with a uniform root gap and in alignment. (Fig 1)

Fig 1



Ensure that there is a uniform gap of 2 mm. Present the distortion; give an allowance of 4^0.

Tack-weld the joint at equal intervals to hold them together, maintaining the alignment. (Fig 1)

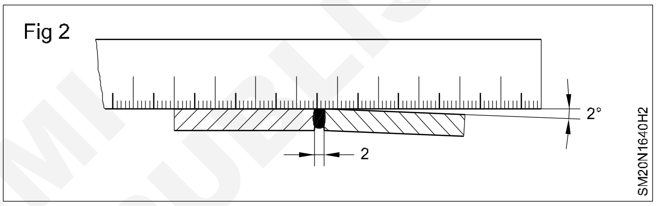
Ensure that the

- distance between the tack-welds is 50 mm.
- length of the tack-weld is 6 mm.

Tack welds should be on the side to be welded and in line with the joint

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

Fig 2

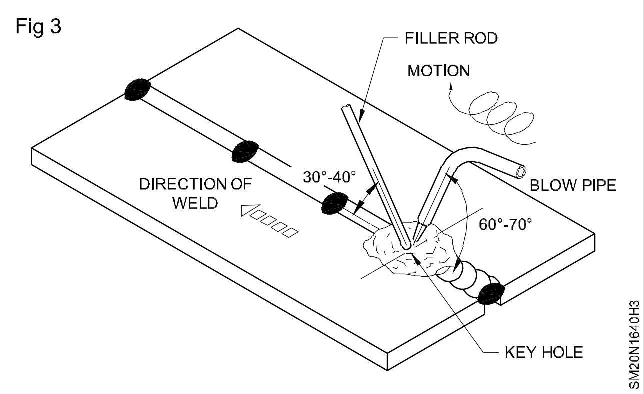


Welding: Keep free space under the joint for complete penetration.

Start the weld right the end of the joint. (Fig 3)

Weld a well fused uniform bead with complete penetration using leftward technique. (Fig 3)

Fig 3



Manipulate the blowpipe to maintain the recommended angle of blowpipe and the filler rod.

Maintain uniform travel speed and feed.

Maintain a keyhole for better root penetration.

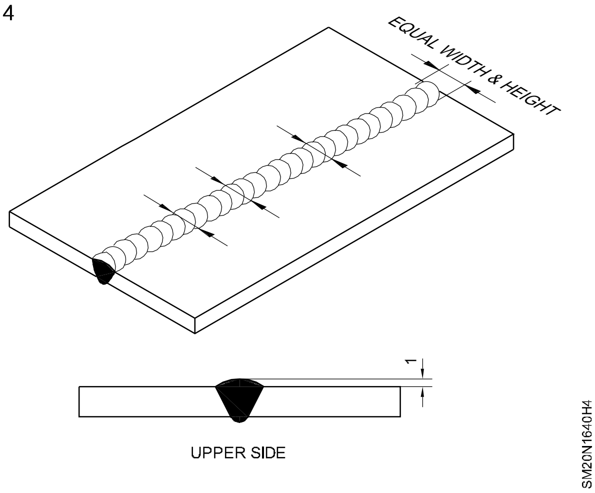
Clean the deposited bead.

Inspect the quality of weld by:

- checking the finish of the job
- checking the alignment (remove distortion, if required).

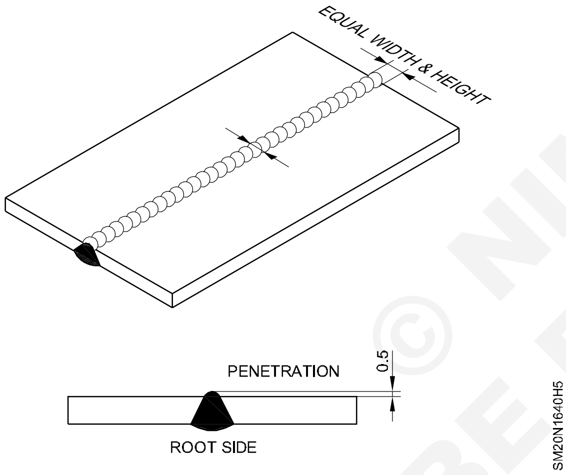
- checking the uniformity of width and height of the weld bead in size. (Fig 4)

Fig 4



- checking the uniformity of the ripples, fusion and complete penetration. (Fig 5)

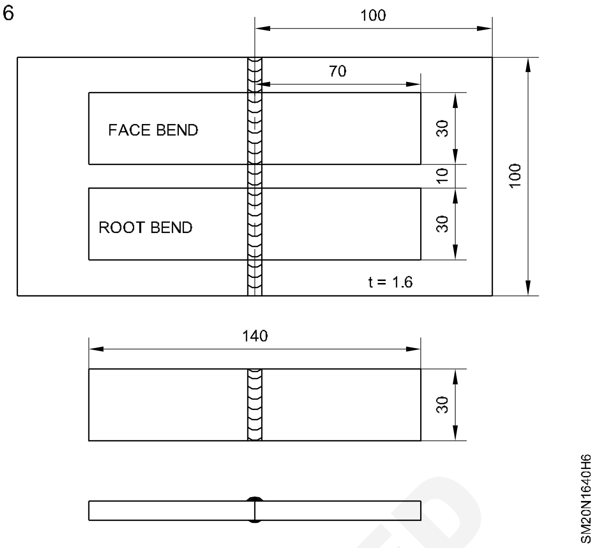
Fig 5



- checking that the weld is free from faults such as undercut, lack of fusion, unfilled crater etc.

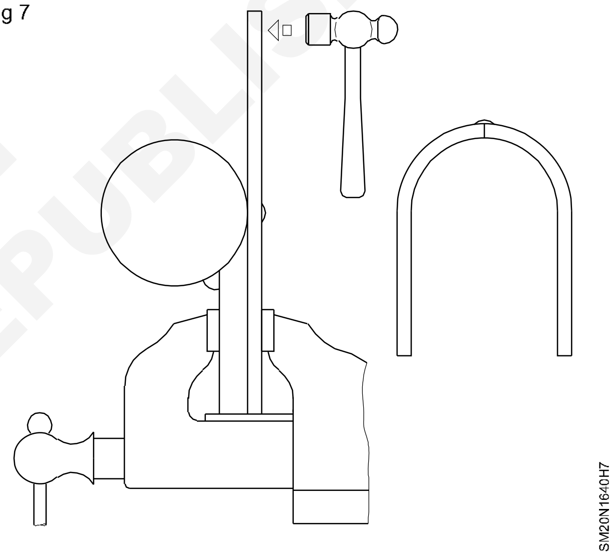
Test: Cut the welded joint into specimen pieces with a hacksaw. (Fig 6)

Fig 6



Test the specimen piece for 'free root bend test' using a bench vice and hammer. (Fig 7)

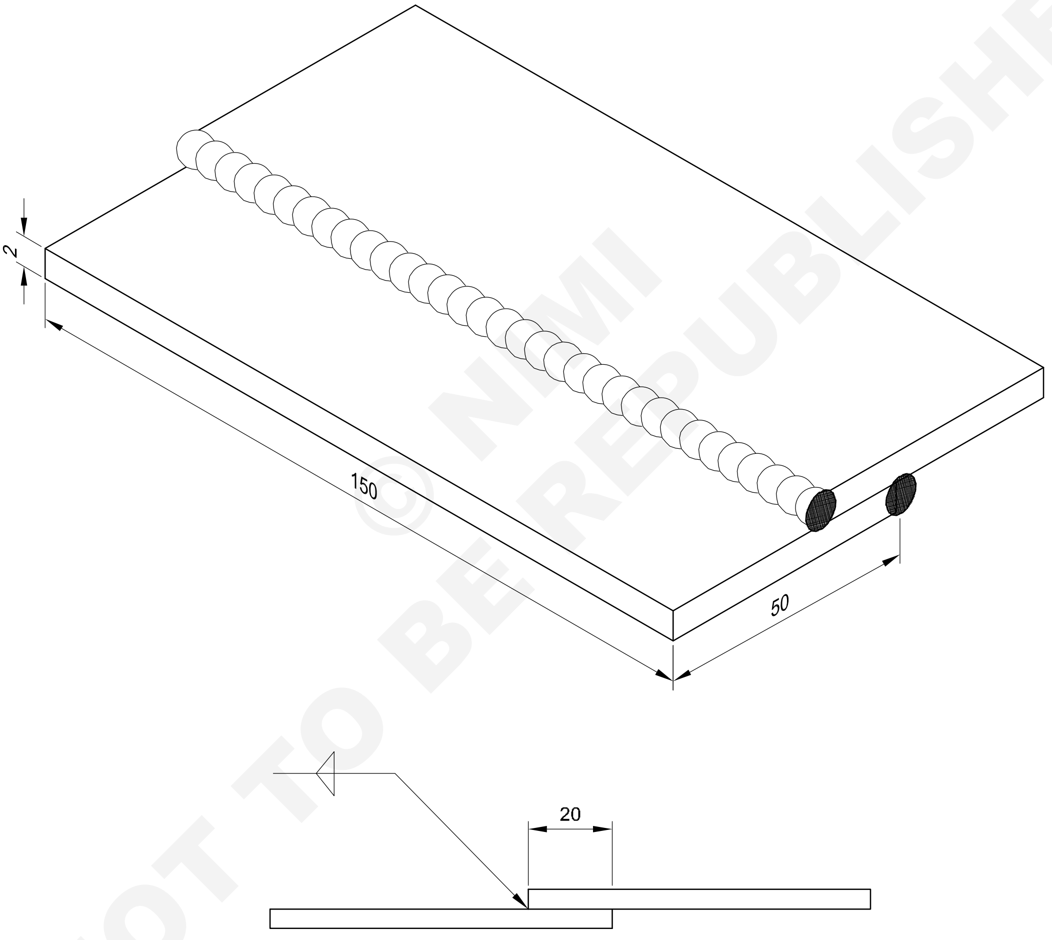
Fig 7



Exercise 1.6.41

Brazing on copper sheet in joint flat position

Objectives: At the end of this exercise you shall be able to
- **remove the oxides and other impurities from the surface of the parent metal**
- **select the correct nozzle size, filler rod, gas pressure and set a soft oxidising flame**
- **select the correct flux for bronze welding of copper**
- **manipulate the filter rod and the blowpipe and braze weld the joint in one run**
- **clean the bead and remove all flux residue**
- **Check the weld for defects, bead size and profile.**



3	ISST 50 x 2 - 150	-	Fe310 - W	-	-	1.6.41
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE
NTS

SQUARE BUTT AND LAP JOINT ON M.S SHEET
2MM THICK BY BRAZING

TOLERANCE ±1

TIME
11 Hrs

CODE NO. SM20N1641E1

Job Sequence

- Prepare the copper sheet as per dimensions.
- Clean the edges of the sheets and deburr.
- Set the sheets as a square butt joint.
- Follow necessary safety precaution.
- Tack - weld for every 40 to 50mm length of the joint
- Check the alignment of the joint
- Select nozzle No.7 and phosphor bronze filler rod.
- Select the correct bronze flux and set soft oxidizing flame.
- Heat the edges of the joint to dull red colour.
- Braze weld the joint using leftward technique.
- Clean the joint and inspect the weld.

Skill sequence

Brazing of lap joint on sheet of 2mm thick

Objectives: This shall help you to
- **brazing of copper sheet.**

Ensure a de-oxidised copper sheet of correct size since commercial copper will develop cracks during welding.

Clean the edges and surfaces free from oil, grease and dirt using pickling/solvent.

Ensure the joint surfaces are free from surface oxides. Use emery sheet, wire brush or wire wool for cleaning the surface.

Set the sheets as butt joint with correct alignment and a root gap of 2.5 mm.

Select a phosphor bronze filler rod.

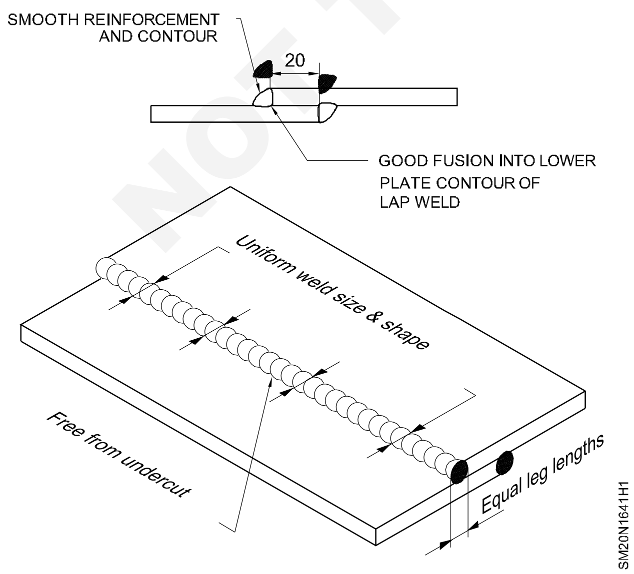
Select the bronze flux.(borax flux)

Set a soft oxidising flame, which will help in controlling the evaporation of zinc and tin from the weld metal.

Preheat the plates until the surface oxides just begin to form.

Tack weld for every 50mm length of the joint to take care of the higher thermal expansion of copper

Fig 1



Hold the blowpipe over the ends of the joint at an angle of 60° -70° and the filler rod at 30°-40°and then tack-weld. The filler rod is coated with flux by heating and dipping into the powder flux.

Hold the blowpipe and filler rod at the angles given for tack welding. Slight weaving of the blow pipe ensures proper fusion of both edges.

Commence at one end and continue with a slight weaving motion, adding the filler rod at regular intervals until the seam is completed.

Ensure uniform root penetration.

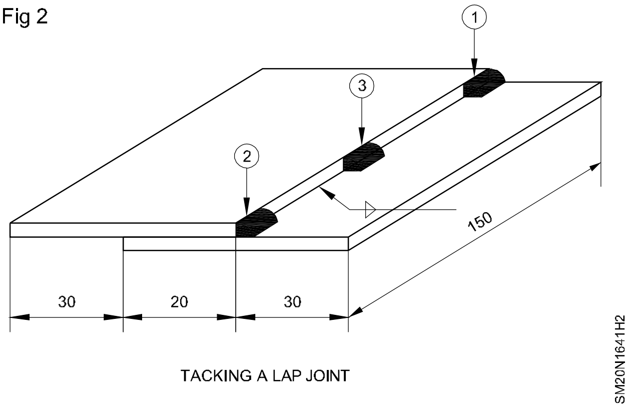
Terminate the weld, keeping the reinforcement up to full section and after closing the crater.

Remove the flux residue.

The deposit should be of uniform size, bright in appearance and free from porosity.

clean the bead and inspect for weld defects and bead size, profile and appearance.

Fig 2



TACKING A LAP JOINT

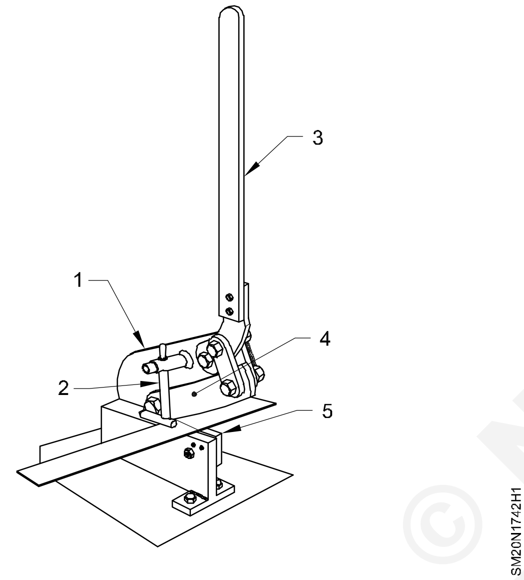
Importance of machinary used in the trade

Objectives : At the end of this exercise you shall be able to
- **identify and operate the machine**
- **to assemble the parts**
- **to set cutting blades.**

PROCEDURE

TASK 1 : **Identify the parts of machine**

Fig 1



Instructor will explain the purpose, operation and parts of the hand shearing machine.

Table 1

Sl. No.	**Name of the parts**
1	
2	
3	
4	
5	

— — — — — — — — —

TASK 2 : **Identify the defects and causes of cutting**

Instructor will explain how to set upper and lower blade, clearance with respect to material thickness to be cut and effects due to excess and no clearance.

1 Trainee should dismantled and assemble upper and lower blades.

2 To practice setting of blades for proper cutting.

3 Cut and observe cutting surface.

Precautions:

1 As per specification the material to be cut should not be more than **3mm thick (10SWG).**

2 Ensure the cutting edge without damage and dents.

3 Ensure the machine is firmly fastened on bench/floor.

Table 2

Defect in setting blade	**Effect observed on material cut**

Get it checked by instructor.

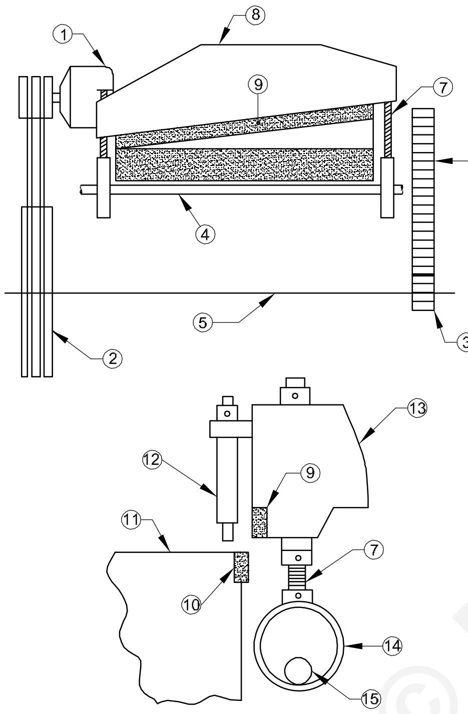
Practice on power shear M/C's mechanism

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

- **to identify parts of power shear mechanism**
- **to operate power shearing machine**
- **to set work and cutting blades.**

TASK 1 : **Identify parts and functions of power shear mechanism**

Fig 2



POWER SHEAR MECHANISM

SM20N1742H2

Instructor will explain parts, functions, how to operate, shearing capacity, safety on power shear mechanism.

Table 1

Sl. No.	**Parts name**	**Functions**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Get it checked by instructor.

— — — — — — — —

TASK 2 : **Identify various method provided for feeding sheet material to be cut in power shearing machine.**

Sl. No.	**Methods used for feeding sheet material in power shearing machine**
1	
2	
3	
4	
5	

Get it checked by instructor.

Safety precaution :

1 Place guard in position, before operating.

2 Never work from back side of the power shearing machine.

3 Understand machine operation fully and operation of emergency switch.

4 Clear gauges from material being cut, if not being used.

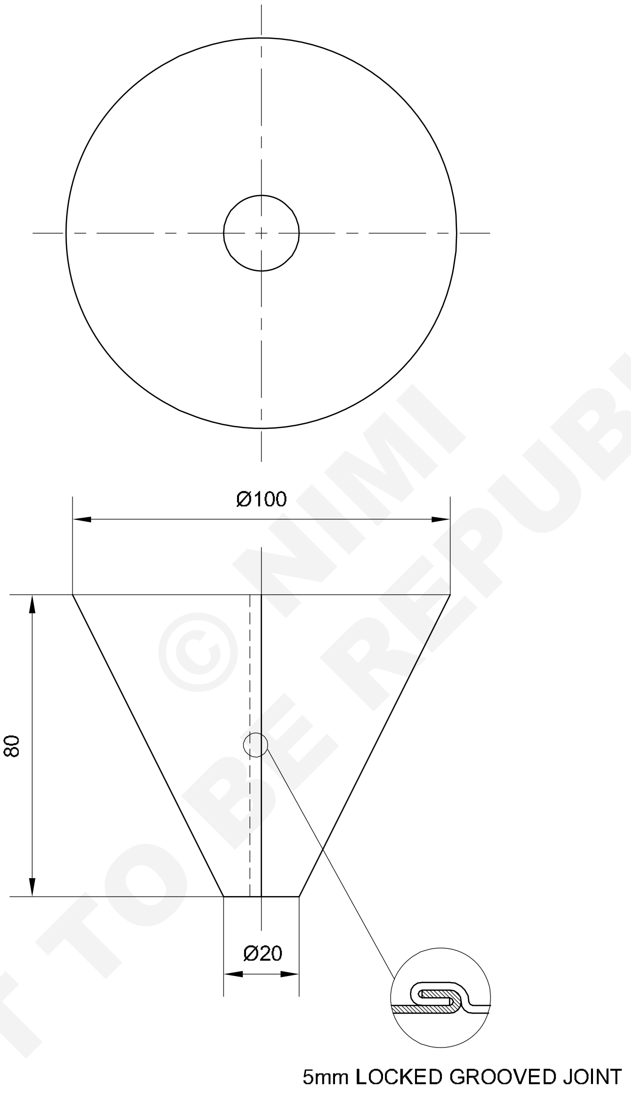
5 Wear protective gloves.

6 Before setting, check shearing machine is switched off.

7 Keep wooden block under pedal as an added safeguard.

Making a frustum of cone with locked grooved joint

Objective : At the end of this exercise you shall be able to
- **to make a frustum of cone by locked grooved joint using hand tools.**



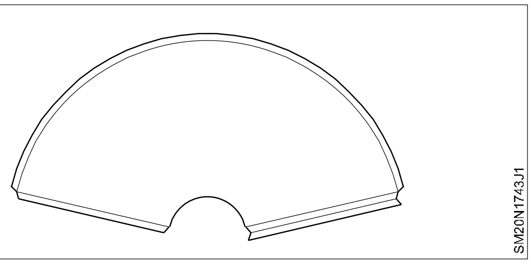
1	250 x 140 x 0.6		ALU - SHEET			43
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	MAKING A FRUSTUM OF CONE WITH LOCKED GROOVE JOINT	DEVIATIONS ±1	TIME 10h
		CODE NO. SM20N1743E1	

Job sequence

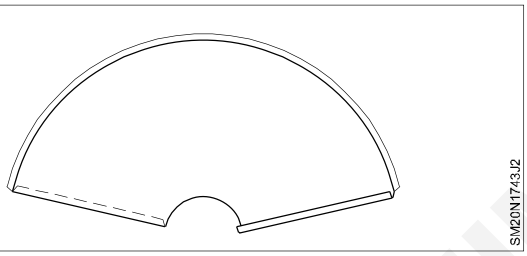
- Flatten the workpiece using a wooden mallet and a tinman's anvil stake. (Fig 1)

Fig 1



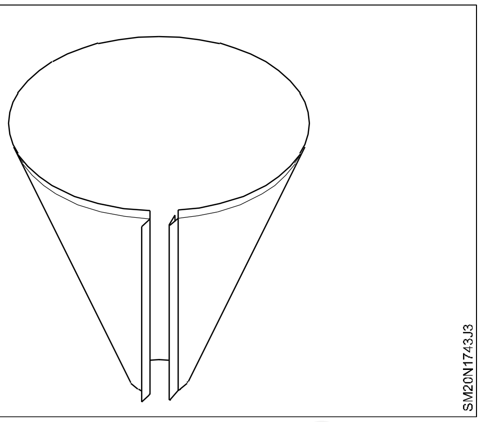
- Check the allowances for the locked grooved joint using a steel rule.
- From hooks on both the ends in opposite directions by using a hatchet stake, a wooden mallet and a $\frac{1}{2}$ Ib ball peen hammer. (Fig 2)

Fig 2



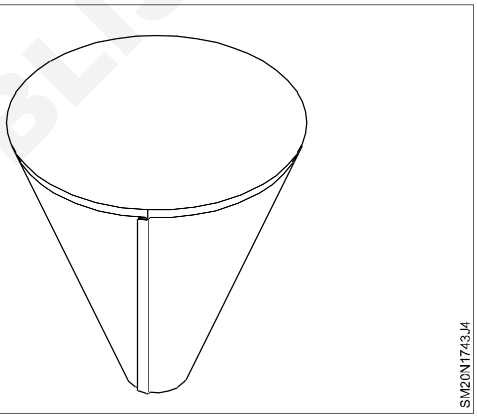
- From the workpiece to the frustum of cone by using a funnel stake. (Fig 3)

Fig 3



- Make a locked grooved joint by using a funnel stake, a hand groover and a 1 $\frac{1}{2}$ Ibs Ball pane hammer. (Fig 4)
- Finish the job using a wooden mallet.
- Check the dimensions of the job by using a steel rule.

Fig 4



Skill sequence

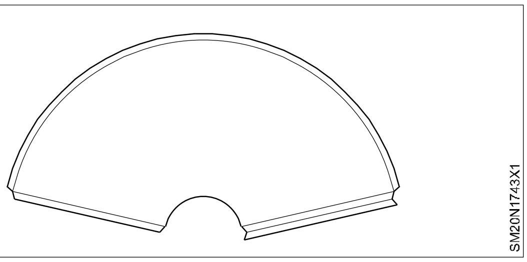
Forming a frustum of a cone with locked grooved joint

Objectives: This shall help you to
- **form a frustum of cone using a funnel stake and a wooden mallet**
- **make locked grooved joint on tapered curved surface using a funnel stake, hand groover and a ball peen hammer.**

Check the pattern and ensure that all the required allowances are provided by using a steel rule as per the job drawing. (Fig 1)

Remove burrs by using a flat file. Mount the hatchet stake on the bench plate.

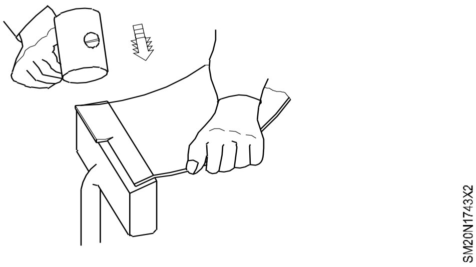
Fig 1



Place the sheet horizontally on the hatchet stake edge at the line marked previously for folding.

With a wooden mallet strike the edge of the job on both ends. (Fig 2) Observe break or fold mark formed.

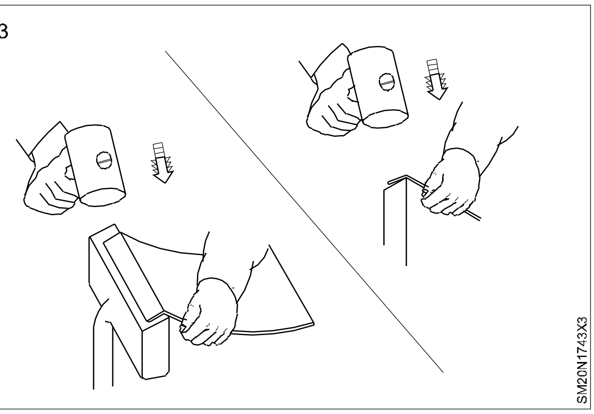
Fig 2



Lower the end of the work slightly using the same angle of striking, increasing the angle of turning.

Repeat the above operation till the edge is turned to the required angle. (Fig 3)

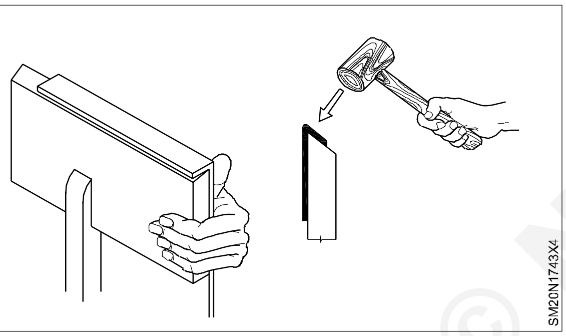
Fig 3



For turning more than 90^0, support the work flat against the face of the stake.

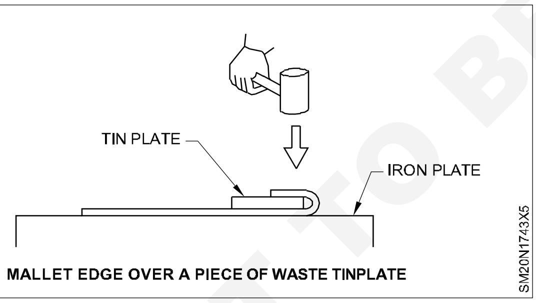
Grip the stake by fingers at 'A' and hold the work in position by thumb. (Fig 4)

Fig 4



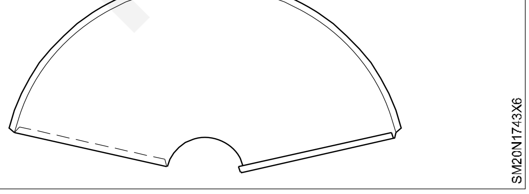
Mallet the edge over a piece of waste tin plate. (Fig 5)

Fig 5



Repeat the same operation on the other edge of the sheet and form hooks. (Fig 6)

Fig 6



Mount the funnel stake on a bench plate. (Fig 7a) Use "long tapered beak horned iron stake" for the cones having small radius, plate. (Fig 7b)

Place one end of the work piece on the funnel stake parallel to the axial line of the stake and bend as shown in Fig 8.

Fig 7

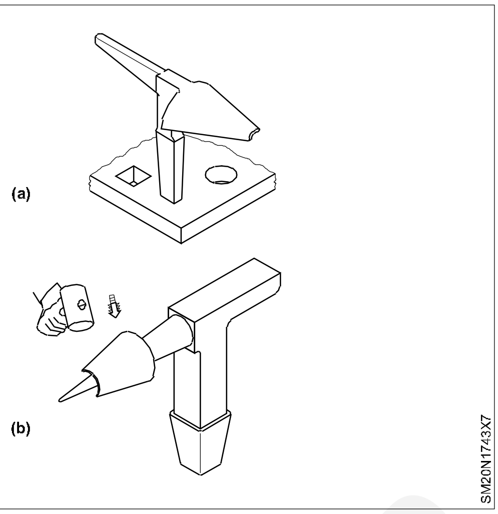
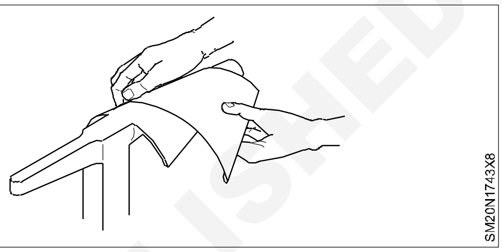
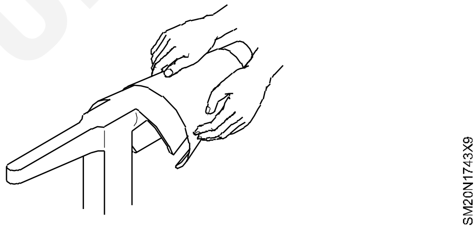


Fig 8



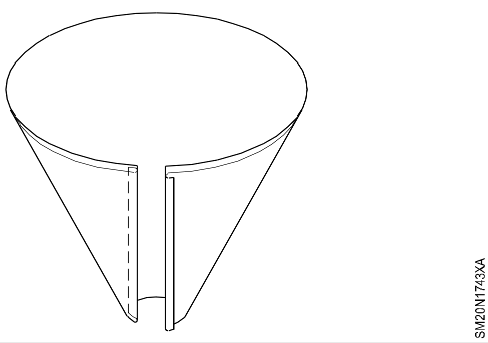
Repeat the same operation on the other end of the workpiece. Bend the workpiece evenly as shown in (Fig 9).

Fig 9



Check the turned up edge of the circular disc and curve it gradually and make both ends to meet together. (Fig 10)

Fig 10



Ensure that the folded edges of the workpiece are parallel, if not the edges will not match as shown in (Fig 11)

Hook the folded edges as shown in Fig 12.

Slowly lock the edges by light blows using a mallet as shown in (Fig 13) Start blows from one end of the joint to the other end to tighten the joint. (Now grooved seam is formed)

Fig 11

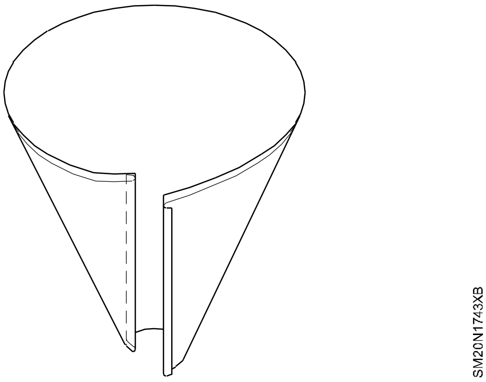


Fig 12

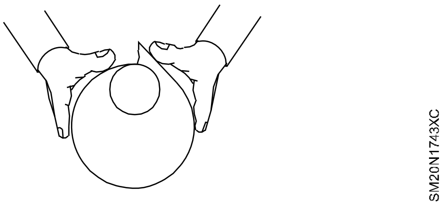
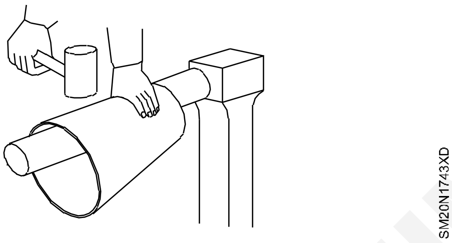


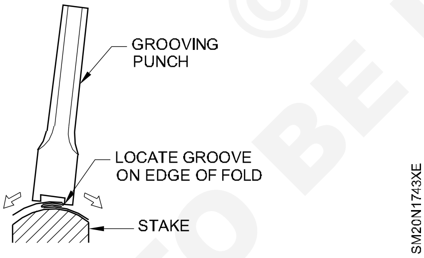
Fig 13



Select the correct size of the groover.

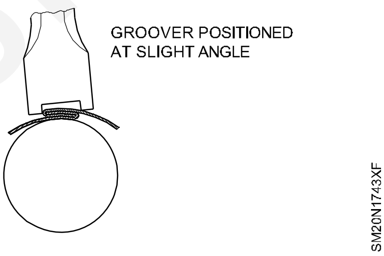
Place the groover over the grooved joint as shown in (Fig 14)

Fig 14



Position the groover at a very slight angle. The edge of joint acts as a guide to the groover. (Fig 15)

Fig 15



Bring the groover to vertical position. (Fig 16)

Strike the top of the groover firmly with ball peen hammer and lock same on the other end. (Fig 17)

Check the ends again to ensure that they are in line. Continue to lock the seam along the line with the hand groover.

Fig 16

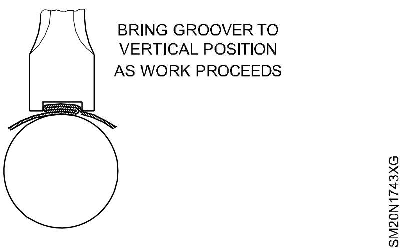
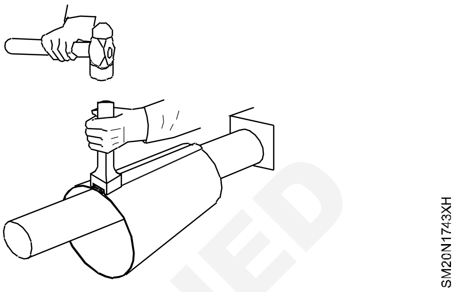


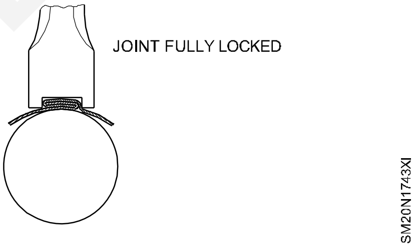
Fig 17



Now the joint is fully locked. (Fig 18)

Finally smoothen with a mallet all over the body and check the dimensions as per the job drawing by using a steel rule.

Fig 18



In order to get proper setting of seam of the required size, it is necessary to use the correct size of a groover. If not, the seam is set too wide or too narrow. See Fig 19, 20,21.

Fig 19

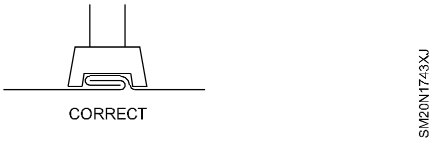


Fig 20

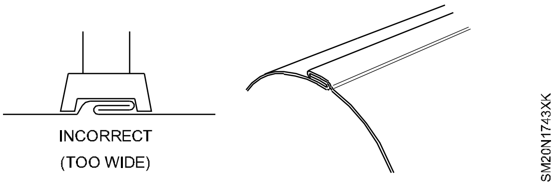
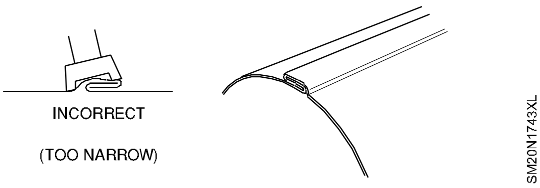
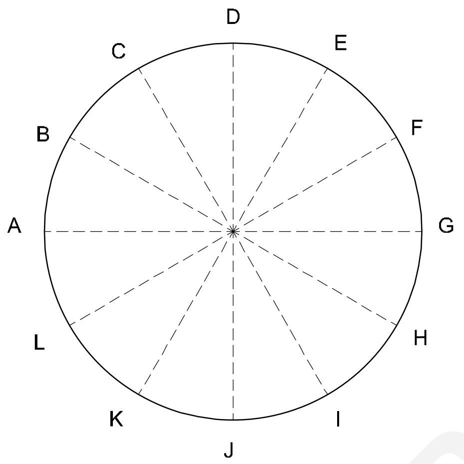


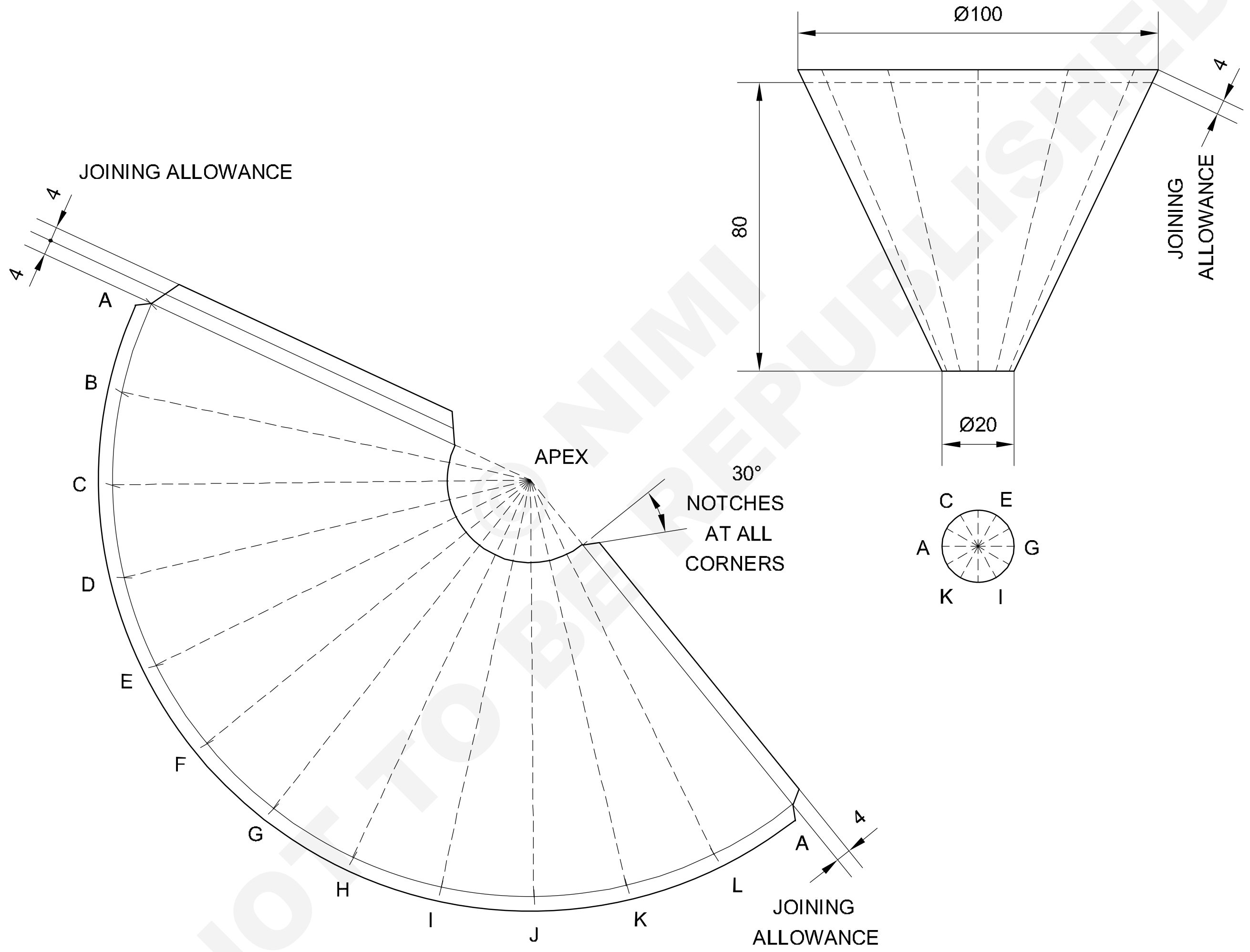
Fig 21



Job sequence

- Develop and layout the pattern for the body of a funnel frustrum of a cone) on a plain drawing paper using a geometry box (instrument box).
- Cut the layout pattern using scissors and paste it on the given raw material using fevicol/gum.
- Cut the Sheet metal on the outlines of the layout pattern of the paper so pasted, using a straight and bend snips.





1	ALU 250 x 140 x 0.5		ALUMINIUM			43
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	BY RADIAL LINE METHOD	DEVIATIONS ±1	TIME 10h
		CODE NO. SM20N1743E2	

Develop and layout the pattern for the frustum of a cone by radial line method

Objective: This shall help you to

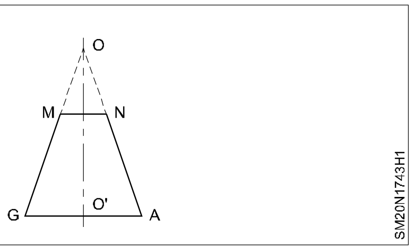
- **develop and layout the pattern for the frustum of a cone by radial line method**

Get a plain drawing paper large enough to make the flat pattern layout.

Draw the elevation of the frustum of a cone in full size 'AGMN' in Fig 1.

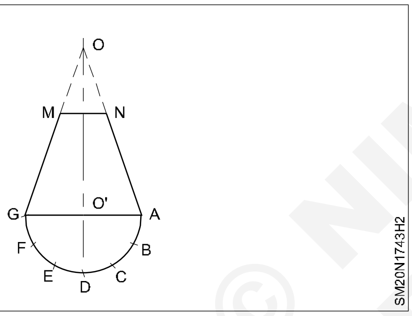
Continue the lines showing taper sides of the body till they intersect at a point 'O'. 'O' is called as an 'Apex'. (Fig 1)

Fig 1



Taking O' as the centre and O'A as radius, draw an arc AG and divide it into six equal parts A-B-C-D-E-F-G. (Fig 2)

Fig 2



With centre 'O' draw arcs AX and NY. X&Y are the points on the centre line of the frustum of a cone. (Fig 3)

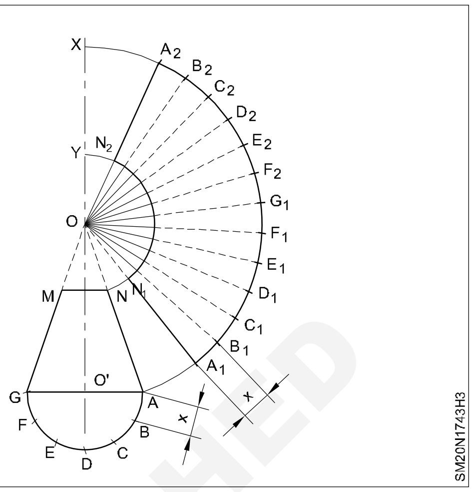
Take distance 'X' and mark off twelve lines along the arc AX to obtain A^1-B^1-C^1-D^1.... to D^2-C^2-B^2....A^2. (Fig 3)

Join the points A^1,B^1,C^1......C^2,B^2,A^2 to the point 'O'.

The development required is then A^1 A^2 N^1 N^2.

This is the development of a frustum of a cone without a joining allowance.

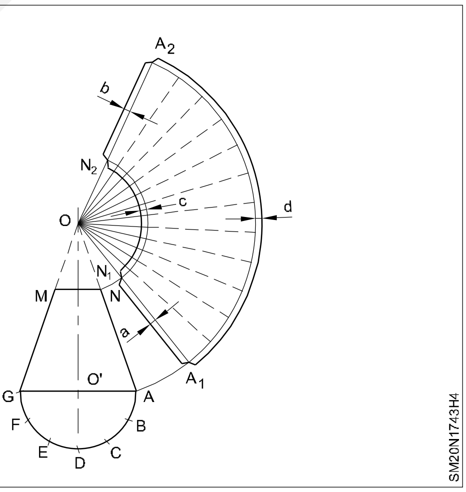
Fig 3



Now add joining allowances 'a' & 'b' by drawing lines parallel to A^1N^1 & A^2 N^2. (Fig 4)

Add hemming or wiring or joining allowance 'c' & 'd' by drawing arc inside the arc N^1 N^2 and outside the arc A^1 A^2. (Fig 4)

Fig 4



Capital Goods & Manufacturing
Sheet Metal Worker- Advanced Sheet Metal Processes

Exercise 1.7.44

Introduction to machinary safety including fire fighting equipment their uses

Objectives: At the end of this exercise you shall be able to
- **name the machinery used in welding shop**
- **record the name and its uses of each machine in given table.**

Fig 1

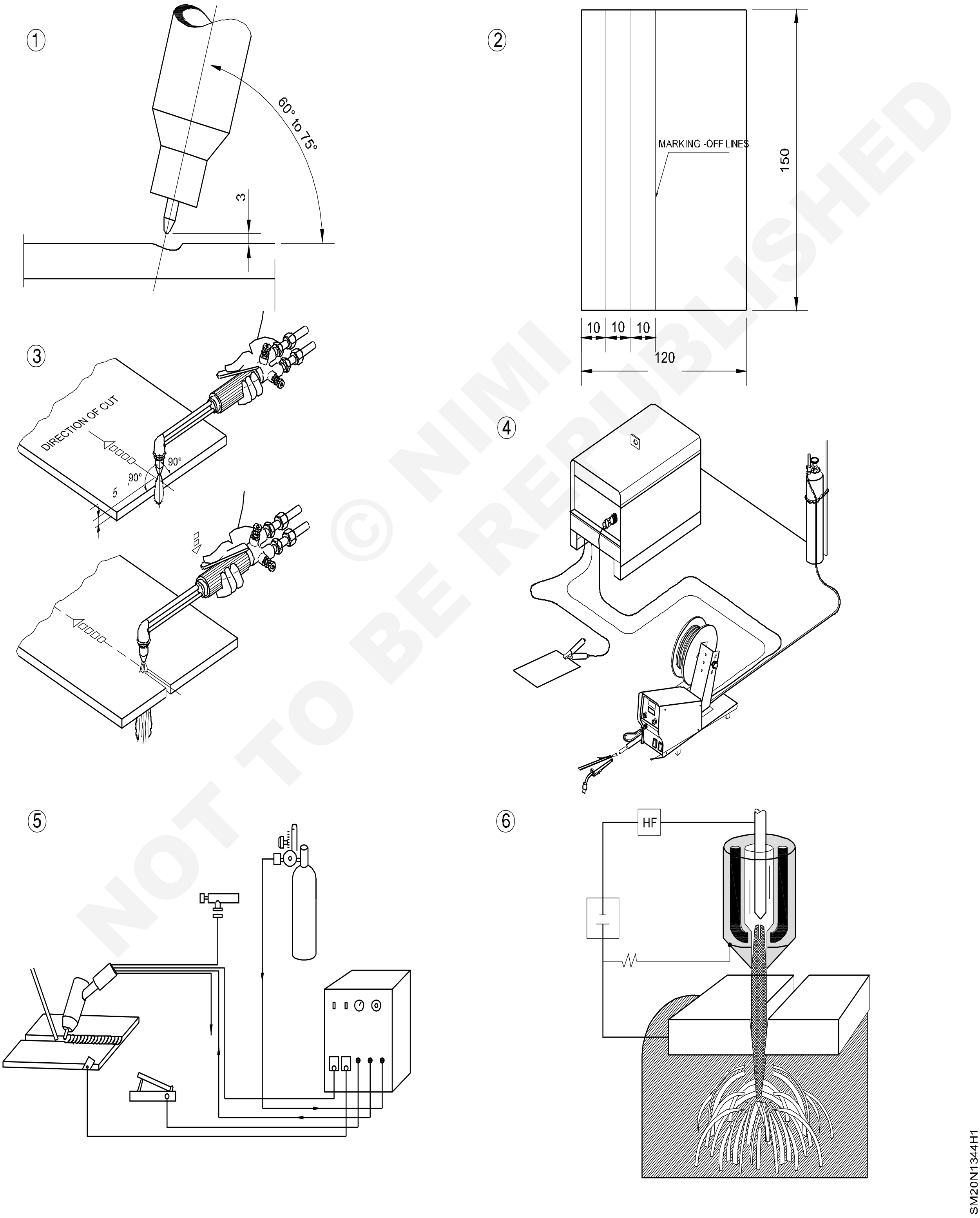


Fig 2

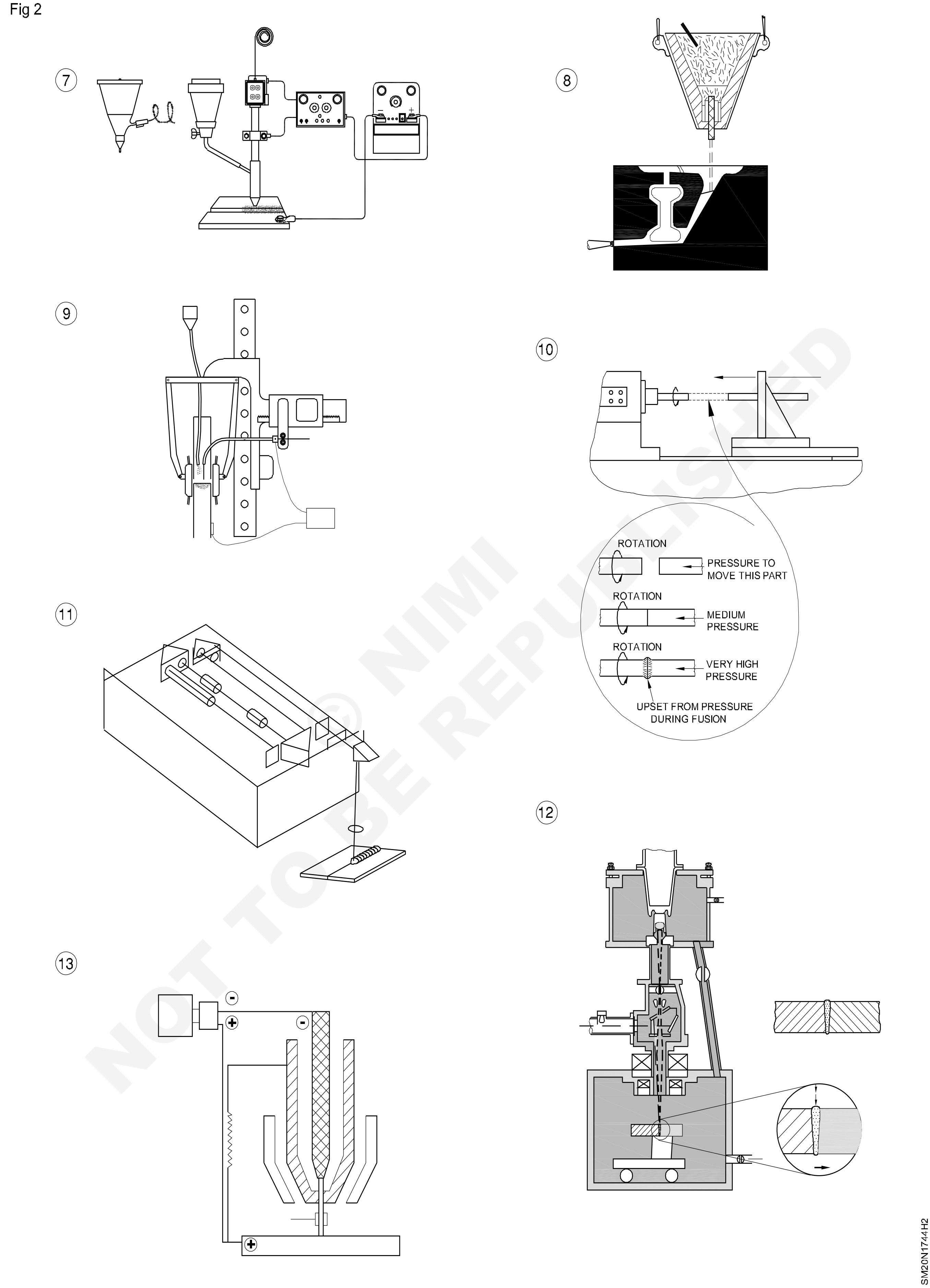

7
8
9
10
ROTATION
PRESSURE TO MOVE THIS PART
ROTATION
MEDIUM PRESSURE
ROTATION
VERY HIGH PRESSURE
UPSET FROM PRESSURE DURING FUSION
11
12
13
-
+
-
+
SM20N1744H2

Fig 3

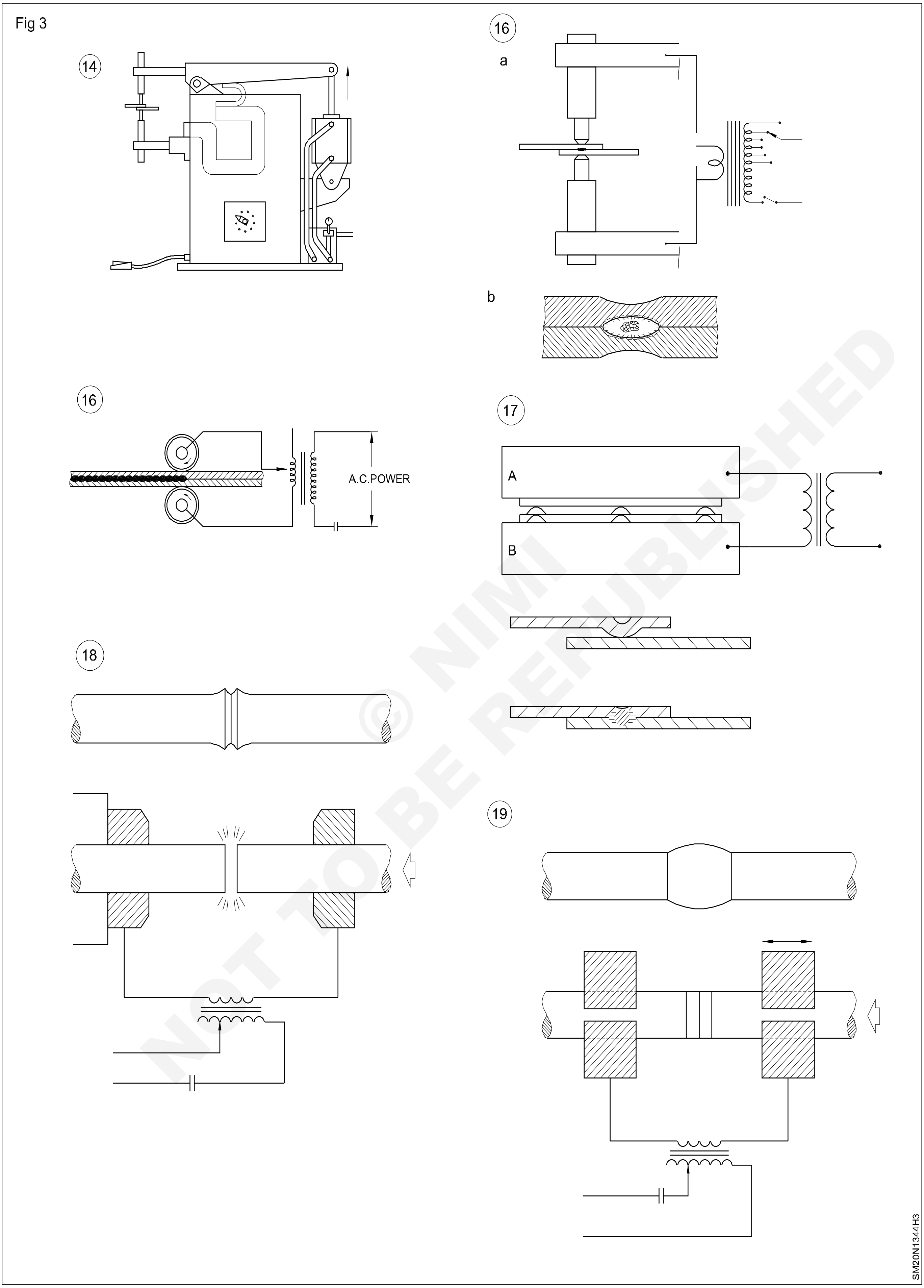
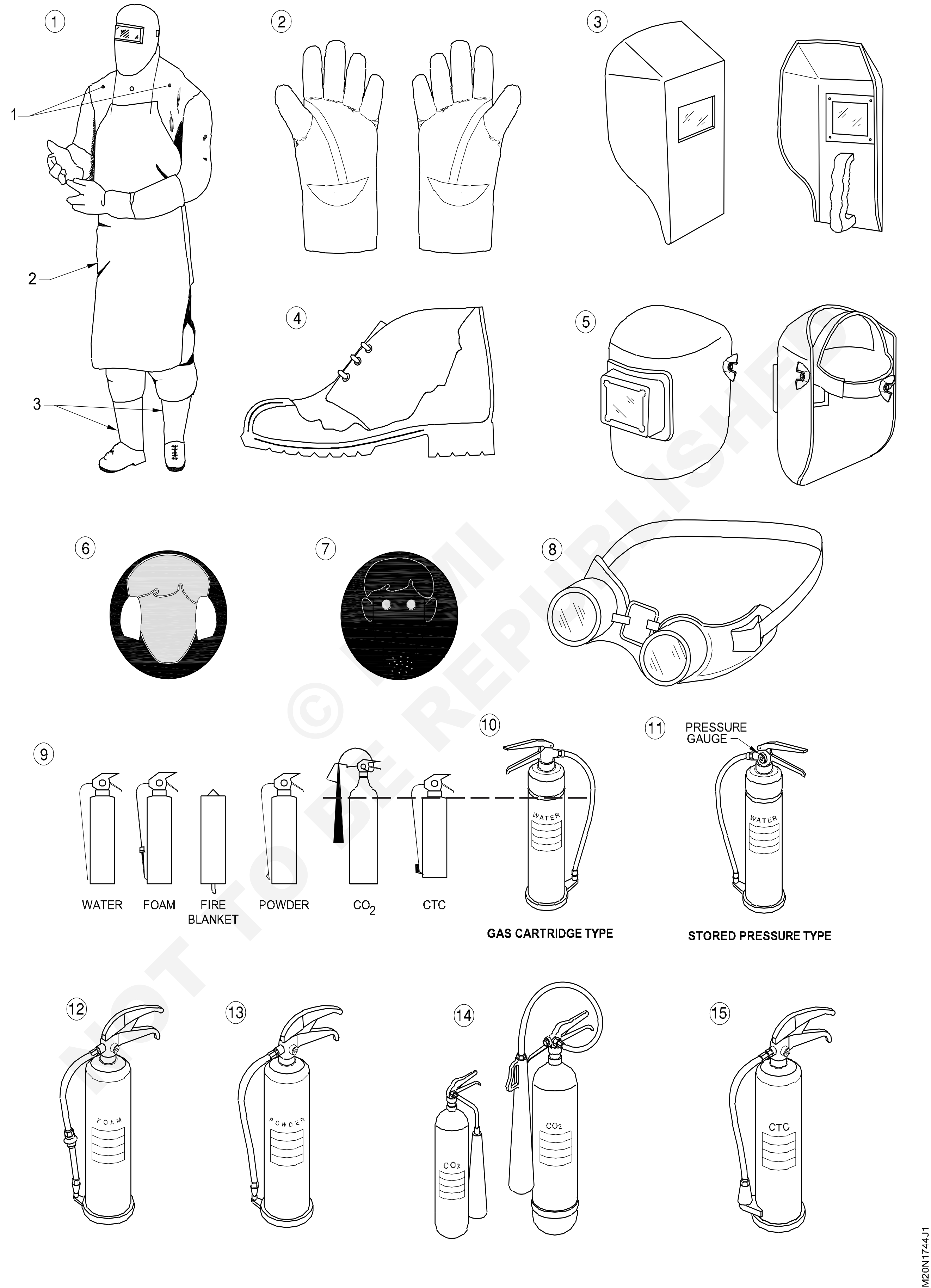


Fig 1



①
1
2
3
②
③
④
⑤
⑥
⑦
⑧
⑨
WATER
FOAM
FIRE BLANKET
POWDER
CO_2
CTC
⑩
WATER
GAS CARTRIDGE TYPE
⑪
PRESSURE GAUGE
WATER
STORED PRESSURE TYPE
⑫
FOAM
⑬
POWDER
⑭
CO_2
CO_2
⑮
CTC
SM20N1744J1

PROCEDURE

TASK 1: **Machinery and their uses.**

1 Identification of machinery in workshop

2 Machinery and their uses and name mentioned

Table 1

SL.No	Machinery Name	uses
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

SL.No	Machinery Name	uses
11		
12		
13		
14		
15		
16		
17		
18		
19		

3 Checked the Instructor

— — — — — — — —

TASK 2: **Safety Device and their uses**

1 Identification of original hols (or) Safety dives reading of table 1.

2 Suitable of safety dives identification of table1

Table – 1

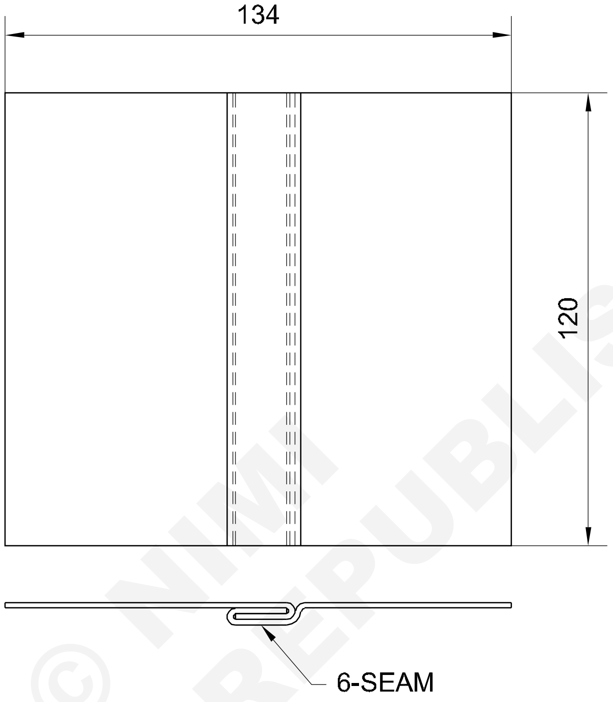
Sl. No	Name PPE	Dangers	Method of safety

3 Checked the Instructor

— — — — — — — —

Practice on locked grooved joint by aluminium sheet

Objectives: At the end of this exercise you shall be able to
- **determine and mark the joining drawing allowances for locked grooved joint**
- **make the locked grooved joint using a hand groover.**



Job sequence

Locked grooved joint (seam)

- Mark and cut the raw material into two pieces of size 100 mm x 75 mm each.
- Flatten the workpieces.
- Determine the fold size of the given seam.
- Mark the straight lines for folding on the two sheets using a steel rule and a scriber.
- Fold the two pieces to an acute angle on the marked line using a hatchet stake steel plate and a mallet to form the hooks.
- Make the folded widths flat by filling with a scrap band sheet of approximately 1.5 times thickness of sheet and pressing with a mallet to get the pocket for lock.
- Interlock the folds and press the joint.
- Using a hand groover lock the joint and finish.

1	ISSH 125 x 160 x 0.508	--	G.I SHEET	--	--	45
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:2	PRACTICE ON LOCKED GROOVED JOINT				DEVIATIONS ±1	TIME 5h
					CODE NO. SM20N1745E1	

Skill sequence

Marking and Forming

Objectives: At the end of this exercise you shall be able to
- **mark the allowance for double hemming**
- **make double hemming at the edges of a sheet metal using a hatchet stake.**

First determine the fold size for the given width of the seam.

Fold size = Width of the lock - 3 times the material thickness.

New from the fold size determine the total allowance for the locked grooved joint.

Total allowance = (3 x the fold size) + (6 x the thickness of the sheet)

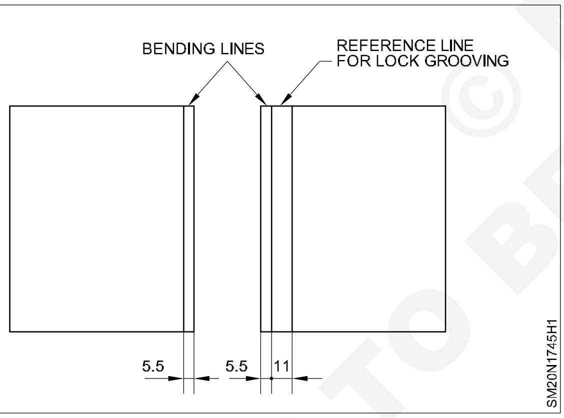
For example, if the width of the lock is 6mm and the thickness is 0.5 mm then, the fold size = 6 - (3 x 0.5) = 4.5mm

The total allowance = (3 x 4.5) + (6 x 0.5) = 13.5+3=16.5mm.

Mark the line at a distance of $1/3^{rd}$ of the total allowance on one sheet and two lines at a distance of $1/3^{rd}$ and $2/3^{rd}$ of the total allowance on another sheet.

For example, if the total allowance is 16.5 mm then, mark the line at a distance of 5.5mm from the edge on one sheet and two lines at a distance of 5.5mm and 11.00mm from the edge on another sheet (Fig 1)

Fig 1



Fold the workpiece to more than 90^0 on the hatchet stake using a wooden mallet (Fig 2) and then place the band sheet of 1.5 times the thickness as shown in Fig 3 and flatten the edge using the wooden mallet. This looks like a hook.

Fig 2

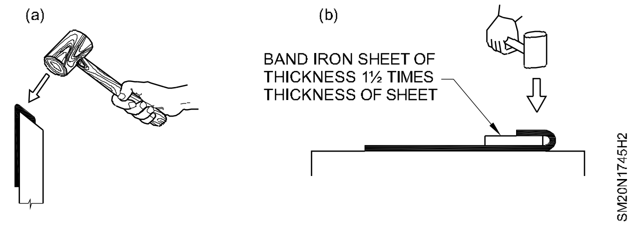
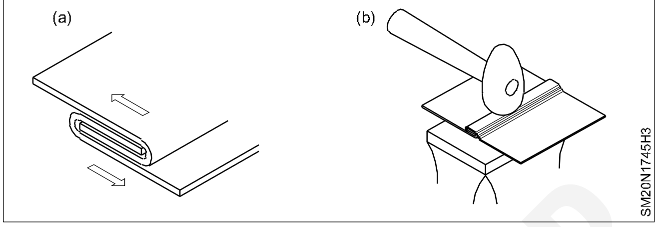


Fig 3

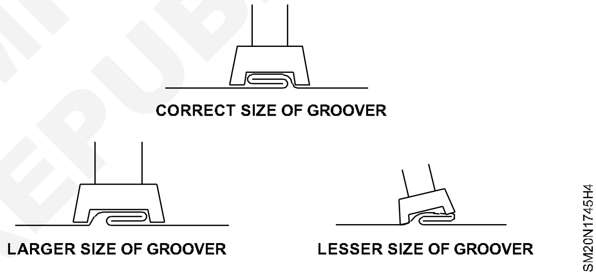


Make a similar hook on the other workpiece also.

Interlock and place the workpiece on the dressing plate. (fig 4)

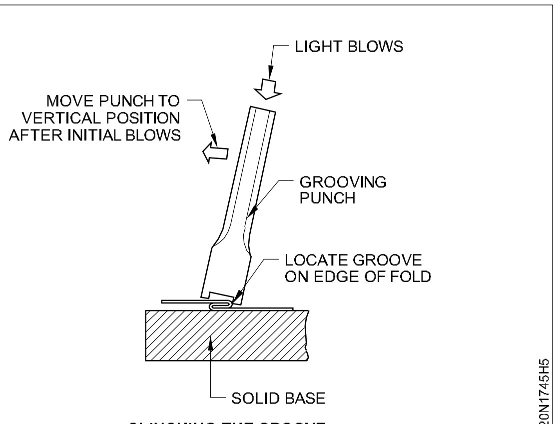
While interlocking, ensure that the interlock is parallel and tight at both ends visually.

Fig 4



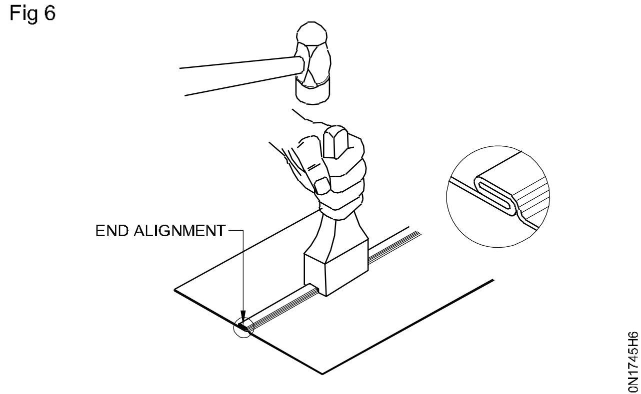
Press the joint to close down using the wooden mallet, to get the grooved joint (seam). (fig 5)

Fig 5



CLINCHING THE GROOVE

Fig 6



GROOVING

Select the hand groover of a given width of the lock (seam). If proper size groover is not used, it may cause improper locking of the grooved joint (fig 6)

Place the groover over the fold at one end as shown in fig 7.

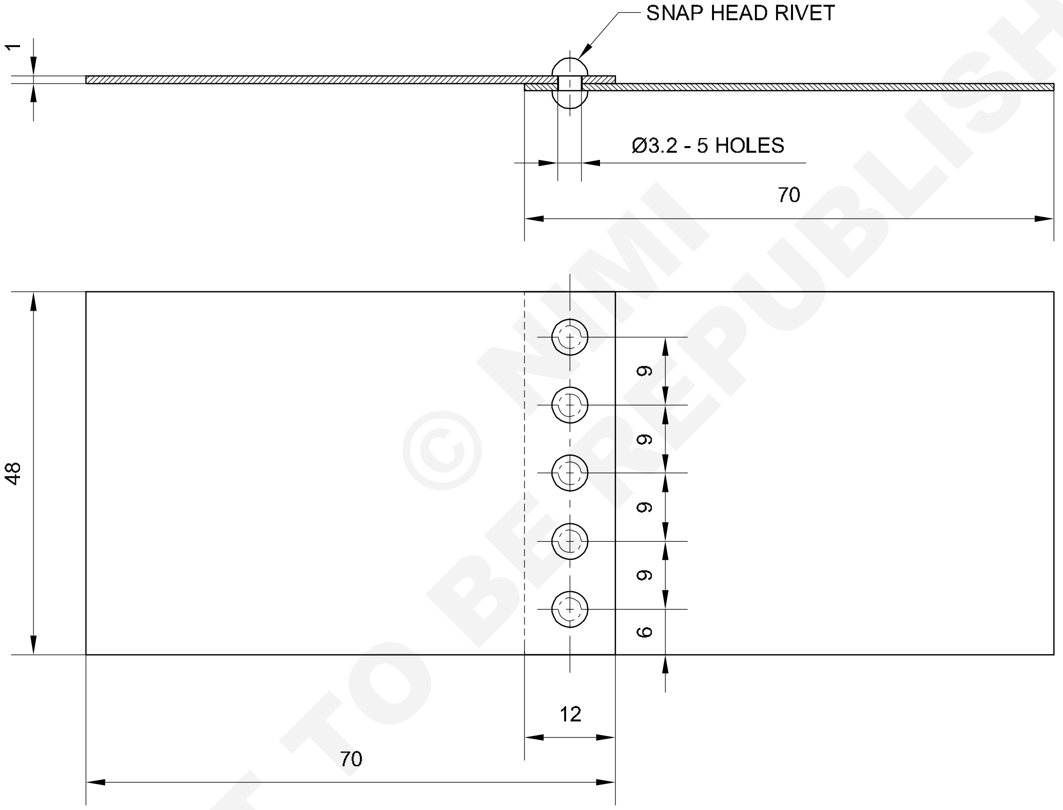
Hold the hand groover in one hand and strike the top of the groover with ball pen hammer by the other hand and clinch the groove. Similarly clinch the groove at the other end.

Advance this work every 1/3 of the groover length, until the entire groove is clinched down (fig 8)

Finish the locked grooved joint (seam) with the hand groover and the hammer.

Single riveted lap joint by aluminium sheet

Objectives: At the end of this exercise you shall be able to
- **layout the spacing for rivet holes to make single riveted lap joint**
- **drill the correct size holes using a power operated portable drilling machine**
- **rivet the snap head rivets with the help of a rivet set, a rivet snap, a dolly using ball peen hammer, to make single riveted lap joint without a slack.**



5	IS:2155 - Ø3 - 6	--	M.S. SNAP HEAD RIVET	--	--	46
1	ISSH 145 x 52 - 1.2	--	MILD STEEL SHEET	--	--	46
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1

**SINGLE RIVETED LAP JOINT BY
ALUMINIUM SHEET**

DEVIATIONS ±0.6

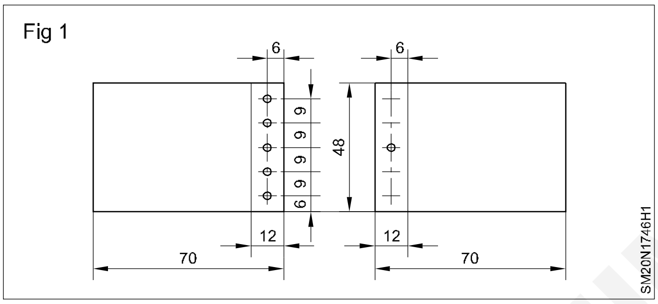
TIME 5h

CODE NO. SM20N1746E1

Job Sequence

- Cut and check the given material to the size 140 mm x 48 mm using a steel rule.
- Flatten the sheet on the dressing plate by a mallet.
- Deburr the edges using a flat smooth file.
- Mark the centre line of length 140 mm and cut the sheet into two pieces of size 70 x 48 using straight snips.
- Layout the spacing for rivet holes to make single riveted lap joint using a scriber and a steel rule on both pieces of the sheet, and mark the centre points of rivet holes using a centre punch and a setting hammer. (See Fig 1 & 2 of Skill sequence)
- Drill ϕ 3.2 holes on all centre points on one piece of the sheet and one central hole on another piece of sheet using a power operated portable drilling machine. (Fig 1)

Fig 1



- Deburr the holes with larger sized drill rotating it on drilled holes, by hand. (Fig 2)
- Place the piece of sheet having all holes drilled above another, such that the overlapped edges of the sheets coincide with the marked lines.
- Insert 3 mm dia snap head rivet in the centre hole. (Fig 3)

Fig 2

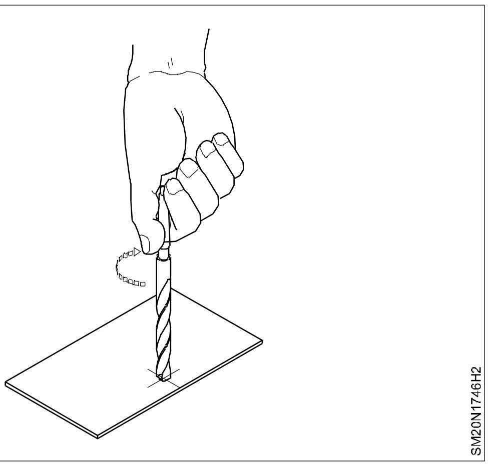
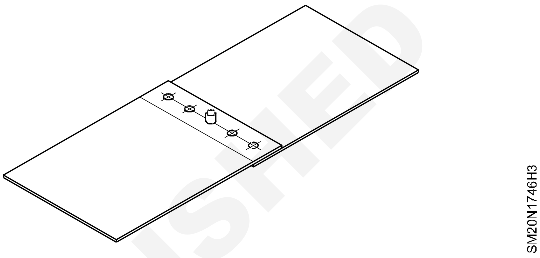


Fig 3



- Form the rivet head, with the help of the rivet snap and dolly using ball peen hammer.
- Drill the remaining four holes on the bottom piece of the sheet, through the holes, already drilled on the upper piece of the sheet.
- Deburr the holes with the larger sized drill, rotating it on the drilled holes, by hand.
- Insert the rivets in alternate holes and form the rivet heads, one by one to make a single riveted lap joint, with the help of a rivet set, rivet snap, a dolly and a ball peen hammer.

Skill Sequence

Layout the spacing for rivet holes to make a single riveted lap joint

Objectives: This shall help you to

- **calculate the distance of the lap, the distance between centre of first rivet and edges and the distance of pitch as per BIS standard**
- **layout the spacing for rivet holes to make a single riveted lap joint.**

Ensure the edges of the workpieces to be joined are free of burr and straight.

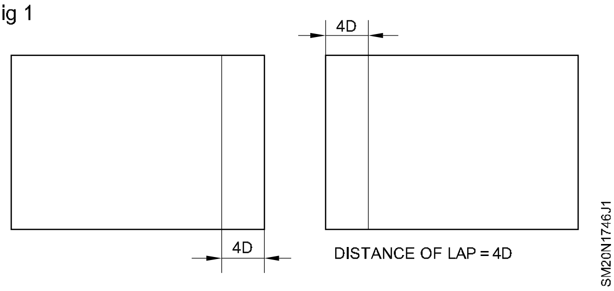
Calculate the distance of the lap.

Distance of the lap = 4 x Dia of the rivet (D)

Diameter of the rivet = 2.5 or 3t from the known thickness, calculate the dia of the rivet, and calculate the distance of the lap.

Mark the line of distance of the lap parallel to the edge, on both workpieces using a scriber and a steel rule. (Fig 1)

Fig 1

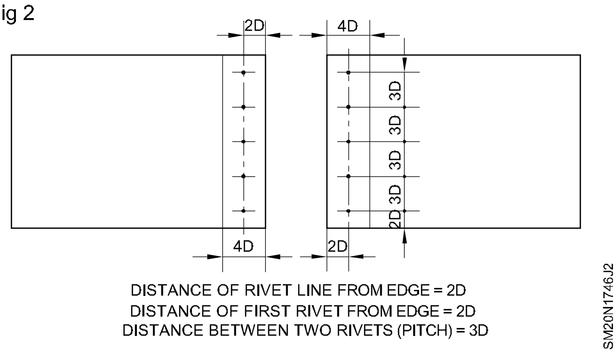


Calculate distance of the rivet line from the edge of the sheet.

Distance of the rivet line from the edge = 2 x the diameter of the rivet (D)

Mark the rivet lines parallel to the edge, on both workpieces (Fig 2).

Fig 2



Calculate the distance of the first rivets from the side edge.

Distance of the first rivet from the edge = 2 x dia of rivet (D)

Mark the distance of the first rivets from the side edges on the rivet line, on both the workpieces using a divider.

Calculate the distance between two rivets i.e. pitch.

Pitch = 3 x the dia of rivet (D)

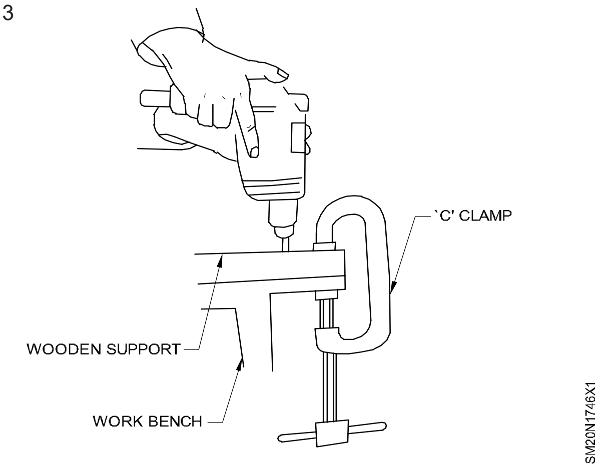
Mark the pitch of the rivets on the rivet lines, on both workpieces (Fig 2) using a divider.

Punch the centre points of the reivets using a centre punch and a setting hammer.

Place the workpiece on a suitable wooden support and clamp with the help of a 'C' clamp.(Fig 3)

Hold the butt of the portable drilling machine in one hand and grasp the gun with fore finger and thumb of the other hand, such that the drill is perpendicular to the surface of the metal to be drilled. (Fig 3)

Fig 3



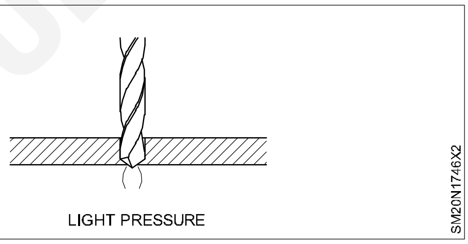
Switch 'ON' the trigger switch with second finger.

Apply pressure on the drill chuck till you get the hole.

While drilling by electric operated portable drilling machine on a sheet metal, light pressure should be applied otherwise, the drill will stall or pick up the workpiece.(Fig 4)

Switch off the drilling machine after the drilling is completed. Deburr the holes by larger sized drill bit by rotating it on the drilled hole by hand.

Fig 4



Riveting snap head rivet

Objectives: This shall help you to
- **make proper use of the dolly, rivet set and rivet snap to perform correct riveting**
- **rivet snap head rivet to make the riveted joint tight without damaging the base metal.**

Ensure that all the rivet holes are drilled on one sheet and only one hole for the centre rivet is drilled on another sheet.

Ensure that the drilled holes are deburred and the sheets are flat.

Hold vice dolly rigidly in the bench vice.

Place the sheet having all holes drilled over the other, align the drilled hole and coincide the marked lines for lap with the edges.

Insert the rivet in the centre hole and place the rivet head on the vice dolly, to avoid deformation, while hammering. (Fig 1 & 2)

Place the deep hole of the rivet set over the shank of the rivet. (Fig 3)

Fig 1

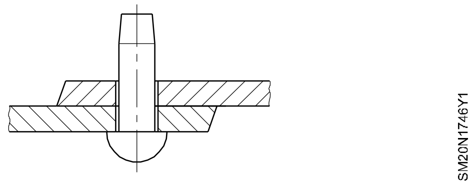
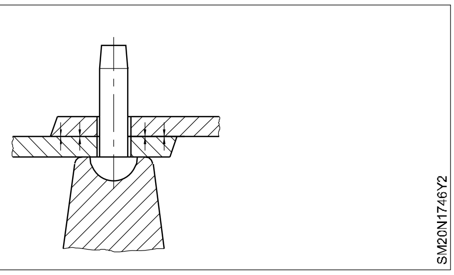
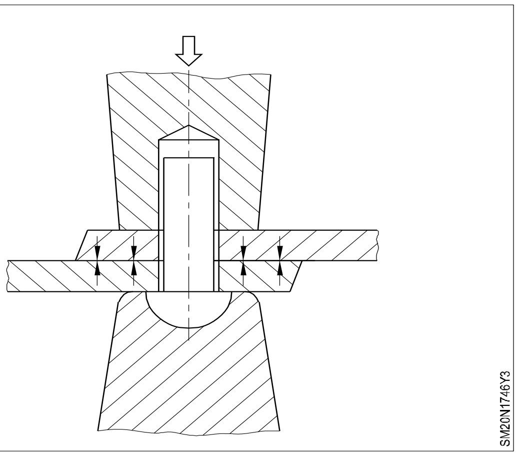


Fig 2



Strike the rivet set with a ball peen hammer to bring the sheets closer, to set the joint firmly for riveting. (Fig 3)

Fig 3



Remove the rivet set over the shank of the rivet.

Form the rivet head roughly by hammering it down initially and then rounding the head using a ball peen hammer. (Fig 4 & 5)

Fig 4

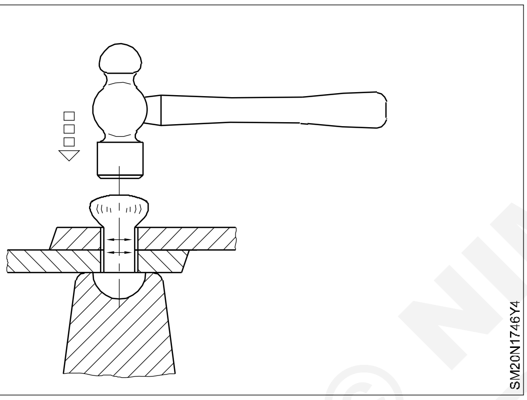
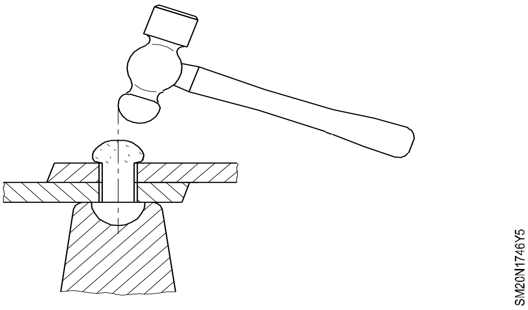
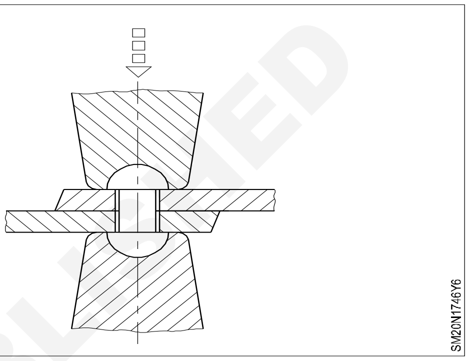


Fig 5



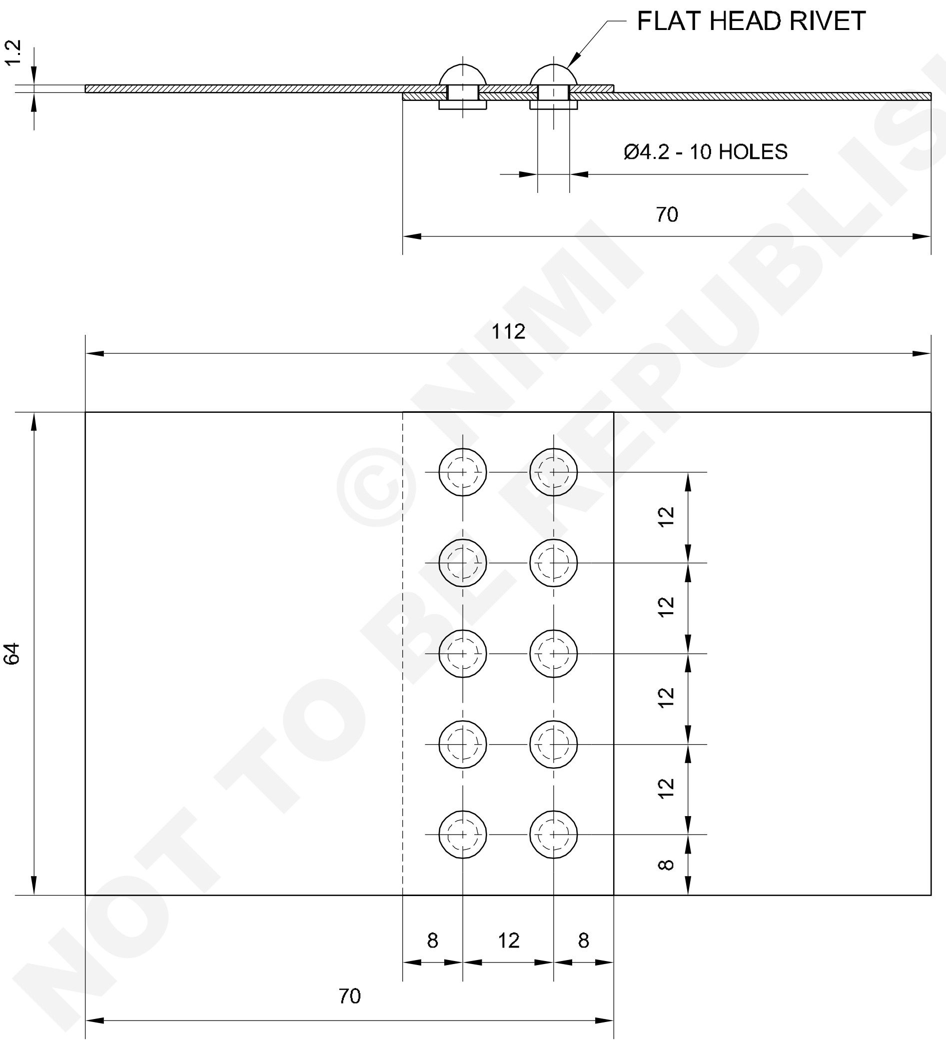
Place the rivet snap over the rounded head of the rivet and strike with a hammer over it to form and finish the rivet head using a ball peen hammer. (Fig 6)

Fig 6



Double strap single row riveted butt joint by aluminimum shut

Objectives: At the end of this exercise you shall be able to
- **Mark and cut the sheet metal safely using a hand lever bench shears**
- **layout the spacing of rivets to make double riveted lap joint (chain) correctly**
- **make double riveted lap joint (Chain), to join sheet metal pieces with the required strength and without slackness**
- **remove faulty rivets from sheet metal riveted joints by drilling**
- **remove faulty rivets from sheet metal riveted joints by punching.**



10	IS: 2155- Ø4 x 6	--	M.S. FLAT HEAD RIVET	--	--	47
1	ISSH 145 x 70 - 1.2	--	MILD STEEL SHEET	--	--	47
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1

DOUBLE RIVETED LAP JOINT (CHAIN SEAM)

DEVIATIONS ±0.6

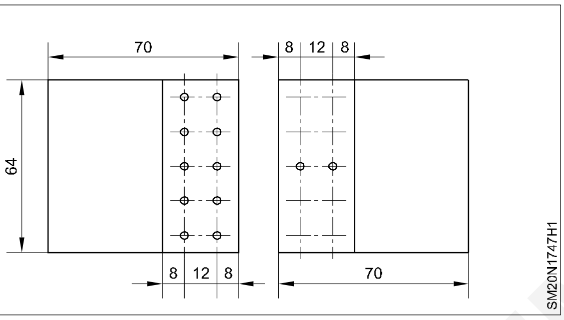
TIME 5h

CODE NO. SM20N1747E1

Job Sequence

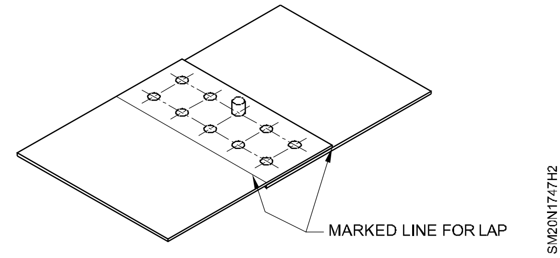
- Cut the given material in two pieces to size 65 x 70 using hand lever bench shears and check the size using a steel rule.
- Flatten the sheet on the dressing a plate by mallet.
- Deburr the edges using a flat smooth file.
- Layout the spacing for rivet holes to make double riveted lap joint using a scriber, a divider and a steel rule on both the pieces of the sheet.
- Mark the centre point for the rivet holes using a centre punch and a setting hammer.
- Drill ϕ 4.2 mm holes at all the points on one piece of the sheet and two centre holes on another piece of sheet using a portable drilling machine. (Fig 1)

Fig 1



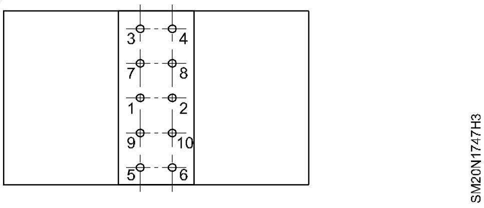
- Deburr the holes with larger sized drill rotating it on the drilled holes by hand.
- Place the piece of sheet having all holes drilled above another such that the edges of the sheet coincides with the marked line for lap. (Fig 2)
- Insert ϕ 4 mm snap head rivet in the centre hole. (Fig 2)

Fig 2



- Form the rivet head with the help of a rivet set and dolly using a ball peen hammer.
- Check that the two sheets are in line using a straight edge.
- Drill the remaining holes on the bottom piece of sheet through the holes, already drilled on the upper piece of sheet.
- Deburr the holes with larger sized drill, rotating it on the drilled holes by hand.
- Insert the rivets in alternate holes and form the rivet heads one by one to make double riveted lap joint (chain) with the help of a rivet set, a dolly and a ball peen hammer. (Fig 3)

Fig 3



Skill Sequence

Layout the spacing for rivet holes to make double riveted lap joint (chain seam)

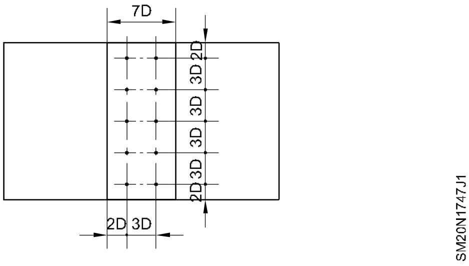
Objectives: This shall help you to

- **determine the distances between the rivets, distances from the edges of the sheet metal and layout the spacing of rivets to make double riveted lap joint correctly.**

Calculation for layout the spacing of rivet holes is similar as single riveted lap joint except the horizontal distance between the two rivets rows is thrice the rivet diameter.

Fig 1 shows the layout for spacing of the rivet holes to make double riveted lap joint (chain), on one sheet. Similarly the layout on another sheet to be made and riveted.

Fig 1



Removing rivets from sheet metal by drilling

Objectives: This shall help you to

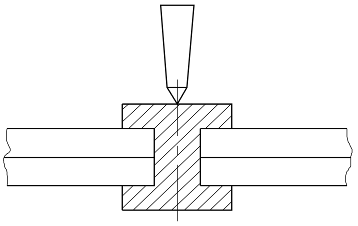
- **remove the rivets from the sheet metal by drilling without damaging the metal.**

The most satisfactory method of removing a rivet on light gauge sheet metal is by drilling.

Carry out the following steps:

– Flatten the rivet head by ball peen hammer and punch the exact centre of the formed head using a centre punch. (Fig 1)

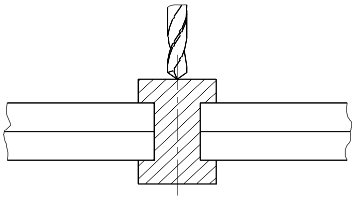
Fig 1



CENTRE-PUNCH HEAD

– Select a twist drill slightly smaller than the shank dia of the rivet. (Fig 2)

Fig 2

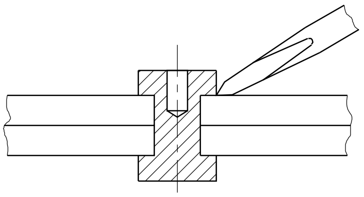


DRILL HEAD

– Drill into the head of the rivet just up to the top surface of the metal. (Fig 3)

– Remove the rivet head with a cold chisel. (Fig 3)

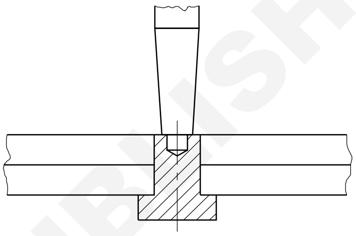
Fig 3



KNOCK HEAD OFF WITH CHISEL

– Place the head of the rivet over a nut, of larger diameter than the head of the rivet. With a solid punch slightly smaller than the size of the rivet shank, drive out the rivet by striking with a ball peen hammer. (Fig 4)

Fig 4



DRIVE RIVET OUT WITH PUNCH

Another simple method for removing the rivets is to cut off the formed head using a sharp cold chisel. The remainder of the rivet is removed with a solid punch, by hammering.

Precaution

The metal should not be distorted.

The rivet hole should not be elongated.

Removing rivets from sheet metal by punching

Objectives: This shall help you to

- **remove the rivet from the sheet metal by punching, without damaging the sheet metal.**

Place the rivet on a solid stake with formed head at upper side, in case of flat head rivet. Use dolly as a support Fig 1 in case of snap head rivet. Flatten the formed head with ball peen hammer to reduce the thickness of the formed head, to approx 1 mm. (Fig 2)

Fig 1

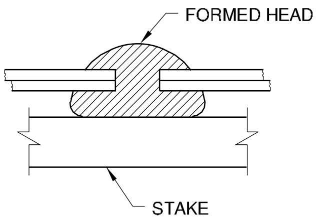
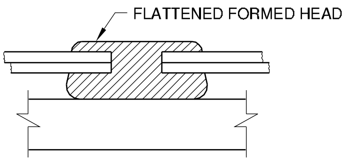
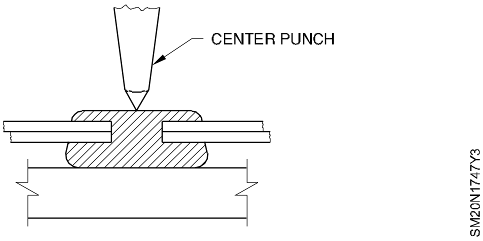


Fig 2



Punch the centre of the head using a centre punch. (Fig 3)

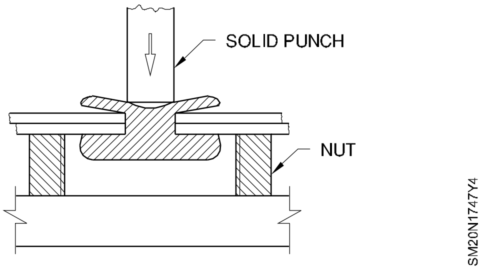
Fig 3



Place the head of the rivet over a nut or a hollow bush of a larger dia than the head of rivet. (Fig 4)

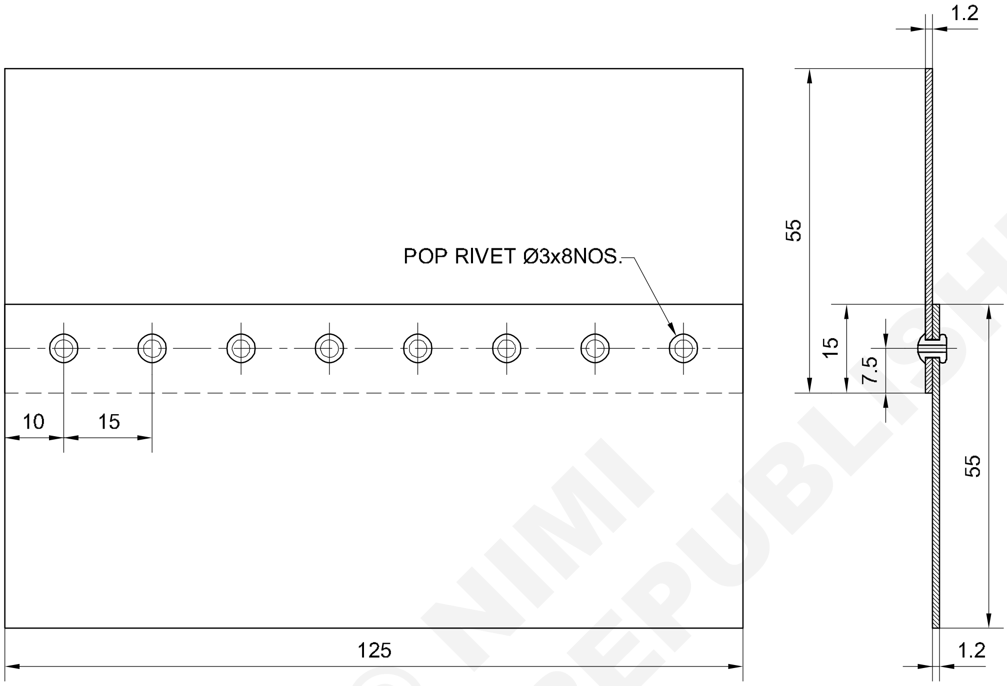
Hold the solid punch of diameter less than the rivet diameter vertically at the centre point already punched and strike with the hammer till the shank comes out of the sheet. (Fig 4)

Fig 4



Pop riveting on Alu. sheet using lazy tong

Objective : At the end of this exercise you shall be able to
- **make holes by using punching machine.**



Job sequence

- Check and cut the material into two pieces of size 125 x 55 mm, using a straight snip.
- Mark on two workpieces as per the job drawing using a steel rule and a scriber.
- Punch the centre points using a centre punch and a ball peen hammer.
- Place two workpieces one above the other, align the edges and line for overlap and clamp with 'C' clamps at both ends. Using a wooden support, drill all holes with ϕ3.2 straight shank drill by portable power operated hand drilling machine.
- Insert the rivet in the lazy tong, position the tong at the rivet hole and complete the pop riveting process.
- Repeat the same process and complete the riveted joint.

8	IS - Ø3 - 12	--	ALU. POP RIVET	--	--	48
1	ISSH 130 x 120 - 1.2	--	ALUMINIUM SHEET	--	--	48
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	POP RIVETING ON ALLUMINIUM SHEET USING LAZY TONG	DEVIATIONS ±0.5	TIME 10h
		CODE NO. SM20N1748E1	

Skill sequence

Using a lazy tong (hand operated) mechanism

Objectives: This shall help you to
- **identify the lazy tong (hand operated)**
- **operate the lazy tong for making pop riveted joint**
- **make pop riveting using a lazy tong (hand operated).**

Drill correct size holes in loctions according to the rivet size.

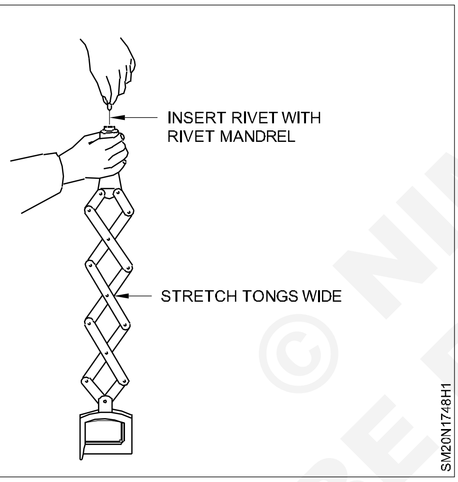
Fit the suitable nosepiece in the body to accommodate the required diameter of the rivet. Ensure that the nosepiece is firmly screwed.

Extend the lazy tong mechanism to its full length. (Fig 1)

Insert the rivet with rivet mandrel into the nosepiece. (Fig 1)

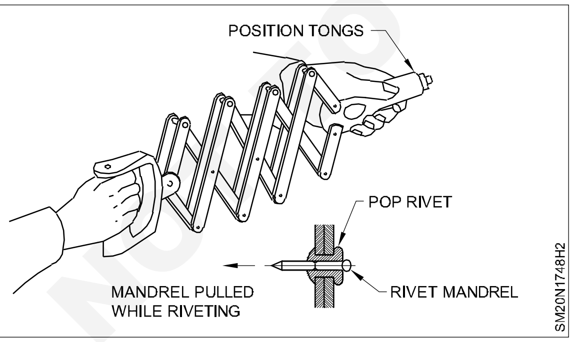
Position the rivet firmly in place in the structure to be riveted.

Fig 1



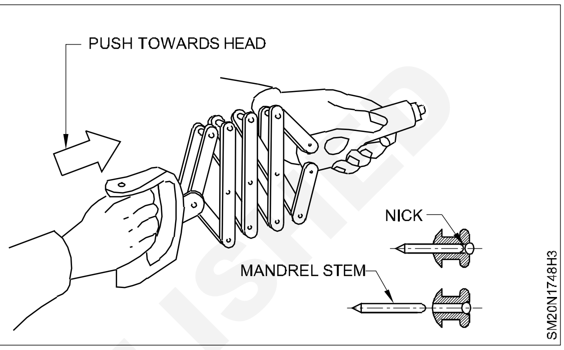
Position the tong by holding the body in one hand. (Fig 2)

Fig 2



Push the handle to close the lever linkage by applying a steady pressure on the handle with the other hand. (Fig 3)

Fig 3



This will pull the mandrel through the rivet.

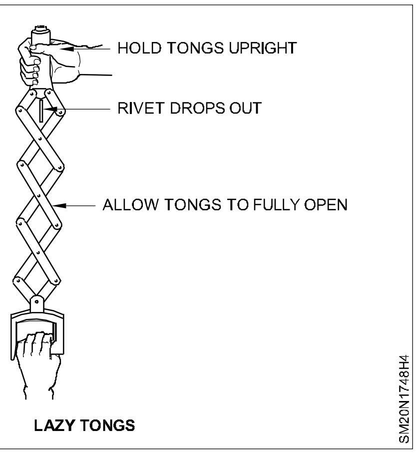
Continue pushing the handle against the workpiece till the mandrel of the rivet breaks and the rivet is set. If the mandrel does not break at the first time, pull the handle to open out the linkages and again push the nosepiece upto the rivet head for another stroke.

Now extend the lazy tong mechanism, to release the broken mandrel, before inserting another rivet.

Broken mandrel may drop either through the nosepiece or through the back of the coupling. (Fig 4)

Repeat the same process till the riveted joint is completed.

Fig 4



Making of aluminium sliding window outer frame (using aluminium window sections)

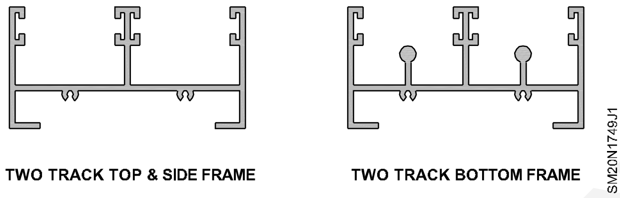
Objectives: At the end of this exercise you shall be able to
- **identify the aluminium window sections for making aluminium sliding window outer frame (Fig 1)**
- **join two track bottom, top and side frames on partition sections using slotted cheese head screws**
- **joint two track bottom and top frames to two track side frames using slotted cheese head screws**
- **select and fix suitable rubber packings on two track bottom, top and side frames.**
- **identification of soldering iron**
- **identifying theuse of each soldering**
- **Identifying the use of each solder.**

PROCEDURE

TASK 1: **Making of aluminium sliding window outer frame**

1 Identify two track bottom frames, two track top and side frames to make an aluminium sliding window outer frame. (Fig 1)

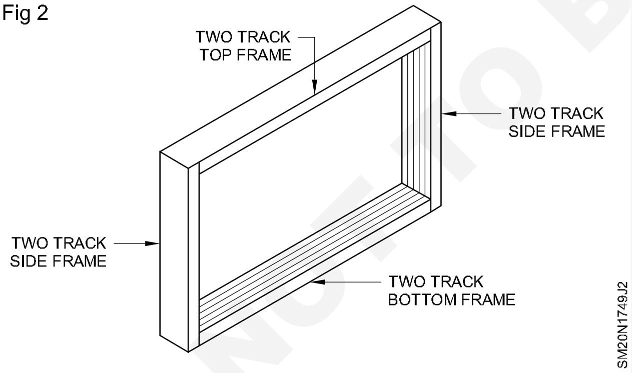
Fig 1



2 Cut the frames to the required length, square to their length using trysquare and hacksaw by hand.

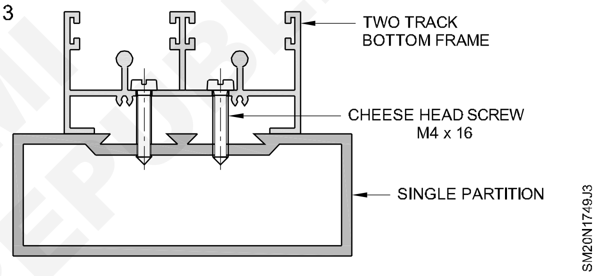
3 While cutting the frames, remember that the top and bottom frames are fixed between two vertical side frames. (Fig 2)

Fig 2



4 First hold the two track side frames vertically at sides against partition and drill ϕ 3 mm holes through inside of the track, passing through single/double partition section, using power operated portable drilling machine. Then enlarge the holes on the bottom track to 4 mm and fix rigidly with slotted cheese head screws. Fix screws at a distance of approximately 300 mm. (Fig 3)

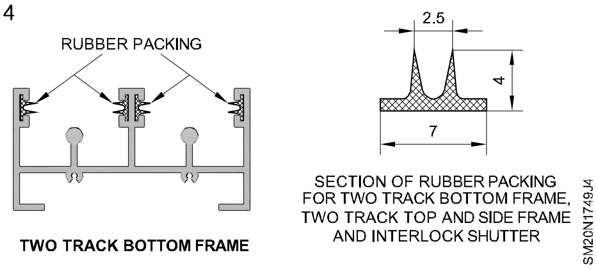
Fig 3



5 After fixing two track side frames on both sides, take exact distances between the two at top and bottom, accordingly cut the lengths of the top and bottom frames. Hold the bottom and top frames in position and fix it on the partition sections similarly.

6 Now apply rubber adhesive to rubber packing and insert the packing in slots of track sections as shown in Fig 4.

Fig 4



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TASK 2: **Identify the modifier (Flux) used in soldering**

1 All metals rust when exposd to the atmosphere and dust and impurities are deposited reducing the effectiveness of soldering write it down. A chemical flux is used to prevent the deposition of oxides and dust and impurities

2 Table 1 Gives the metal

3 Type of flux (Fx) to be used against each metal

— — — — — — — —

TASK 3: **Aluminimum soldering practice**

1 Work to be done 12 identify salt and its composition

Inductor soldering example

Regarding its composition and uses describe

2 Soldering is a method of joining the top wire and the paste with a bonding filler metal. Solder is divided into soft solder and hand solder and solder is divided into pine. Extra pine and eutectic solder. The metallic some solders in Table 1 is given below, is given. Mention is types and uses.

3 Composition of soldering metal Special types of soft solders

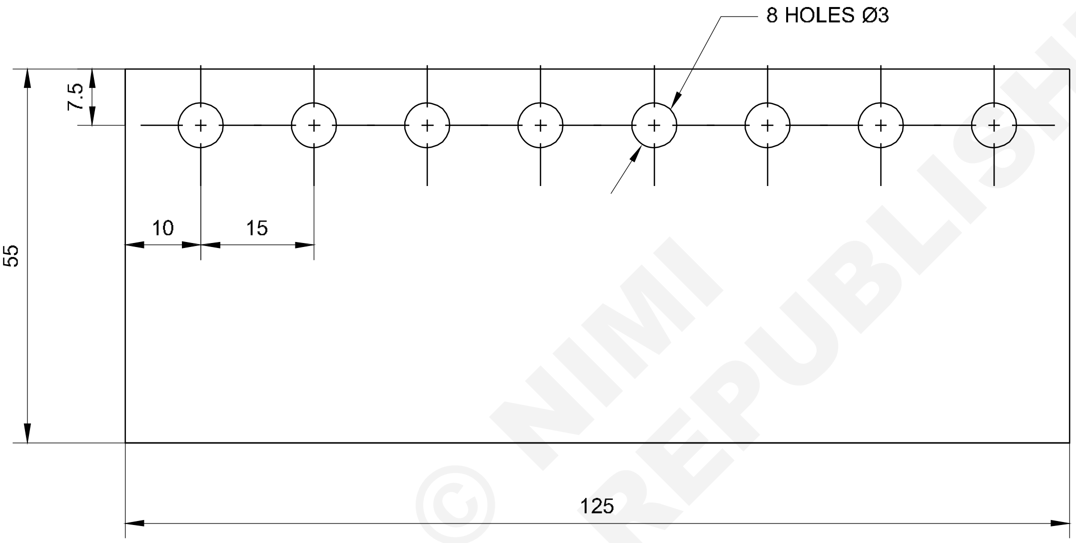
4 Containing a little zinc with a melting point below 300 c are used for soldering aluminium.

5 1 zinc - 2 lead - 53% tin - 45% (snpb 53 zn) 2 zinc 20 lead 58% tin 40% (snpb 58 zn) is used.

— — — — — — — —

Making holes in. sheet metal using punching machine (22 SWG)

Objective : At the end of this exercise you shall be able to
- **make holes by using punching machine.**



Job sequence

- Check raw material size & cut into two parts.
- Flatten, mark as per drawing and cut to size.
- Centre punch at 8 points, wher holes to be punched.
- Align punching machine to centre punch mark and punch hole at 8 points.
- Deburr.

2	260 x 240 x 1.2	⟶ 2-1-08	ALU. SHEET	–	–	50
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:4	MAKING HOLES IN ALU.SHEET METAL BY HAND PUNCHING MACHINE	DEVIATIONS ±1	TIME 5h
		CODE NO. SM20N1750E1	

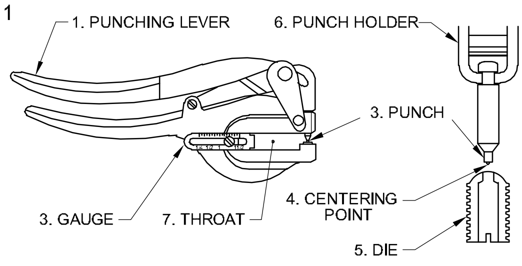
Skill sequence

The hand lever punch

Objectives: 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)

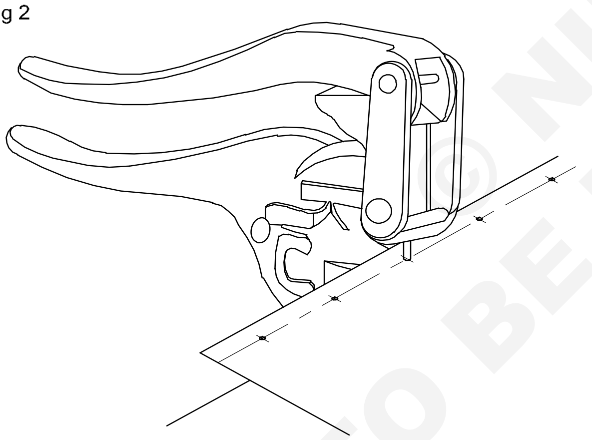
Fig 1



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.

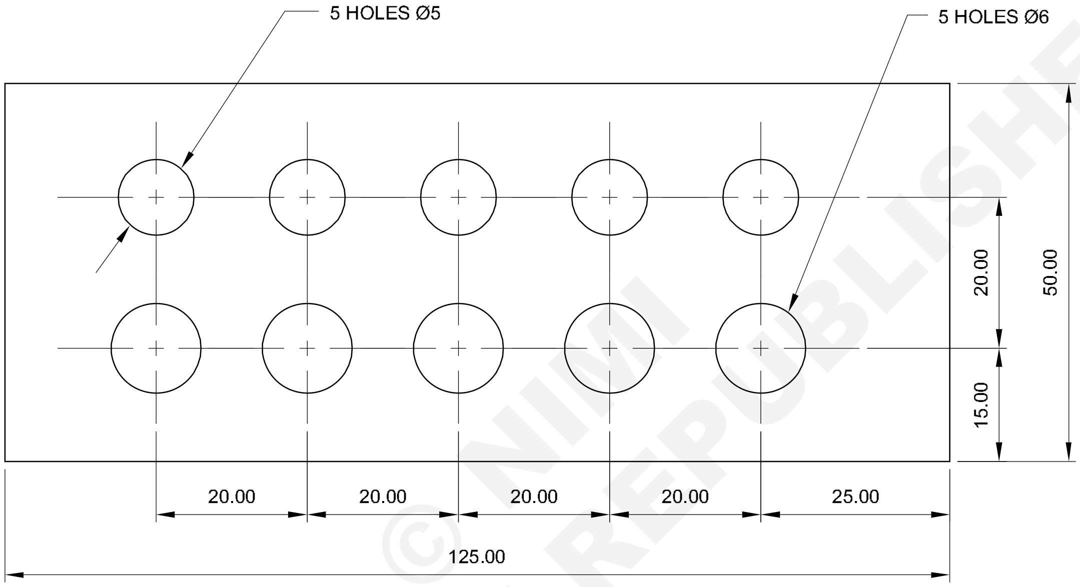
5 **Die:** It is threaded outside and a slot is provided at the bottom side to facilitate changing it, with the help of a screw driver.

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 e

Making holes by electrical drilling machine

Objective : At the end of this exercise you shall be able to
- **make holes by using punching machine.**



Job sequence

- Check raw material size.
- Cut to size and hole centres as per drawing.
- Punch centre point by centre punch.
- Fix job on vice/fixture with wooden support at the bottom.
- Fix drill chuck in spindle and required drill in chuck.
- Drill holes on the respective centres.
- Deburr holes.

1	140 x 60 x 2	–	ALU. SHEET	–	–	51
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:4	MAKING HOLES IN ALU.SHEET METAL BY DRILLING MACHINE	DEVIATIONS ±1	TIME 5h
		CODE NO. SM20N1751E1	

Drill grinding (118° point angle) and drill grinding for sheet metal drilling

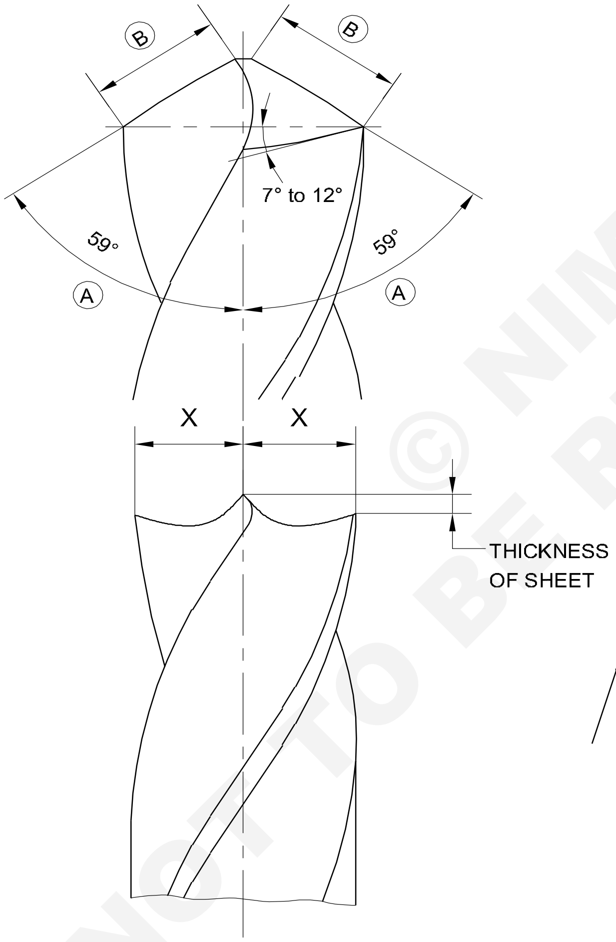
Objectives: At the end of this exercise you will be able to
- **re-sharpen the twist-drill point to 118°, when it becomes blunt**
- **check the drill point with drill grinding gauge for the accuracy of grinding operation**
- **alter the standard drill point for drilling sheet metal.**

Note to the instructor

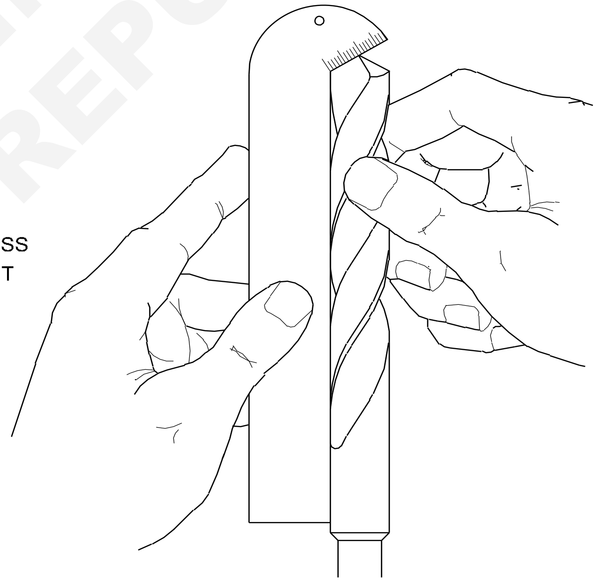
1 Please provide old worn out drills from section stores for grinding of standard 118° point.

2 Please demonstrate grinding drill point for sheet metal drilling and give skill information sheet to each trainee.

Stock size : Old wornout drill from section stores.



DRILL POINT FOR
DRILLING SHEET METAL



CHECKING LIP LENGTH
AND ANGLE

-	-	-	-	-	-	51
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1

DRILL GRINDING (118° POINT ANGLE) AND
DRILL GRINDING FOR SHEET METAL DRILLING

CODE NO. SM20N1751E2

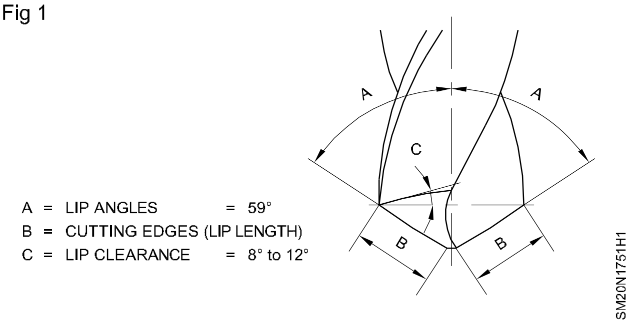
Job sequence

- For general purpose drilling of steel the point of the twist drill is ground with an angle of 118°.
- Select a bench grinder fixed with a dressed silicon carbide grinding wheel.
- Use the face of the wheel for grinding the drill.
- Follow the safety procedures of working in a bench grinder.
- Wear safety goggles.
- Grind both lips with equal length and equal lip clearance of approximately 12°.
- Maintain the lip angle 59° either side from the axis of the drill.
- Check the angle with a drill grinding gauge and ensure the angle. (Fig 1)

Caution: Don't cool HSS drill in water allow to cool in air only.

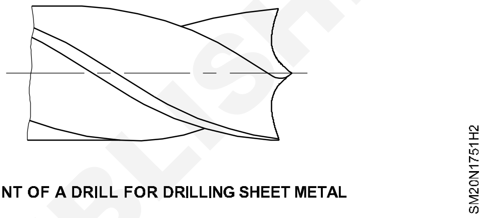
- For drilling sheet metal drill with usual point angle is not suitable.
- Grind the end of the drill flat and square with the axis.

Fig 1



- Leaving the web, grind the 2 lips with a slight radius as shown in the Fig 2.
- Sharpen the web like a point to penetrate in to the sheet metal.

Fig 2



POINT OF A DRILL FOR DRILLING SHEET METAL

Skill sequence

Sharpening of drills

Objective: This shall help you to
- **sharpen drills on an off hand grinder.**

A drill will loose the sharpness of its cutting edges due to continuous use, and improper use of drills will also spoil the cutting edges.

Spoiled or blunt cutting edges of the drills must be sharpened on a grinder.

Check the grinding wheel for loading, glazing, trueness and cracks. Call your instructor for advice. Dress and true the wheel if necessary.

Protect your eyes either with goggles or by lowering the eye protecting shield near the tool rest and adjust the tool rest 2 mm closer to the wheel, if necessary.

Switch on the grinder.

Hold the shank of the drill lightly between the thumb and the forefinger, and with the other hand hold the portion near the point. (Fig 1)

The hand near the point of the drill should be pivoted lightly on the tool rest at 'x' for easy manipulation. (Fig 2)

Hold the drill level (Fig 1) and turn it to 59° to the face of the wheel and swing the drill slightly downward and towards left. (Figs 3 & 4)

Fig 1

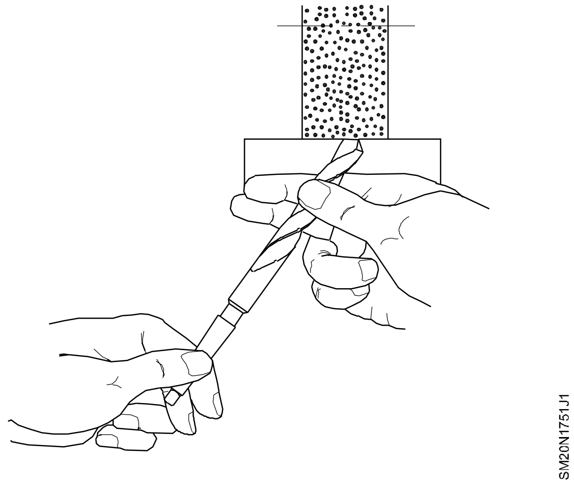


Fig 2

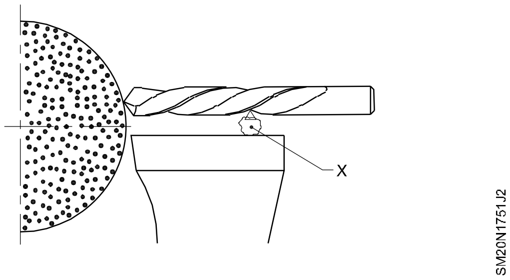
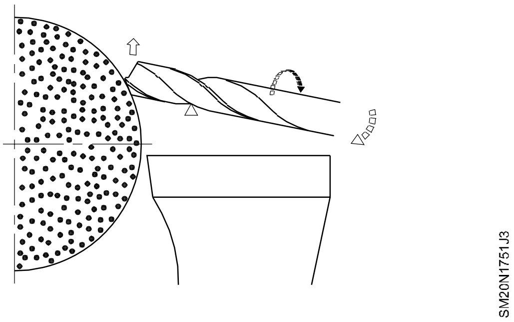
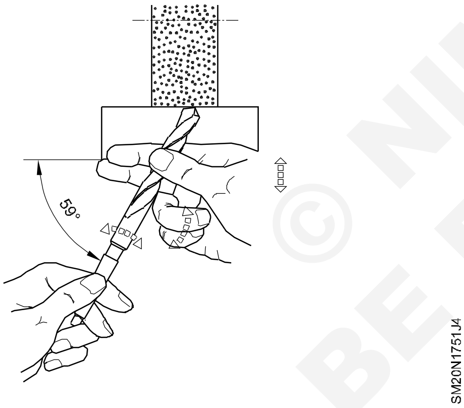


Fig 3



Rotate the drill to the right by turning it between the thumb and the forefinger. (Fig 4)

Fig 4



This turning movement is not necessary for smaller dia. drills.

While swinging down, apply a slight forward motion. This will help to form the clearance angle.

While swinging and turning the drill make sure you do not grind the other cutting edge.

All movements of the drill in angular turning, swinging and forward movements, should be well coordinated. They should result in one smooth movement to produce a uniformly finished surface.

Repeat the process to re-sharpen the other cutting edge.

Check both the cutting edges with a drill angle gauge, for correctness of the lip angle and equality of the lip lengths. (Figs 5 and 6)

Check the lip clearance angle in Fig 5 visually. The angle should be between 8° to 12°.

When you are satisfied correct equal angle and equal lip length. Drill a hole in a scrap metal. Before drilling confirm correct drill speed (r.p.m.) use cutting fluid.

Verify the condition of the hole while drilling. Did the drill chatter? If chattering happened, this could be caused by too much lip clearance. If the hole is over size by more than 0.12 to 0.25 mm then check lips lengths for uneven or the lip angles for uneven.

Fig 5

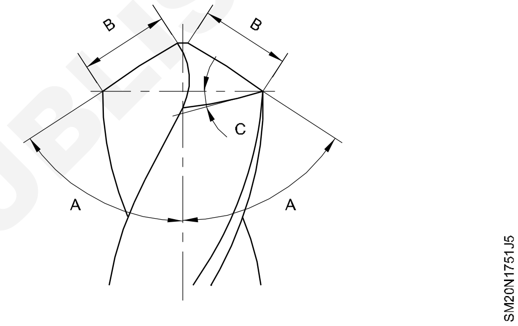
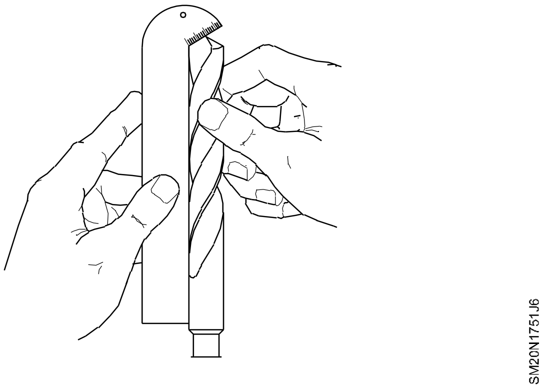


Fig 6



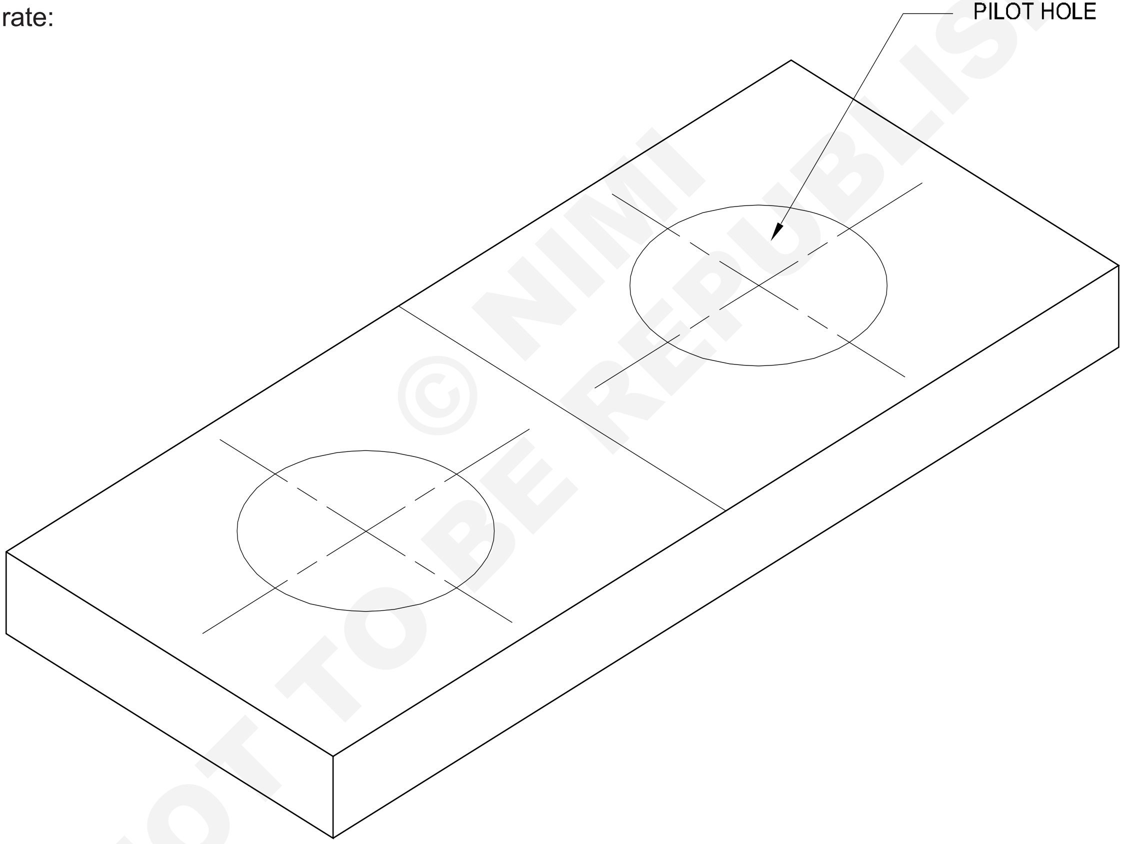
Dril paning with use of hand and electric drilling machning grinding drill bit.

Objectives: At the end of this exercise you shall be able to
- **Tri-paining**
- **alter the standard drill point for drilling sheet metal.**

Job sequence

Trepaining

- Circular cutter 's are commonly used for circular cutting. The ear
- Blades have a cutting edge on one side only sprouts are like tools. The leaves are not firm. Great care must be taken in selecting the cutting speed end feed rate:
- Setting up the plot hole for circular cutting Drill a pilot hole to insert the ring cutter. Tip on the cutting tool Make sure it is sharp and undamaged. Hold that circular cutter in the Tamar tool. Lock on the head of circular cutter Loose the screw. Using a steel rule, set the cutter to the required radius (Fig 1&2)



						52
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:4	**TRI- PANING WITH USE OF HAND AND ELECTIC DRILLING MACHINE, GRINDING A DRILL PIF**	DEVIATIONS ±1	TIME 5h
		CODE NO. SM20N1752E1	

Fig 1

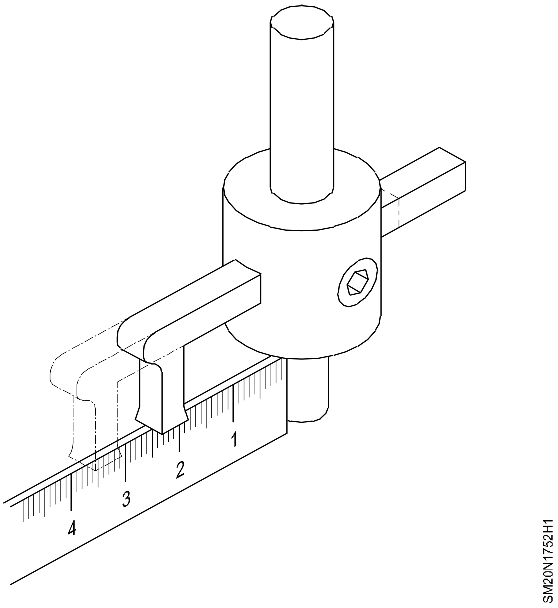
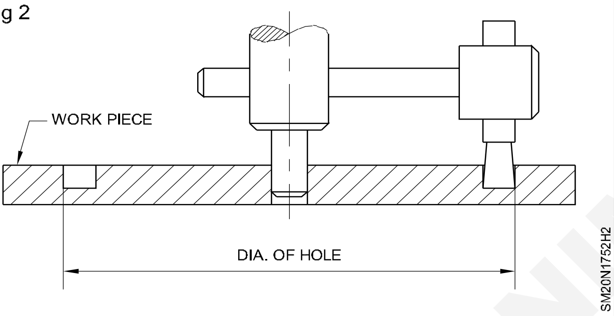
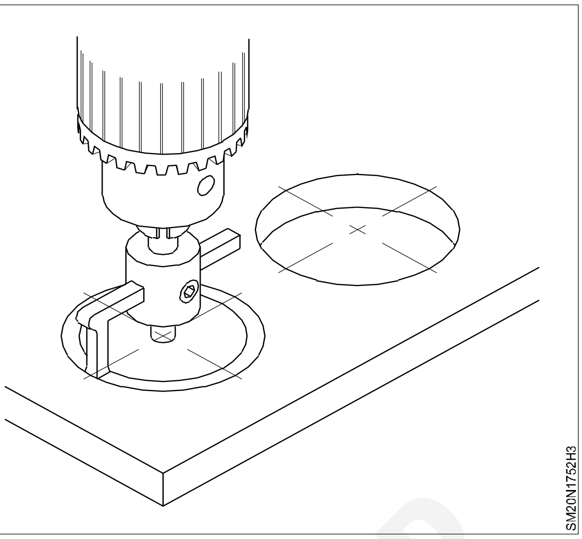


Fig 2



- Tighten the lock screw.
- Cutting a hole with a cutting tool Align the spigot hole visually and gently insert the spigot into the guide hole. (Fig 3)
- Choose the right spindle costume (should be closed to empty at normal cutting speed)
- Turn the machine on and rotate the spindle until the cut touches the workpicece.
- Feed the cutter regularly.
- Feeding should be very slow.
- Also require only manual control and feeding.
- Attention is needed near the end of the cut make sure the workpiece is flat and well supported.

Fig 3



- For general purpose drilling of steel the point of the twist drill is ground with an angle of 118°.
- Select a bench grinder fixed with a dressed silicon carbide grinding wheel.
- Use the face of the wheel for grinding the drill.
- Follow the safety procedures of working in a bench grinder.
- Wear safety goggles.
- Grind both lips with equal length and equal lip clearance of approximately 12°.
- Maintain the lip angle 59° either side from the axis of the drill.
- Check the angle with a drill grinding gauge and ensure the angle.

Caution: Don’t cool HSS drill in water allow to cool in air only.

- For drilling sheet metal drill with usual point angle is not suitable.
- Grind the end of the drill flat and square with the axis.
- Leaving the web, grind the 2 lips with a slight radius.
- Sharpen the web like a point to penetrate in to the sheet metal.

Skill sequence

Sharpening of drills

Objective: This shall help you to
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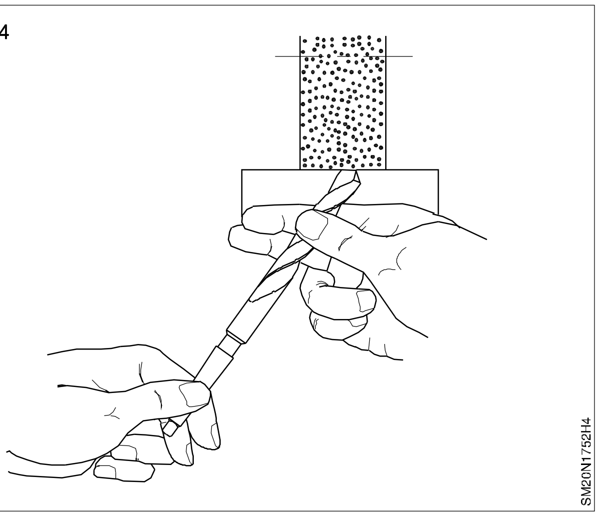
Protect your eyes either with goggles or by lowering the eye protecting shield near the tool rest and adjust the tool rest 2 mm closer to the wheel, if necessary.

Switch on the grinder.

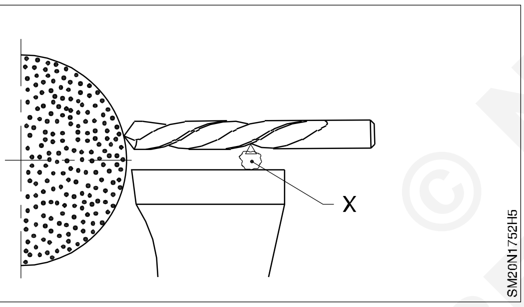
Hold the shank of the drill lightly between the thumb and the forefinger, and with the other hand hold the portion near the point. (Fig 1)

Fig 4



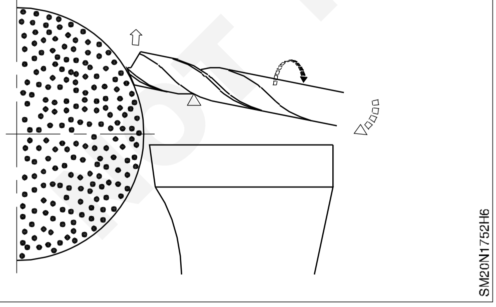
The hand near the point of the drill should be pivoted lightly on the tool rest at ‘x’ for easy manipulation. (Fig 2)

Fig 5



Hold the drill level (Fig 1) and turn it to 59° to the face of the wheel and swing the drill slightly downward and towards left. (Figs 3 & 4)

Fig 6

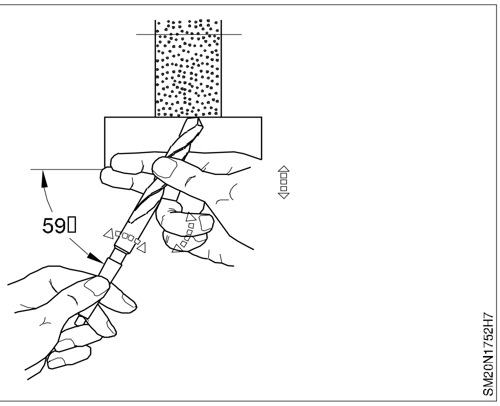


Rotate the drill to the right by turning it between the thumb and the forefinger. (Fig 4)

This turning movement is not necessary for smaller dia. drills.

While swinging down, apply a slight forward motion. This will help to form the clearance angle.

Fig 7



While swinging and turning the drill make sure you do not grind the other cutting edge.

All movements of the drill in angular turning, swinging and forward movements, should be well coordinated. They should result in one smooth movement to produce a uniformly finished surface.

Repeat the process to re-sharpen the other cutting edge.

Check both the cutting edges with a drill angle gauge, for correctness of the lip angle and equality of the lip lengths. (Figs 5 and 6)

Fig 8

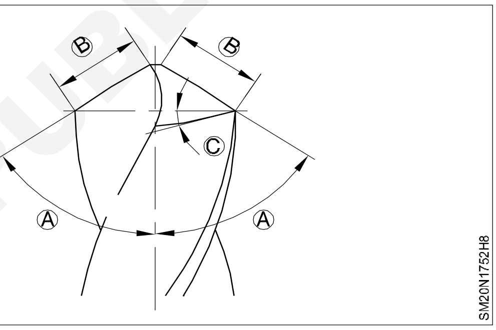
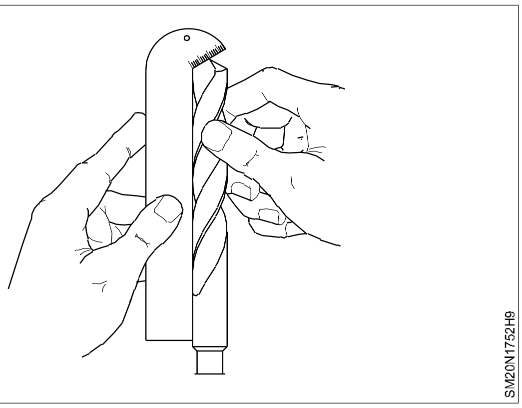


Fig 9



Check the lip clearance angle in Fig 5 visually. The angle should be between 8° to 12°.

When you are satisfied correct equal angle and equal lip length. Drill a hole in a scrap metal. Before drilling confirm correct drill speed (r.p.m.) use cutting fluid.

Verify the condition of the hole while drilling. Did the drill chatter? If chattering happened, this could be caused by too much lip clearance. If the hole is over size by more than 0.12 to 0.25 mm then check lips lengths for uneven or the lip angles for uneven.

Capital Goods & Manufacturing

Exercise 1.7.53

Sheet Metal Worker- Advanced Sheet Metal Processes

Practice in drilling holes in walls and ceiling as applied to ducting work.

Objective : At the end of this exercise you shall be able to
- **Drilling in wall and eaves with hand**
- **Drill - Correct installation of duck work.**

Job sequence

- Marking should be done on the wall and floor where the duck is to be installed
- Push the puncture site.
- Ready to run power drilling machine should be done.
- Fit the drilling machine drill bit
- Accomplish where drilling is required by mission

Fig 1

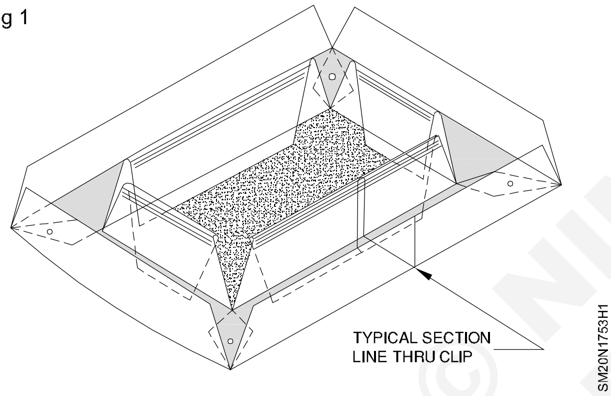
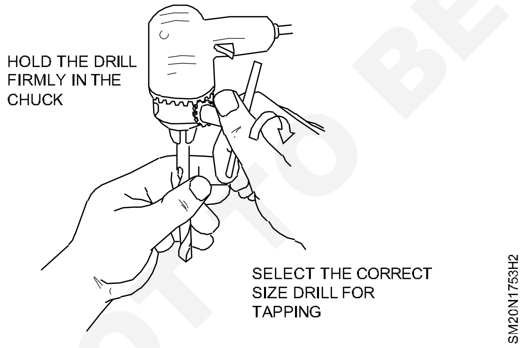


Fig 2



- Fit the wooden block in the hole.
- Prepare the duck to fit properly
- Screws for fixing Please choose.
  - 0 check that it is firmly fitted
  - Wear safety glasses.

Use a higher spin speed for smaller size drills and a lower spin speed for larger size drills.

Fig 3

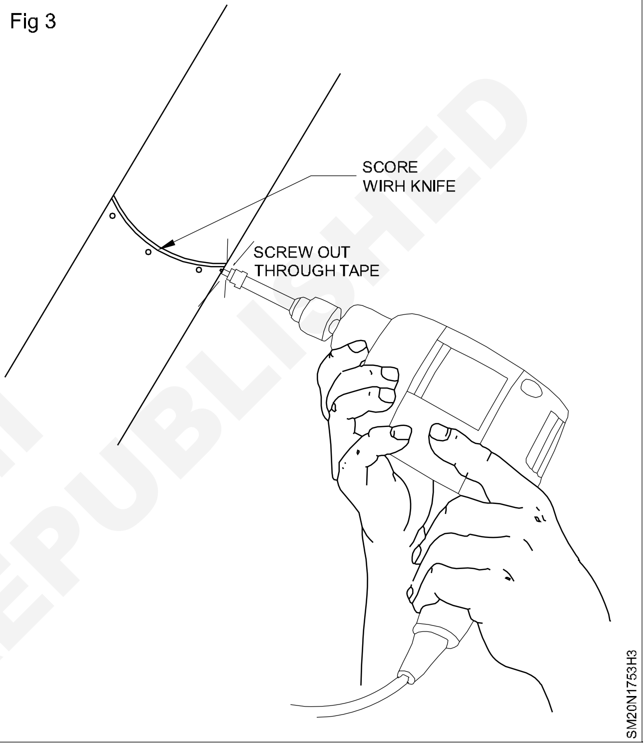
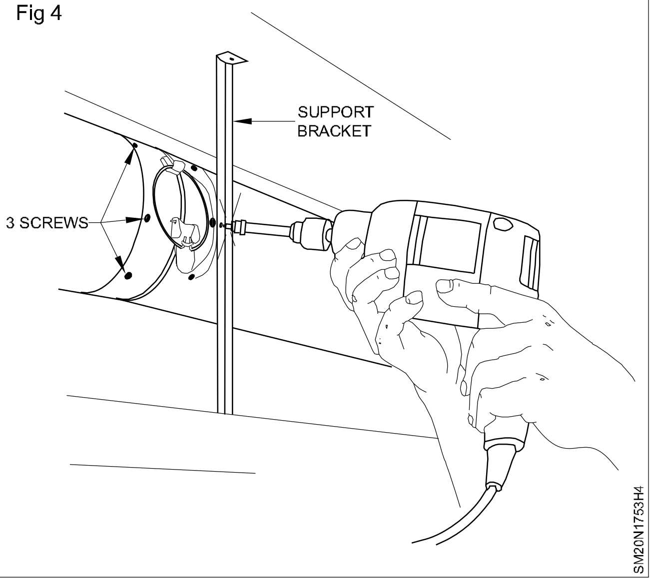


Fig 4



Making a brass bowl

Objectives: At the end of this exercise you shall be able to
- **prepare the Rawl Jumber and plug**
- **practice on using of Rawl Tool**
- **fix the wooden screw on the wall using grips or gutties.**

Requirements

Tools and Instruments/equipment

• Rawl bit holder 6mm, 8mm, 10mm 12mm	- 1 No.
• Jumber bit 6mm, 8mm, 10mm, 12mm	- 1 No.
• Ball been hammer 500 gm	- 1 No.
• Screw driver 200mm	- 1 No.

Materials

• Rawl plug	- 1 box.
• Grip plug	- 1 box.
• Wooden guddies	- 1 box.

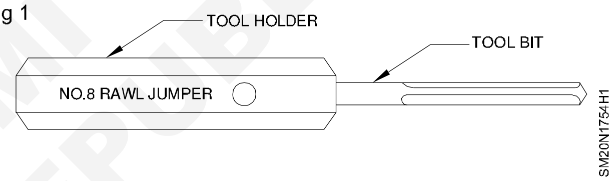
PROCEDURE

TASK 1: **Prepare the Rawl jumber**

1 Select the proper rawl bit holder with correct size of jumber bit as in Fig 1.

2 Hammer the tool holder slightly by loading the tool bit, so that the tool bit inserted up to the mark of hole in the tool holder.

Fig 1



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TASK 2: **Practice on using of a Rawl tool holder with bit**

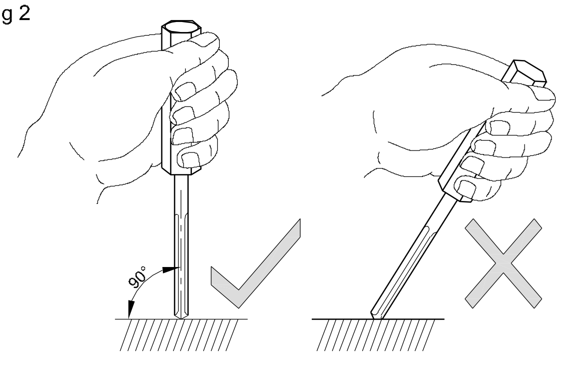
1 Mark the point of the fixing screw on the wall to be jumbered.

2 Keep the rawl bit on the point at right angle to the wall surface as in Fig 2.

3 Hammer the head of tool holder to make the hole.

4 Turn the jumber at intervals of hammer stroke in clock wise as

Fig 2



Types of rawl plug materials

1 Dost, fiber, plastic, stone, fiber and sometimes nyton inserts are inserted into the holes.

2 The plug is fixed by means of screws which are penetrated into the wall quickly likes

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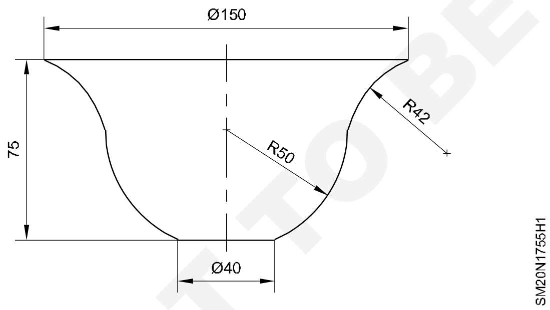
Making a brass bowl

Objectives: At the end of this exercise you shall be able to
- **mark concentric circles using steel rule and dividers**
- **form hemispherical parts by hallowing process**
- **form hemispherical parts by raising process**
- **anneal the sheets in middle of the above processes**
- **stretch the metal by stretching hammer and ball stake**
- **emboss the metal by hand process**
- **raise the body of the metal after hollowing**
- **form curve by turning up operation**
- **form curve by edge turning to set stiffening**
- **finish the surface of the article by planishing**
- **clean the job by acidic processes (pick ling)**
- **do sweating operation by tinning the bottom**
- **finish the body of the bowl by buffing and polishing.**

Job Sequence

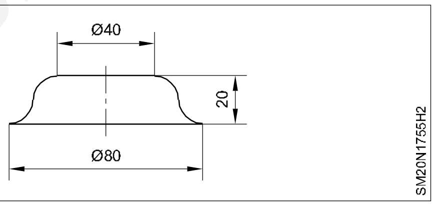
- Develop and layout the pattern for the body of the bowl by finding the slant height using geometrical constructional method.
- Draw concentric circles of R 120mm for the outer diameter R 75mm for bent out and R 20mm for bottom.
- Cut along the outer circle mark using a Tinman's shear.
- Anneal the disc to make it soft and for easy working.
- Form the basin by hollowing process using a hollowing block and hollowing hammer. (Fig 1)

Fig 1



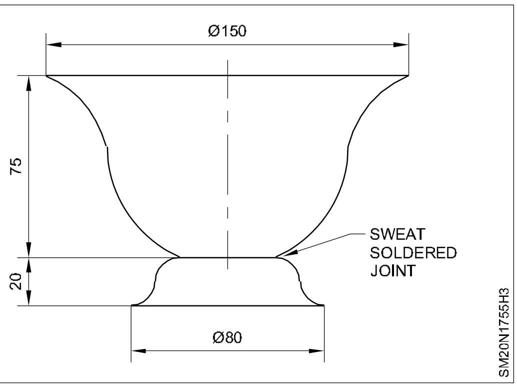
- During the process of hollowing wrinkles will develop along the edge of the disc.
- Flatten it by using a planishing hammer over an anvil stake.
- Form the bent out of the basin using a round head stake, end facked mallet and a raising hammer.
- Flatten the bottom of the basin flat, to facilitate the sweating of the same. Mark, trim and finish the edge of the bowl.
- Similarly, mark and form the bottom of the bowl as per job drawing as done for the body. (Fig 2)

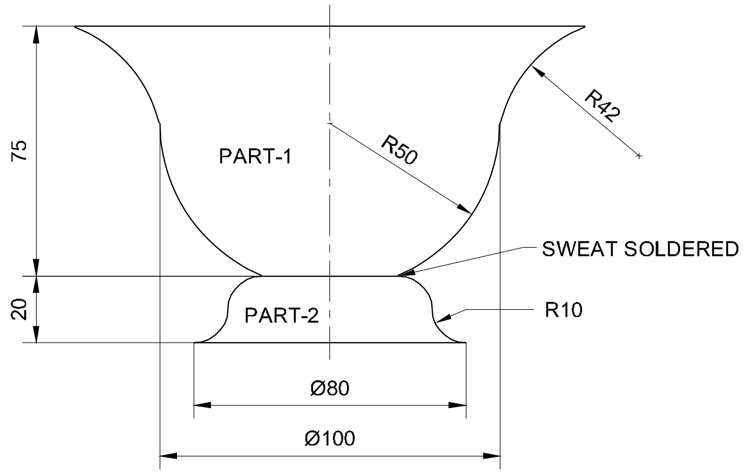
Fig 2

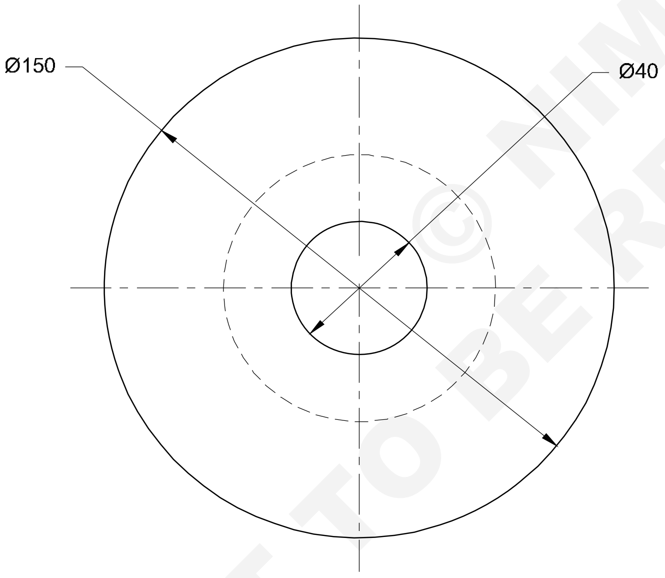


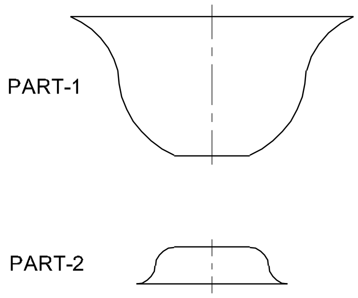
- Clean and dip the parts in pickling solution to clean the parts.
- Clean, tin, assemble sweat solder the body and bottom of the basin by soldering process. (Fig 3)
- Apply the polishing vax, solution over the body of the job and finish it over a buffing wheel for polishing.

Fig 3









–	60% x 40%	–	SOFT SOLDER	–	–	–
1	IS 2378 - 120 x 1.6 - 120	–	CuZn 39	–	2	55
1	IS 2378 - 240 x 1.6 - 240	–	CuZn 39	–	1	55
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2

PROJECT: BRASS BOWL

PART: **1. TOP** **2. BOTTOM**

DEVIATIONS ±1

TIME 15h

CODE NO. SM20N1755E1

Skill sequence

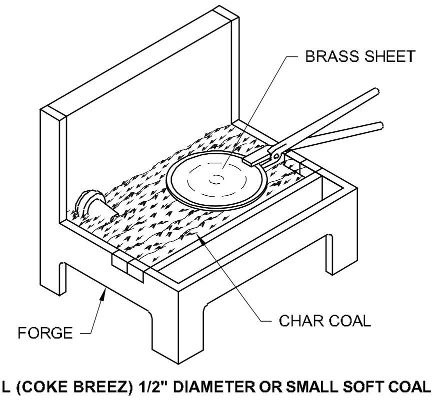
Hollowing and raising process

Objectives: This shall help you to
- **form hemispherical parts by hollowing and raising**
- **anneal the brass discs during hollowing and raising**
- **clean the hemispherical shaped body to the required finish.**

Mark and cut the discs to required size using tinman's shear.

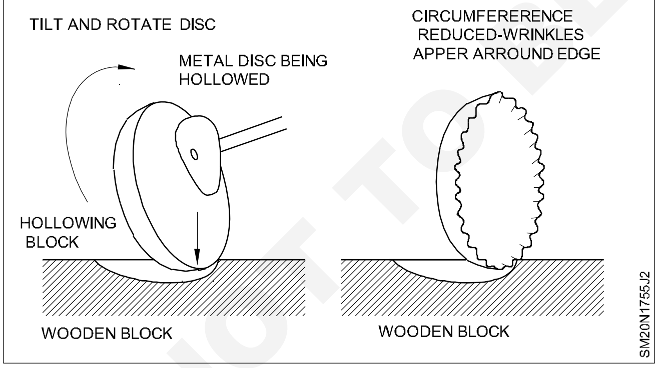
Anneal the discs by heating it in a forge upto orange colour and quench it immediately in water. The sheet becomes soft and will be easy to shape it to required shape. (Fig 1)

Fig 1



Place the annealed disc on the hollowing block and start hammering with a hollowing hammer, starting the hammer blows from the edge of the disc to the centre by gradually rotating the disc at every stroke. (Fig 2)

Fig 2



Wrinkles will develop along the edge of the disc during the process of hollowing.

Flatten it using a planishing hammer/mallet over an anvil stake/round headed stake. (Fig 3)

Hollow the disc till we get the required depth and shape by checking with a gauge plate. (Fig 4)

Anneal the disc time to time as the metal will get hardened due to hammering. This is called work hardening.

Finish the hollowing operation with a bosing mallet to get a smooth surface.

Fig 3

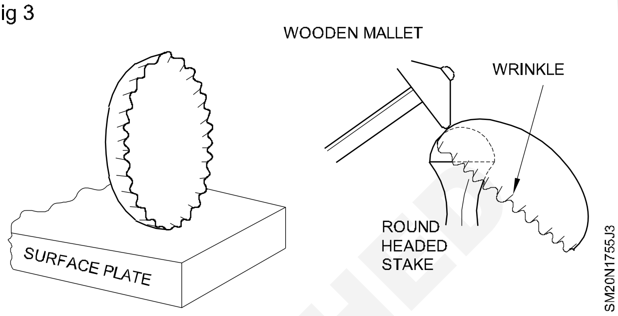
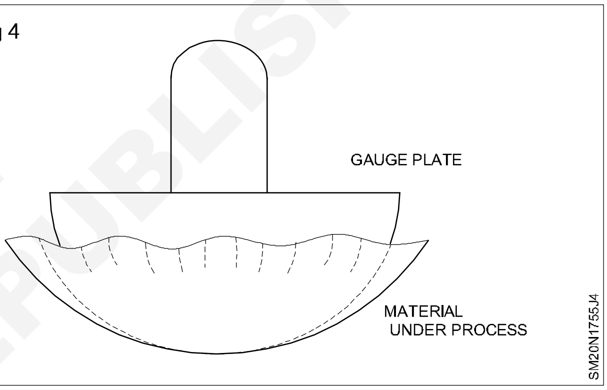


Fig 4

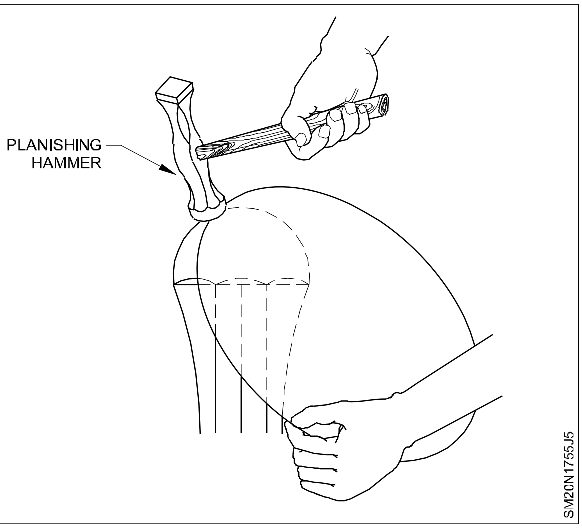


If annealing is not done time to time the metal will get hardened and cracks will develop.

Keep the bowl over a round head stake and start hammering from the centre to the edge by rotating the bowl to every stroke using a raising hammer. This will give a uniform finish on the outer surface.

Use a planishing hammer to remove minor dents and get a smooth finish. (Fig 5)

Fig 5



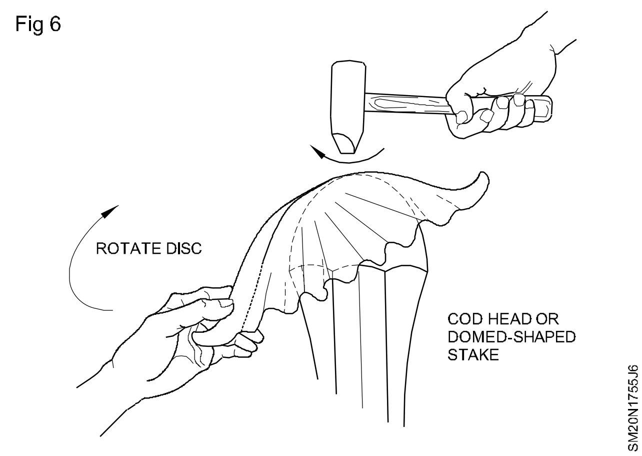
Anneal the article time to time as required.

Mark off the height to be formed for the mouth of the bowl as per drawing.

Place the bowl on a round head stake and turn up the shape using end facked mallet. (Fig 6)

Flatten the base of the bowl to the required diameter using a round bottom stake and mallet.

Fig 6

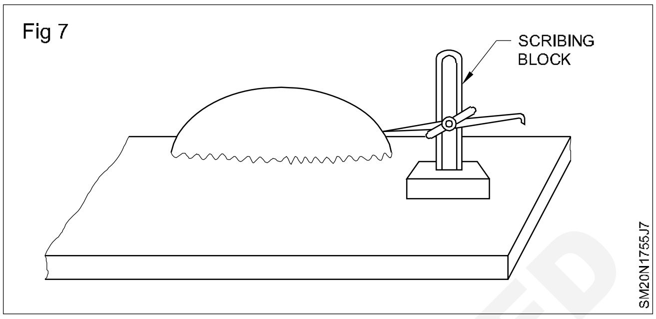


Finish the edge of the bowl over a round head stake and a cross pane hammer.

Mark off and trim the extra metal and finish the edge by filing. (Fig 7)

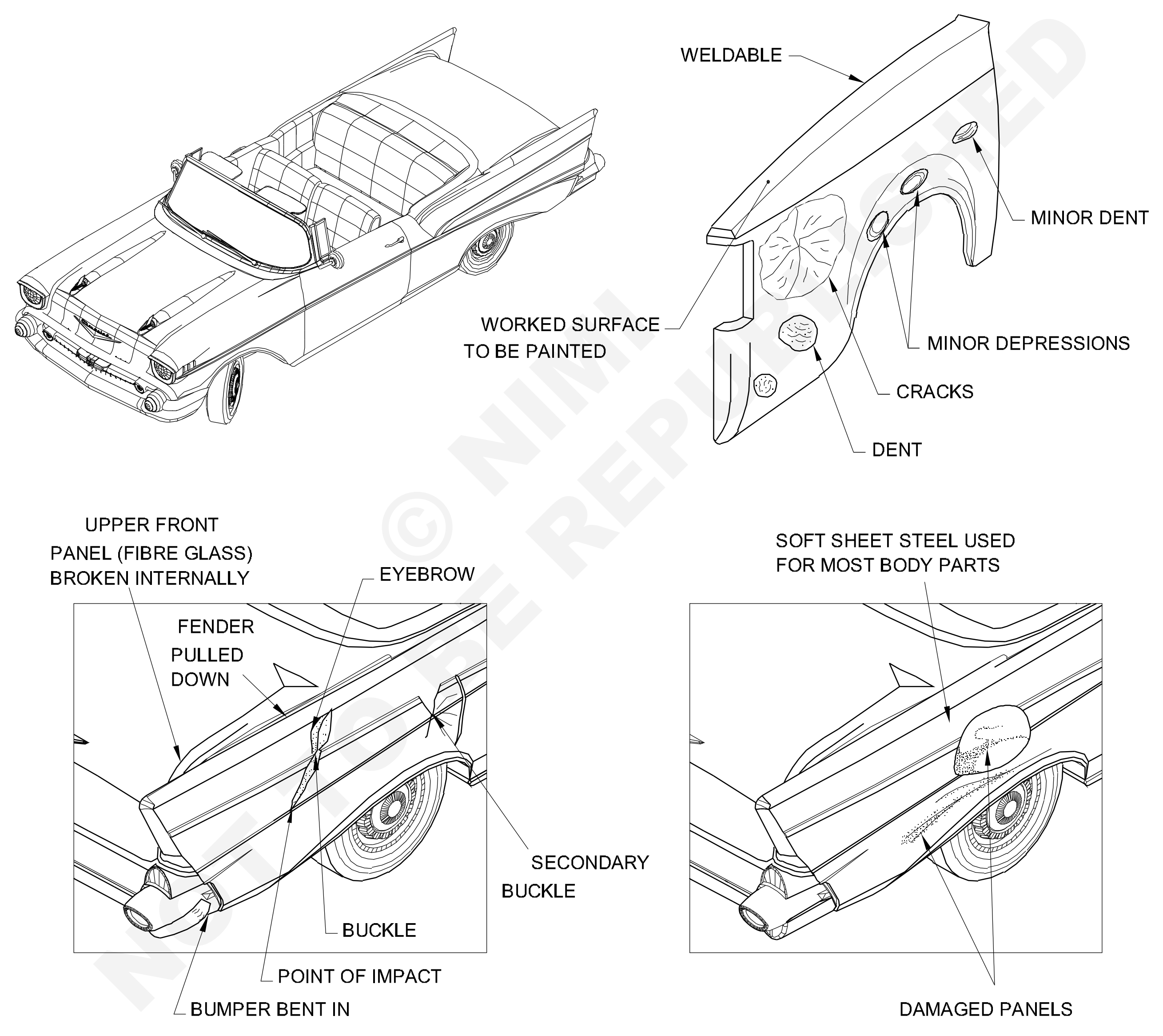
Clean the scales on the articles using emery paper and dip it in a pickling solution. (Hydro chloric and or Dilute Sulphuric Acid)

Fig 7



Repairing damaged body's of vehicles

Objectives : At the end of this exercise you shall be able to
- **rectify the dents, folds, bends to bring back the original shape of body by heating with blow lamp or blow pipe and using suitable tools**
- **prepare the surface for spray painting by hand process**
- **paint the body using a spray gun.**



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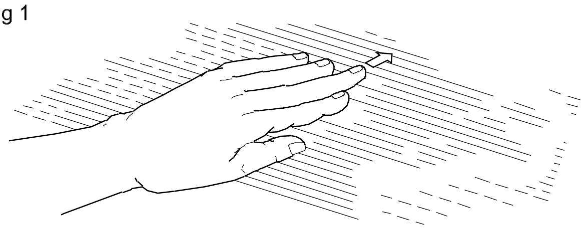
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

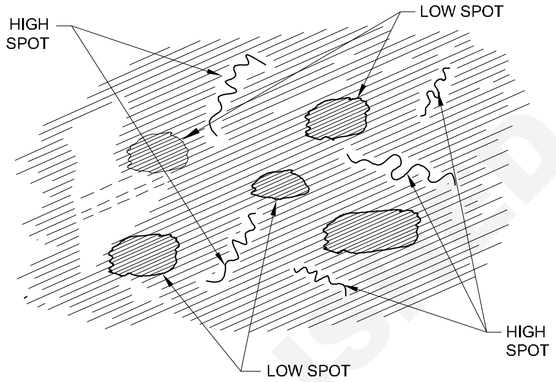
SCALE NTS	**REPAIRING THE DAMAGED BODIES OF VEHICLES.**	DEVIATIONS	TIME 15h
		CODE NO. SM20N1756E1	

Job sequence

- Locate the damaged spots on the body or parts of the body. (Fig 1) Mark a circle for locating low spots and vary lines for high spots on the surface.
- If the dent is minor, remove the dent using a planishing hammer and a suitable support. (dolly)
- If the dent or damage is major, heat the damaged spot with blow lamp or blow pipe and remove the dent or the damaged portion using planishing or a suitable hammer and a support (dolly). Repeat the same, till you get a smooth surface and the required shape.
- If the damage or dent cannot be repaired by the previous process, lead load the surface.
- Finish the lead loaded surface by filing and with emery paper.
- Prepare the surface for spray paint, using a metal primer and a metal putty.
- Paint the surface with suitable colour using a spray gun and compressed air.

Fig 1


LOCATE HIGH SPOTS



LOCATE AND MARK HIGH SPOTS

Skill sequence

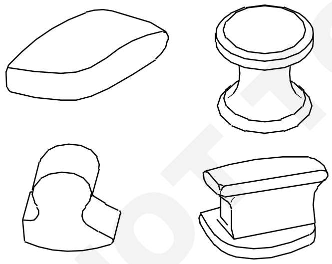
Rectify minor dents on the body or part of the body of the vehicle

Objectives : This shall help you to
- **select a suitable hammer and a supporting dolly to rectify the particular dent**
- **rectify the dent to reshape the surface using a planishing hammer and a dolly.**

Mark the dents with a chalk piece. Mark high spots with vary lines and low spots with circle.

Select the suitable dolly depending upon the shape of the dent or the damage. (Fig 1)

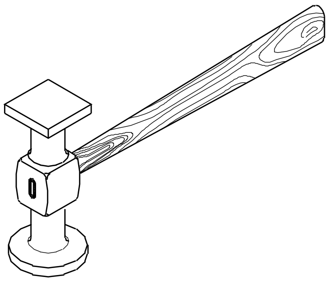
Fig 1



DOLLY BLOCKS OF VARIOUS CONTOUR TO CHOOSE FROM

Select the suitable hammer depending upon the shape of the damage. (Fig 2) Hold the dolly under the damaged surface as support in one hand and slowly hammer the surface with the other hand. Hammering should be done slowly from the surface around the point of damage towards the point at which maximum damage has occurred (point of impact). Strike the surface gently, until you get a solid ringing sound.

Fig 2



PLANISHING HAMMER

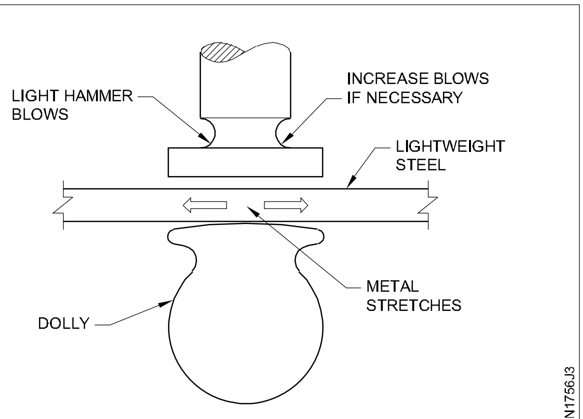
Do not apply heavy blows on the damaged surface directly which may cause excess stretching of the surface. (Fig 3)

While planishing, ensure that the movements of the hammer and the hand dolly are co-ordinated such that there is always contact between hammer, the metal and the hand dolly. (Fig 4) This is called metal to metal contact.

While striking with the hammer, adjust the force according to the extent of the damage. (Fig 5)

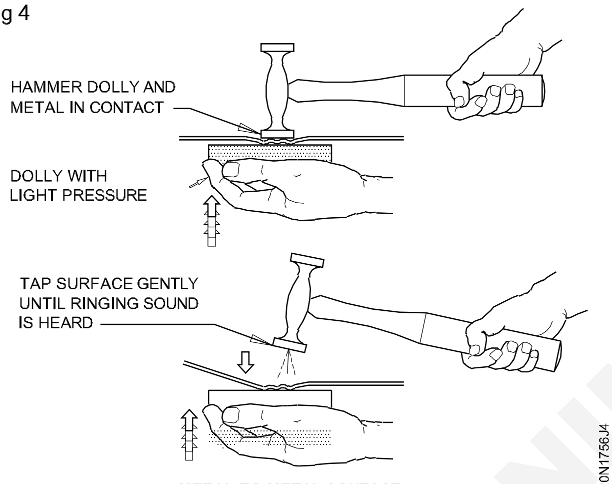
Continue tapping the surface, till you feel by hand that it is as close as possible to the original shape. After planishing the surface, polish it using a smooth emery paper.

Fig 3



PRESSURE OF BLOWS

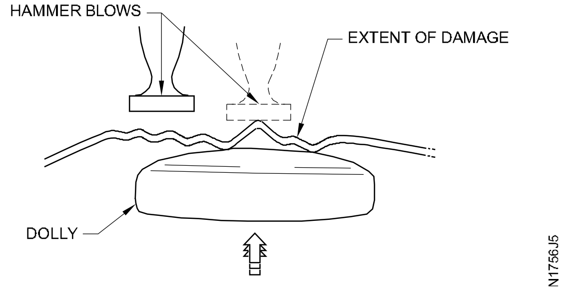
Fig 4



METAL TO METAL CONTACT

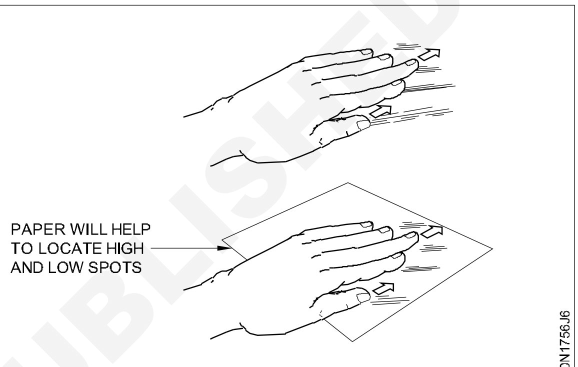
Feel the surface by hand for smoothness. If your hand perspires, use a piece of paper under your hand to examine the damage. (Fig 6) If you identify high or low spot, rectify as it is done earlier.

Fig 5



AMOUNT OF FORCE USED

Fig 6



TEST BY FEEL AND SIGHT

Rectify major dents/damages of body or parts of the body of the vehicles by heating the surface and hammering

Objectives : This shall help you to

- **remove major dents or damages of surfaces with blow lamp or blow pipe by heating the surface and planishing using a suitable hammer and a dolly.**

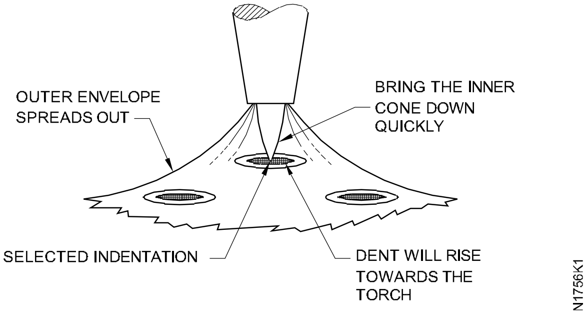
Dents or damages which cannot be rectified by cold working are rectified by heating and planishing. These are major damages.

Mark the damaged area with a chalk piece. Heat the surface around the point of damage using a blow lamp or a blow pipe and tap the heated area with a suitable hammer and a dolly.

Accordingly heat the damaged area, progressing from outside to the point of damage shown as in Fig 1,2,3 and reshape the surface by tapping with the hammer.

The hammer blow should be glancing, slapping over, with the hammer rebounding from the metal immediately after impact. (Fig 3)

Fig 1



HEAT AN INDENTATION

The blow should not be like the one that a carpenter uses for driving a nail. The blow should be delivered from the wrist.

When heavier blows are required wrist and arm pressure are used. (Fig 3) Apply hammer blows gently to avoid over stretching of the metal.

Planish the surface, till you get the finish and shape as close as the original shape.

Fig 2

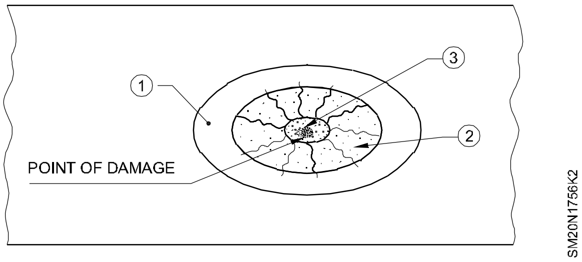
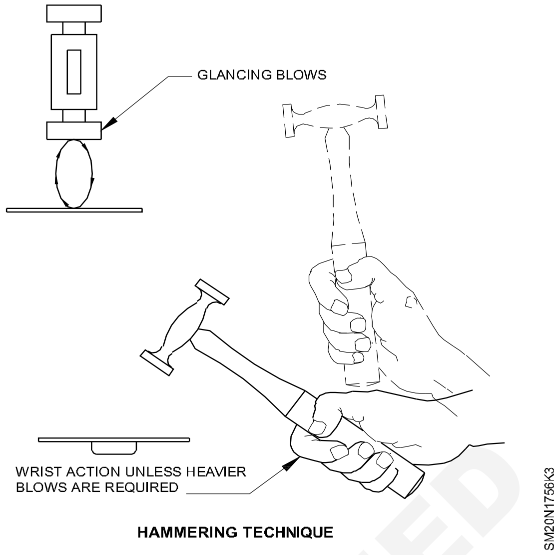


Fig 3



HAMMERING TECHNIQUE

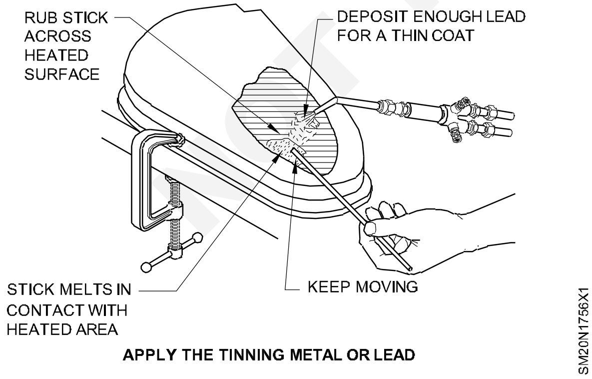
Rectify major dents/damages of body or parts of the body of the vehicles by lead loading

Objective : This shall help you to

- **rectify the major dents/damages of the metal surfaces by lead loading.**

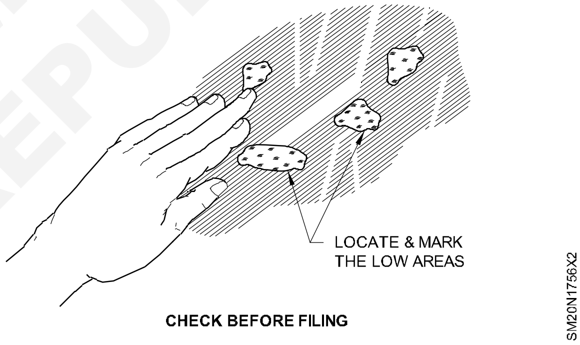
When the dents or damages in the surface are difficult to reshape by striking with the hammer either in cold or hot condition, they are reshaped by lead loading. First clean the surface to be lead loaded with a smooth emery paper. Apply the flux (flux used for soldering) with brush on the damaged surface to be lead loaded. Deposit enough lead into the cavities over the surface by using lead stick with a blow pipe (Fig 1) and a wooden spectula, dipped in oiled cotton waste till the lead is spread enough to cover the dents/damages to get original shape. Cool the lead loaded surface with a wet cloth. Locate and mark the low areas before filing. (Fig 2) File the lead loaded surface by a curved cut file to remove the extra layer until you get a smooth surface. (Fig 3) Finish the surface by a smooth emery paper.

Fig 1



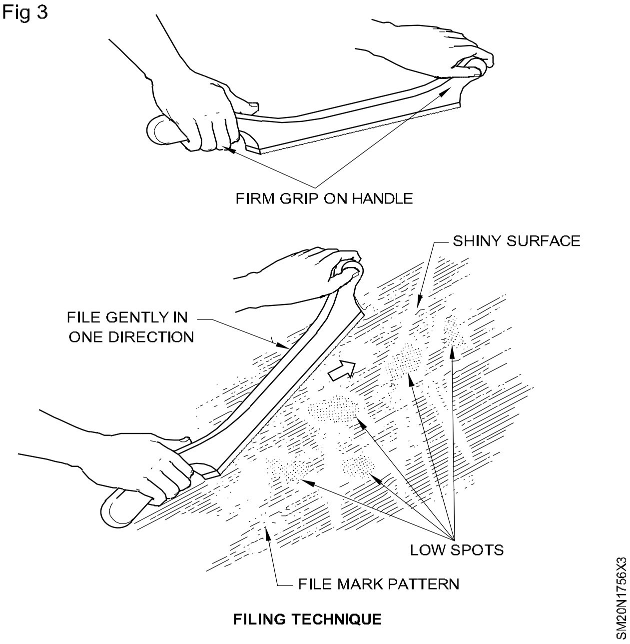
APPLY THE TINNING METAL OR LEAD

Fig 2



CHECK BEFORE FILING

Fig 3



FILING TECHNIQUE

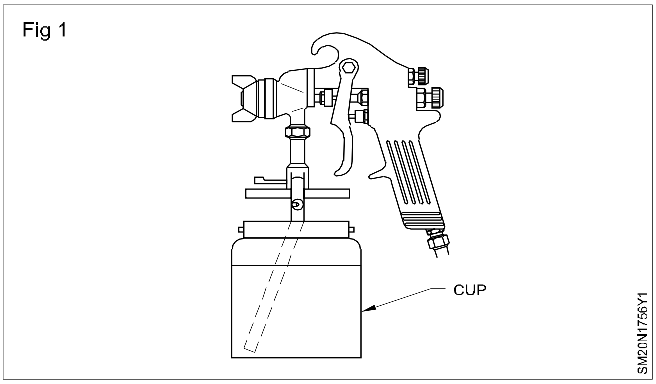
Cleaning the spray gun

Objective : This shall help you to

- **clean the spray gun to get uniform and correct spray pattern using a solvent, a toothpick and a cloth.**

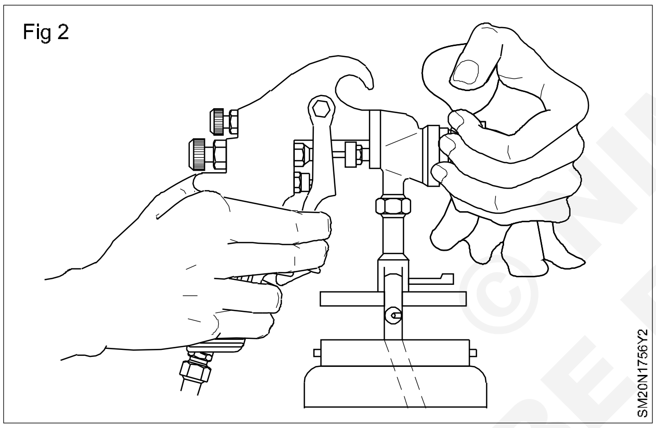
Loosen the cup from the gun. Raise the gun over the cup end of the fluid line and unscrew the air cap two or three turns (Fig 1).

Fig 1



Hold a cloth over the air cap. Pull the trigger of the gun. This forces the paint present in the gun back into the cup. (Fig 2)

Fig 2



Empty the cup. Rinse it with the solvent (thinner). Remove the solvent after the cup is cleaned. Add more solvent. Put the cup back on the gun and operate it to flush out all the paints from the gun. (Fig 3) Remove the air cap from the gun and soak it in the solvent and dry it off with compressed air.

If the holes in the air cap become clogged, soak it in the solvent and use tooth pick or broom straw to clean out the holes. (Fig 4) Never use metal objects such as wire, drill etc. After the spray gun is cleaned, reassemble it for future use. Lubricate the spray gun daily, preferably before using with the recommended lubricant. Coat the needle valve spring with petroleum jelly.

Fig 3

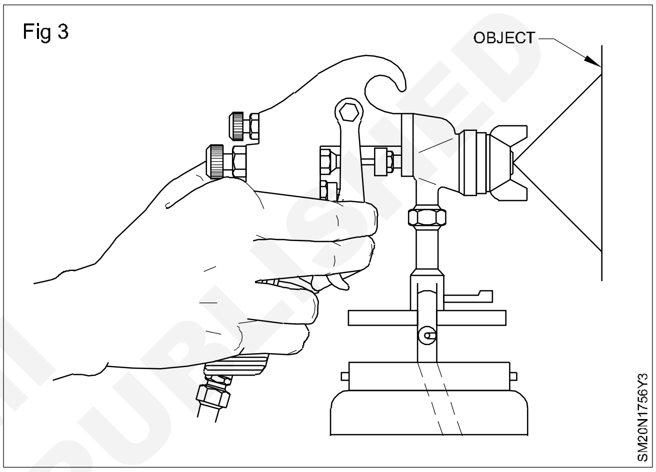
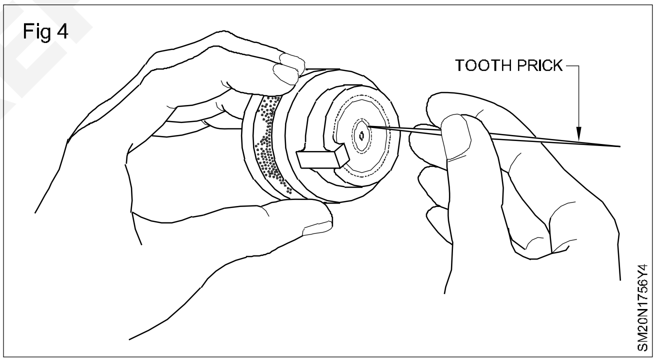


Fig 4



Spray painting

Objective : This shall help you to

- **paint the sheet metal surface to get good look using a spray gun and compressed air.**

Prepare the surface for spray painting.

Check the oil level of the air compressor. Drain out the water from the tank through drain valve 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.

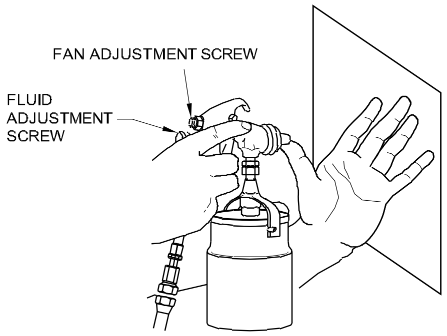
Connect the spray gun to the outlet nose pipe of the compressor.

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 should be visible. Hold the spray gun about 200 mm 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 75 mm wide. Fig 2 shows the pattern with low air pressure and Fig 3 shows the pattern with high air pressure.

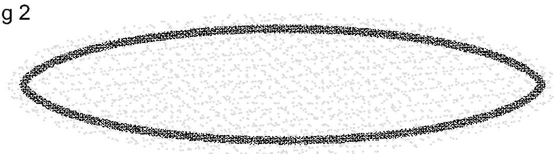
Adjust the air pressure at the gun until the desired the pattern of the spray is obtained.

Fig 1



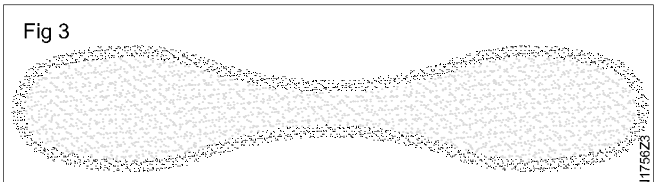
MEASURING THE CORRECT DISTANCE FOR SPRAY PAINTING.

Fig 2



LOW AIR PRESSURE

Fig 3

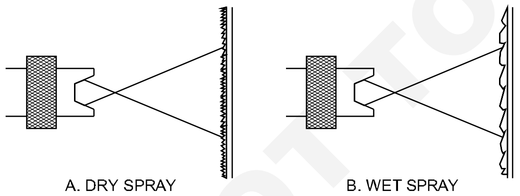


LOW AIR PRESSURE

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 pressure by 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. Hold the gun level with and at right angle to the surface to be painted.

Fig 4

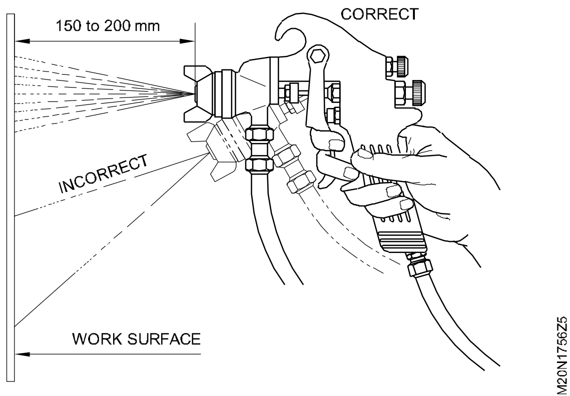


A. DRY SPRAY B. WET SPRAY

IMPROPER TEXTURE OF THE SPRAY PATTERN

Use your wrist stiff and use your arm and shoulder to move the spray gun across the surface 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 surface 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 0.3 m per second approx. Never stop the motion. Movement should be uniform.

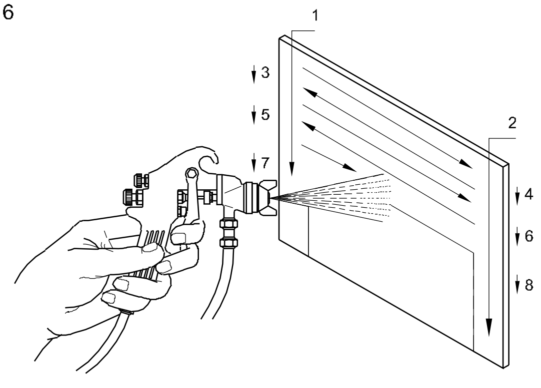
As you reach the end of the first pass, release the trigger just enough to close the fluid needle valve.

Shift the arm downwards one 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)

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 surface is to be painted, then start and end each pass with the sweeping motion angling away from the work.

Fig 6

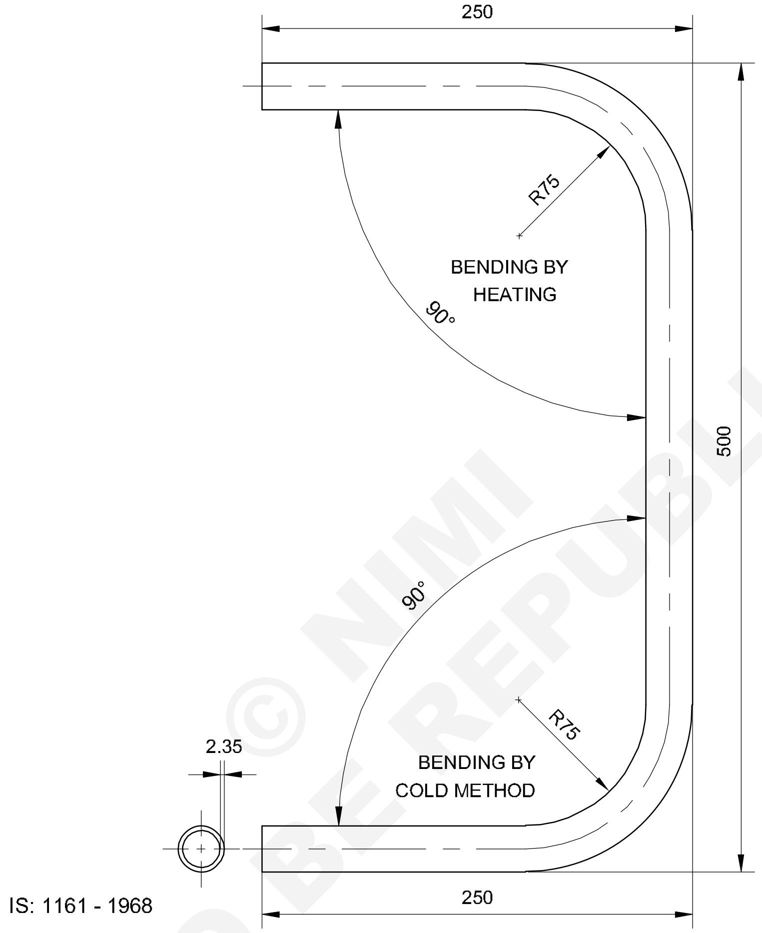


SEQUENCE OF PASSES WHILE SPRAY PAINTING

— — — — — — — —

Practice on pipe bending by hand

Objectives: At the end of this exercise you shall be able to
- **bend the pipe by heating and match with a template using sand and pegs**
- **bend the pipe by cold method as per template on a hand operated pipe bending machine.**



Job sequence

- Cut the pipe to size using hacksaw frame blade.
- Mark the bending lines on pipe.
- Bend one end by heating, using sand and pegs.
- Check the angle of bend and bending radius by template and rectify if necessary.
- Bend the other end using a hand operated pipe bending machine.
- Check the angle of bend and bending radius by template.

1	S/TUBE NB 20 x 2.35 - 1000	–	TUBE Fe310 (ERW)	–	–	57
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:4

PIPE BENDING ON PRACTICE BY HAND

DEVIATIONS ±1

TIME 5h

CODE NO. SM20N1757E1

Skill sequence

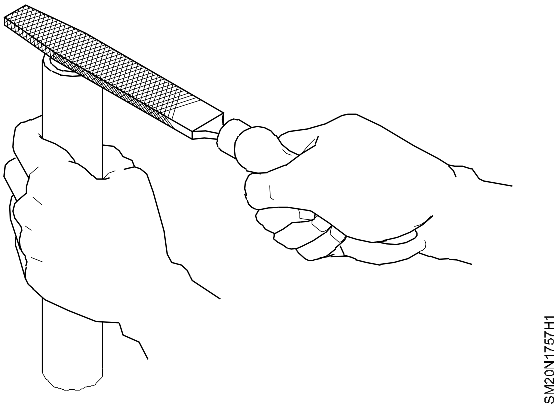
Bending pipes using sand and pegs

Objective : This shall help you to

- **bend pipe by hot method.**

File the pipe ends square. (Fig 1)

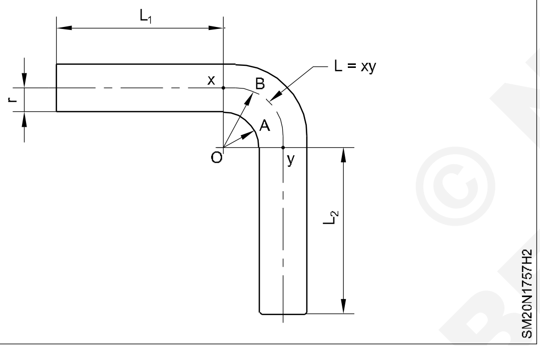
Fig 1



Remove burrs.

Calculate the length of the pipe.(Fig 2)

Fig 2



If D = diameter of bend

θ = angle of bend

L = length of curved portion

then, $L = \pi \times D \times \frac{\theta}{360}$ = Length of nuetral axis

If OA = inner radius of bend (R)

AB = radius of pipe (r)

OB = radius of bend (R+r)

then, $L = \pi \times 2(R+r) \times$.

Total length of pipe = $L_1 + L_2 + L$.

Measure and mark off the:

– centre of the bend (Fig 3)

– beginning and end of the bend from the centre line.

Measure the inside diameter of the pipe and select two suitable wooden pegs for the pipe. (Fig 4)

Fig 3

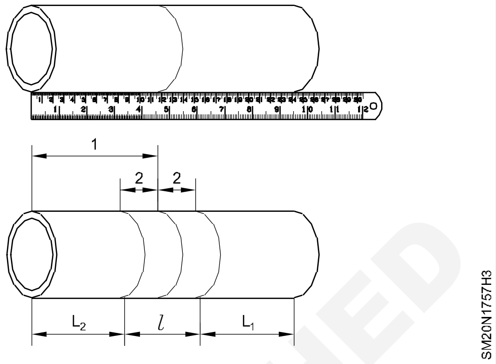
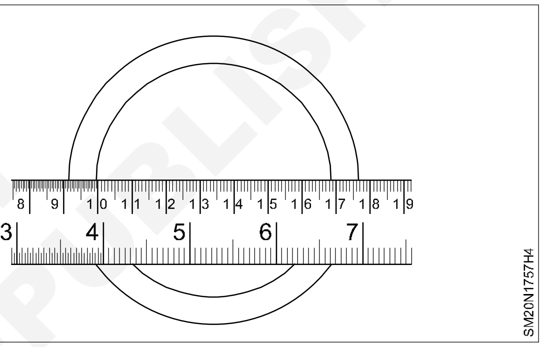
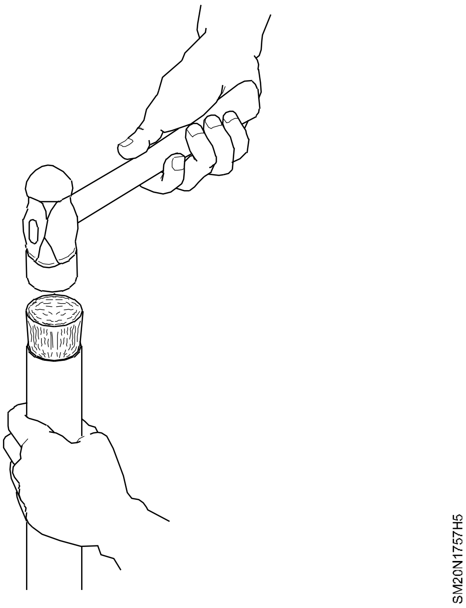


Fig 4



Plug one end of the pipe with a wooden peg.(Fig 5)

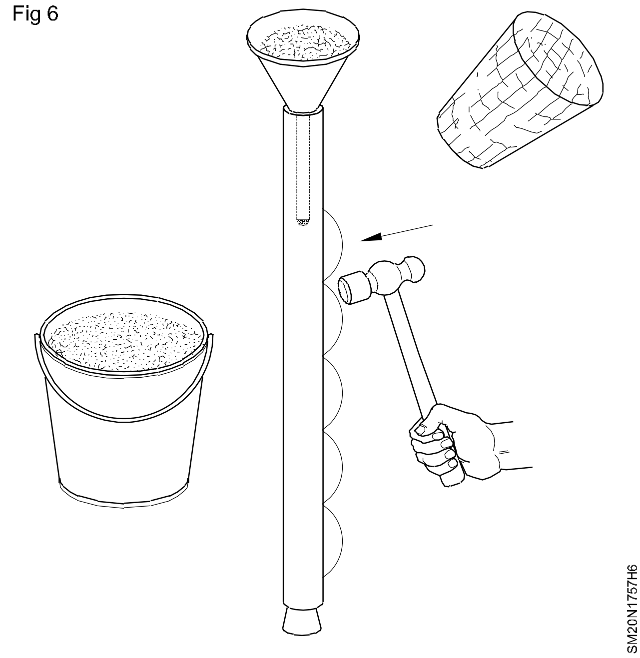
Fig 5



Fill the pipe with clean, dry and fine sand [Compress the sand by tapping the pipe up and down with a soft hammer.] (Fig 6) and plug the end.

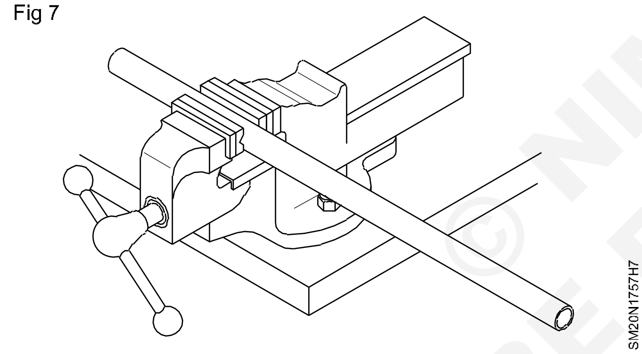
Ensure that the entire pipe is filled with sand.

Fig 6



Clamp one end of the pipe in a vice and protect the clamped portion of the pipe with lead or copper shims. (Fig 7)

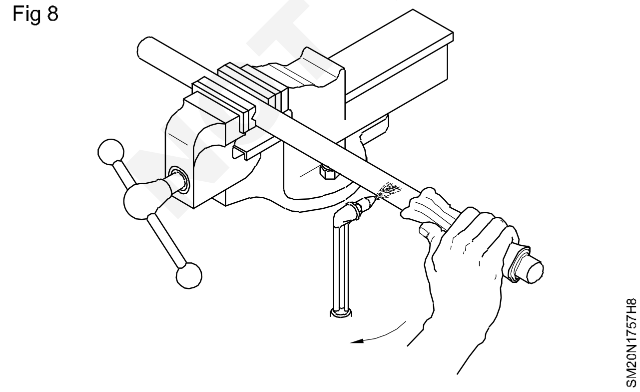
Fig 7



Heat the area to be bent with oxy-acetylene torch evenly until it glows dull red. (Fig 8)

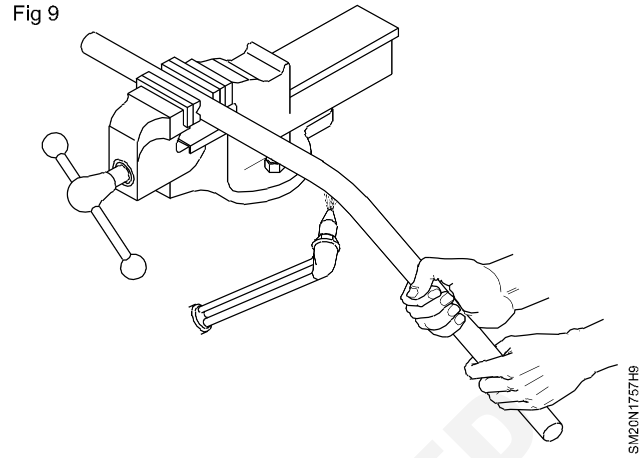
The bend area should not be overheated.

Fig 8



Pull down the pipe gently in the direction of the bend. (Fig 9)

Fig 9



Take short pulls until the correct bend angle is reached.(Fig 10-1,2,3)

Check the bend radius with a template. (Fig 11)

Apply heat throughout the whole operation and overbend slightly and straighten out the the final bend. (Fig 10)

Fig 10

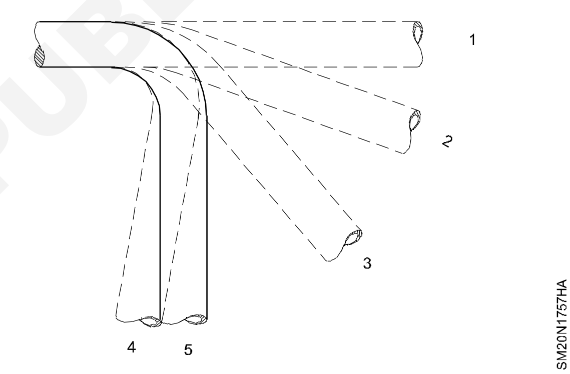
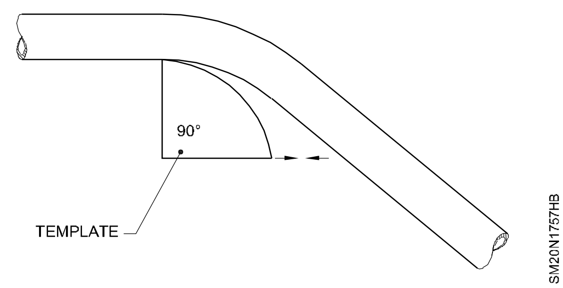


Fig 11



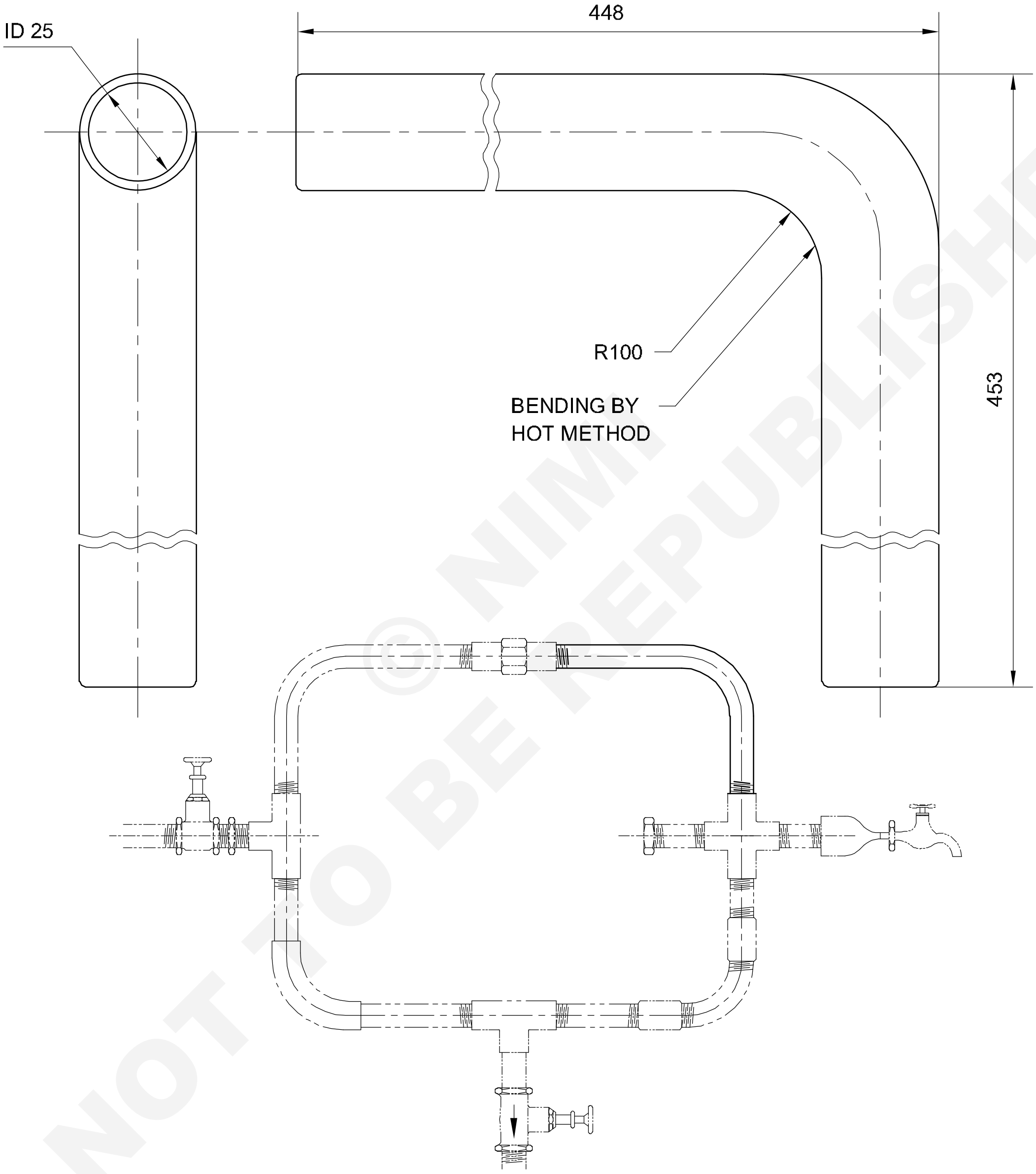
Remove one end of the plug.

Ensure that the pipe is cooled before removing the plug.

Remove the sand by tapping the pipe gently with hammer.

Pipe bending using hydraulic pipe bending machine

Objective : At the end of this exercise you shall be able to
- **bend G.I. pipe by hot method using sand and pegs.**



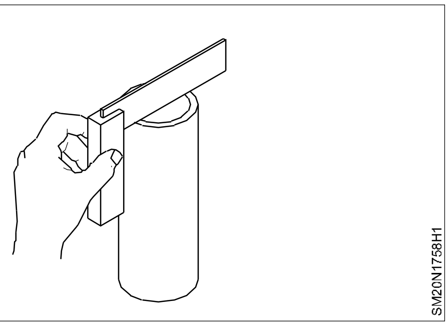
1	–	–	–	–	–	58
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**PIPE BENDING (USE TO PIPE BENDING MACHINE)**	DEVIATIONS ±0.5
		CODE NO. SM20N1758E1

Job sequence

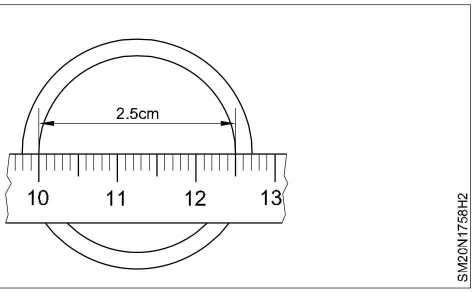
File the pipe ends and check up its squareness. (Fig. 1)

Fig 1



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

Fig 2



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

r = radius of bend (i.e) 150mm

Ø=angle of bend

l=length of curved portion

then

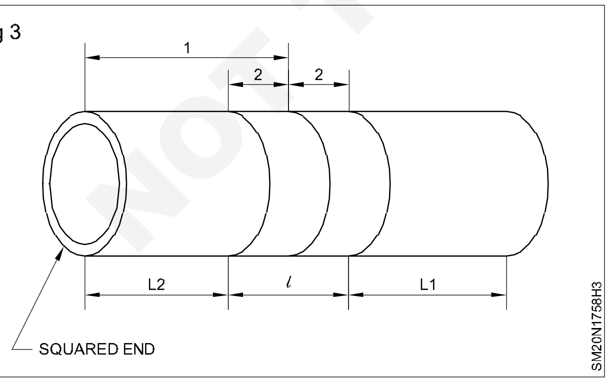
$$l = \frac{\pi \text{ x } D \text{ x } Ø}{360}$$

L = Total length

$= L_1 + l + L_2$

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

Fig 3



Select the standard former to suit the size of the pipe. (Fig. 4)

Fix the bending machine in a benchvice and ensure it is tightened properly. Locate the tube stop bar at the required position. (Fig. 5)

Fig 4

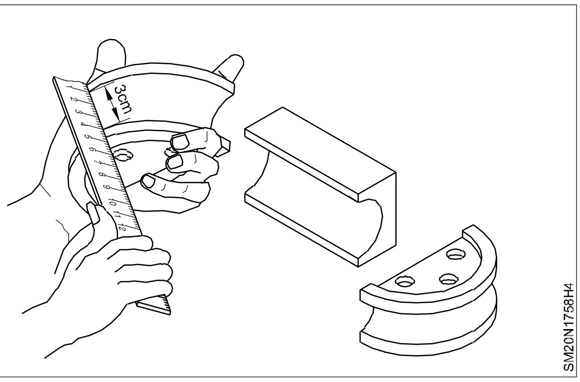
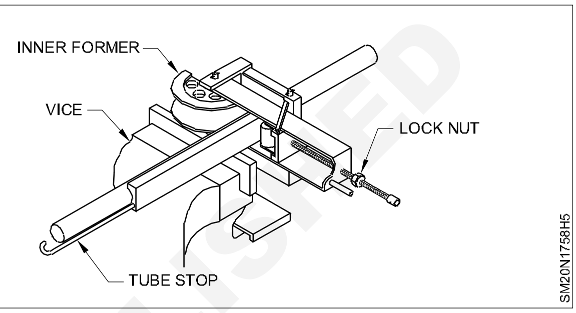
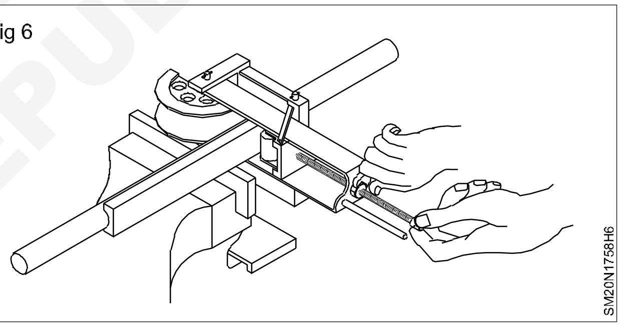


Fig 5



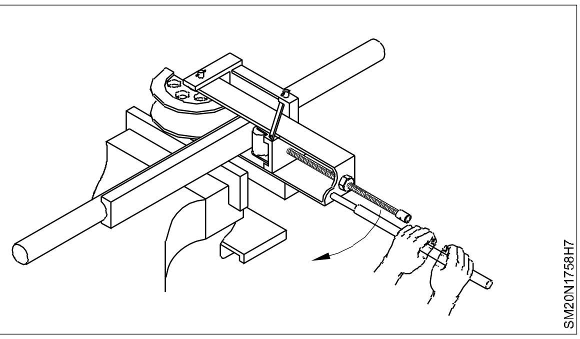
Set the roller on the bending arm by adjusting the screw and lock nut. (Fig. 6)

Fig 6



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

Fig 7



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

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

Check level of former and first leg (90° bend) with spirit level by placing spirit levels as shown in Fig. 10.

Check the angle of bend and radius using standard template. (Fig. 11)

Fig 8

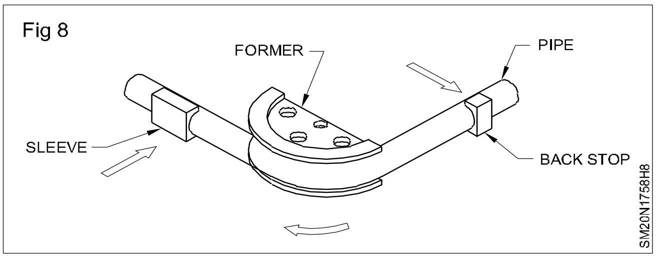


Fig 9

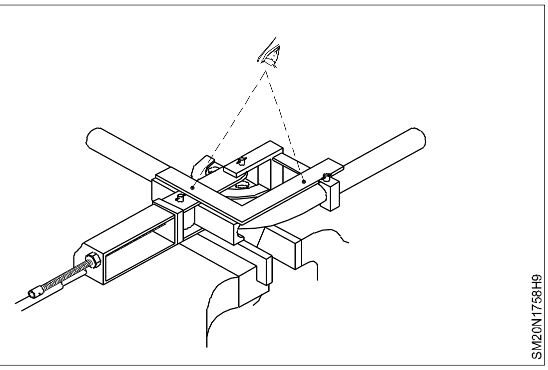


Fig 10

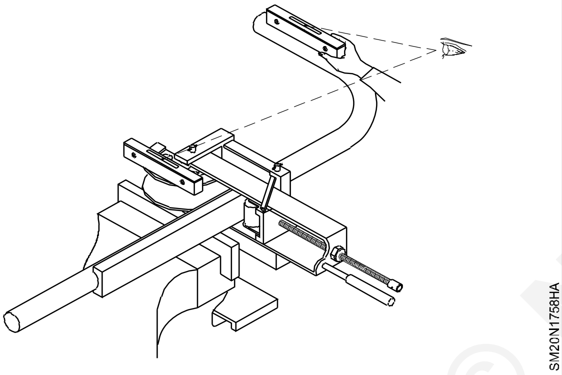
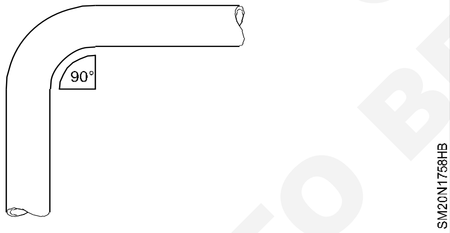


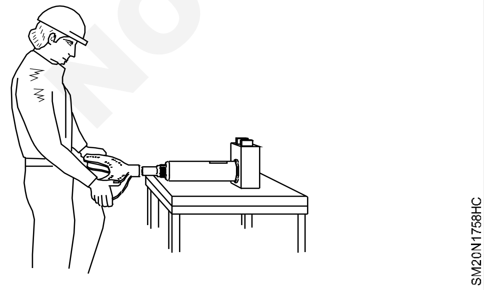
Fig 11



Bending 120° by Hydraulic bending machine

Fit the pipe former on to the cylinder arm. (Fig. 12)

Fig 12



Place the pipe between the forming head plates and against the former. (Fig. 13) Support the pipe and fit dollies (or rollers) between the upper and lower plates of the forming head. Locate them in position by inserting pins through the plates and the dollies. (Fig. 14)

Fig 13

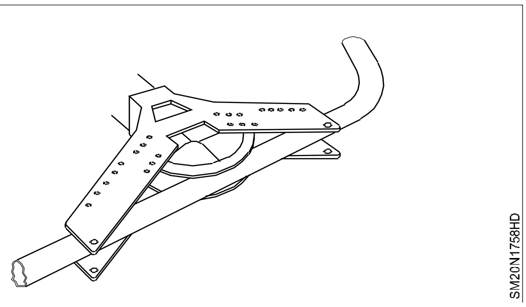
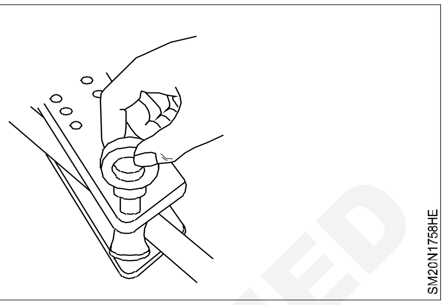
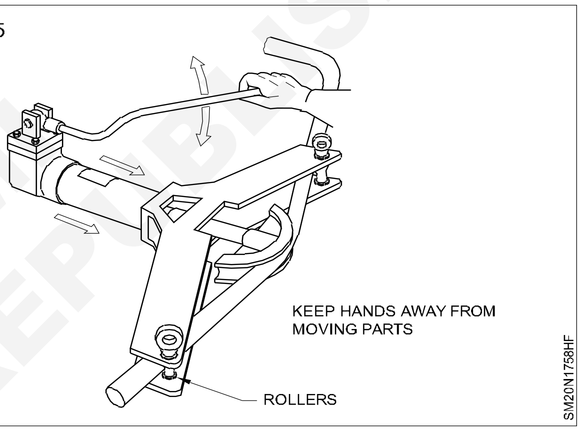


Fig 14



Close the pressure release valve on the pump body then start pumping to push the former against the pipe. (Fig. 15)

Fig 15



Turn the pressure release valve anti-clockwise to release the pressure in the hydraulic cylinder. When the arm has moved back about 6 mm to 10 mm close the pressure release valve to hold the ram steady. (Fig. 16) Check both bends 90° and 120° by placing pipe on the layout. (Fig. 17)

Fig 16

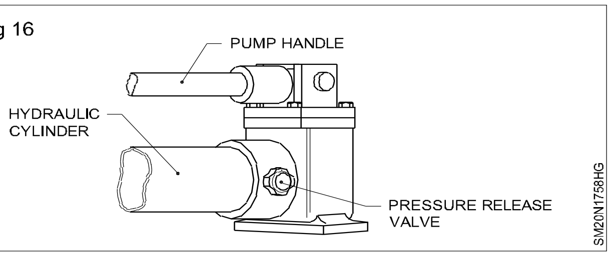
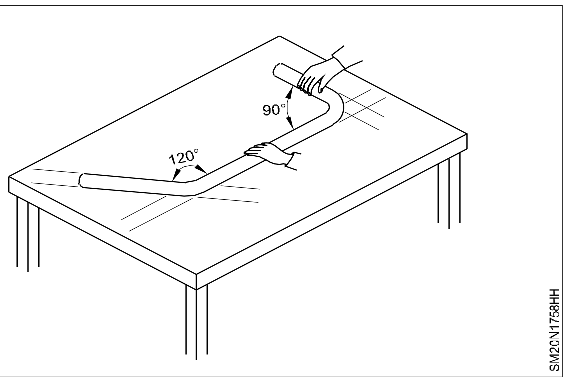


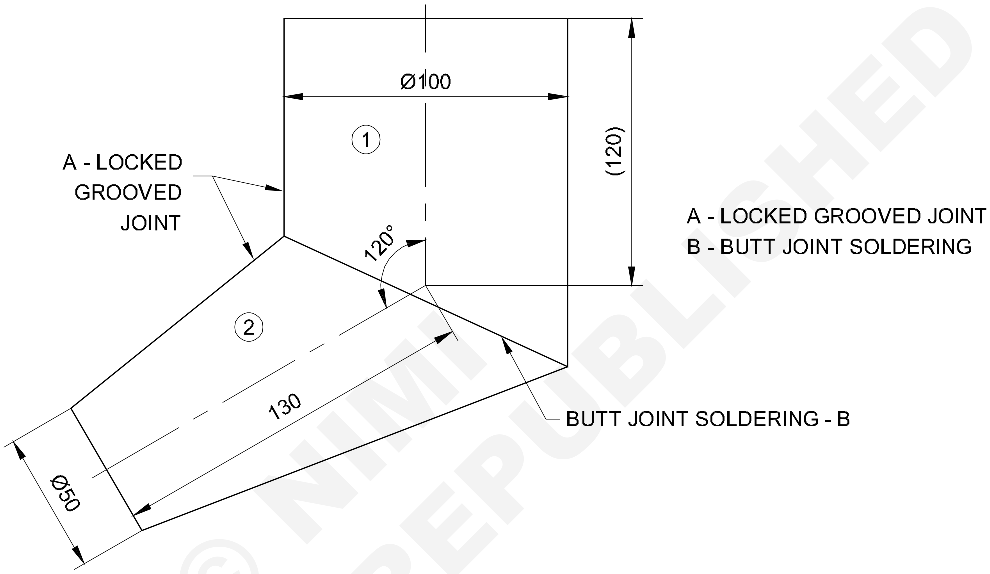
Fig 17



Development of a cone cylinder fitted to a cone

Objectives : At the end of this exercise you shall be able to
- **develop the pattern for an elbow between round and conical**
- **assemble the round and conical elbow with lobster back bend by soldered butt joint.**

Cylinder fitted to a core



Job sequence

- Develop and layout the pattern for 120° cylindrical and conical elbow pipe (Part 2&3) by parallel line and radial line methods respectively.
- Form Part 2 and Part 3 as per job drawing using beak iron stake, round mandrel stake and wooden mallet and join by locked grooved joints.
- Assemble part 1 & 2 by soldered butt joint.

–	60% x 40%	–	SOFT SOLDER	–		04
1	ISSH 320 x 0.61 - 250	–	ALU		2	04
1	ISSH 340 x 0.61 - 130	–	ALU		1	04
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS

PROJECT: MAKING A LOBSTER WITH BACK BEND
BY ALUMINIUM SHEET (22 SWG)

DEVIATIONS ±1

TIME 10h

CODE NO. SM20N1759E1

Skill sequence

Elbow between round and conical pipe

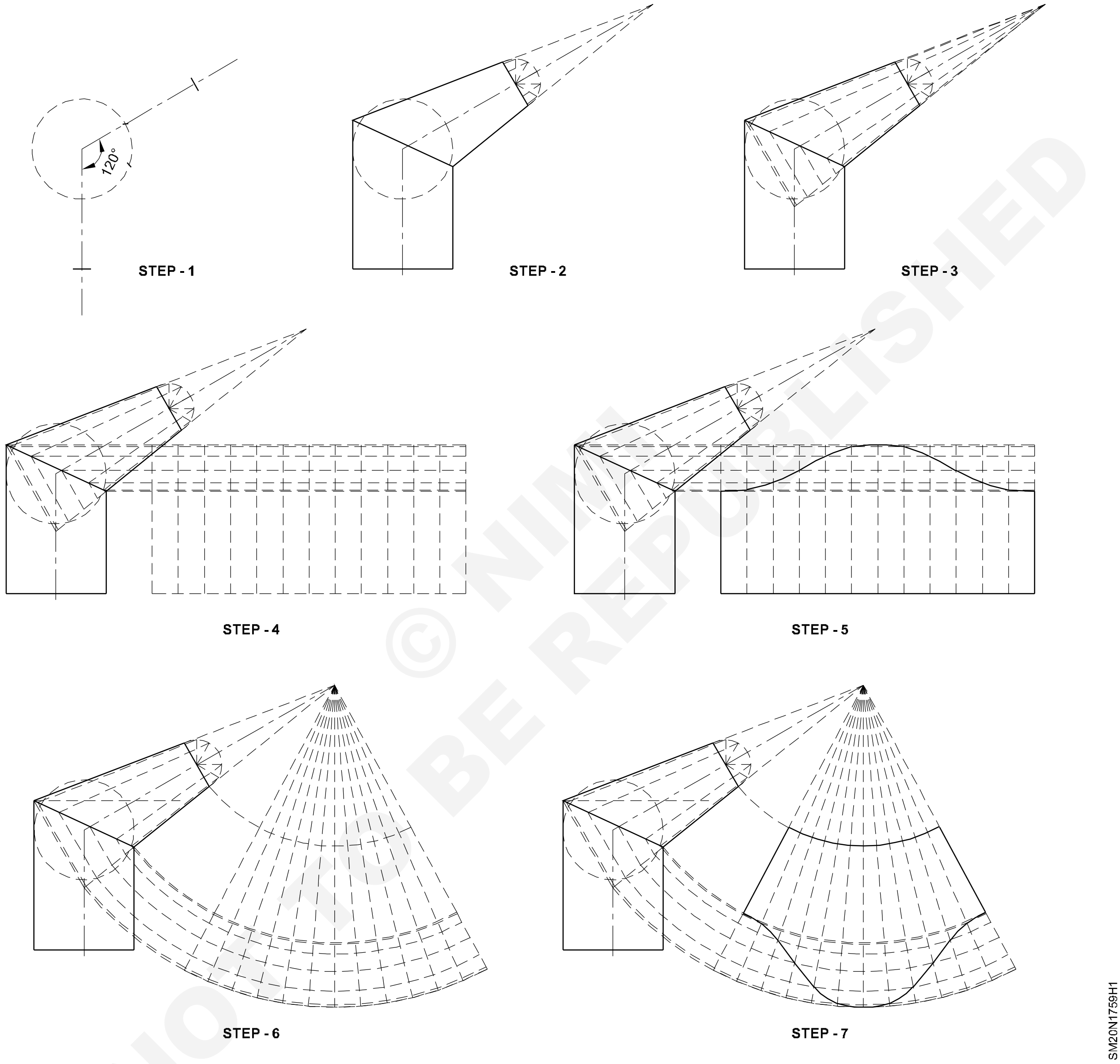
Objective : This shall help you to

- **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

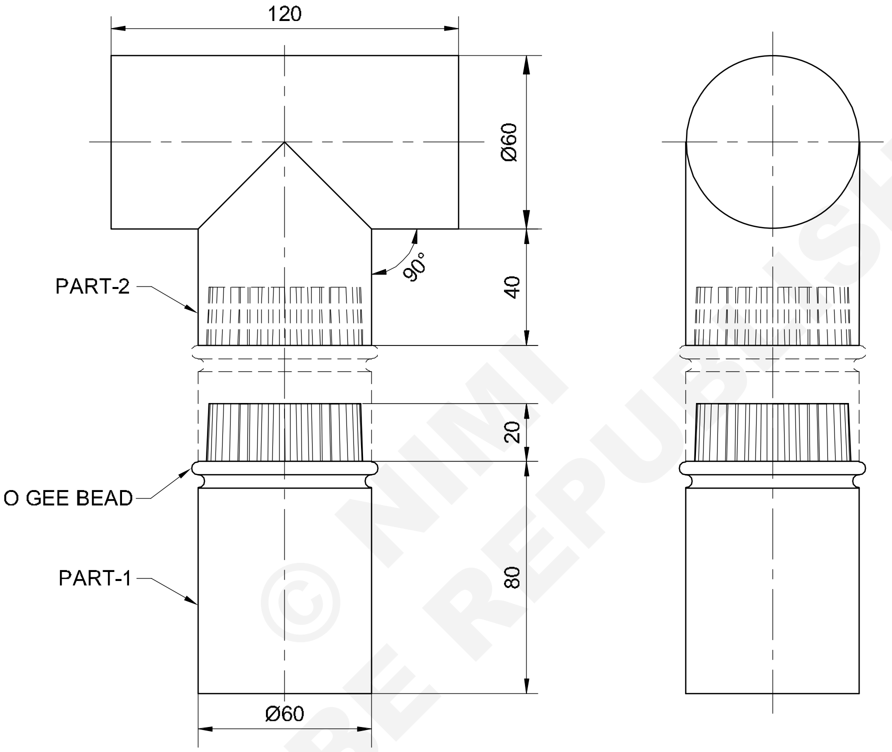
Fig 1



'Equal dia & TEE' pipe joint with crimping & OGEE beading by GI sheet

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

- **develop and layout the pattern for 90^0 "T" pipe of equal diameter by parallel line method**
- **form and join the main and branch pipe by using locked grooved joingt**
- **join two pipes at an angle of 90^0 by soldered butt joint to make 90^0 'T' pipe of equal diameter**
- **form crimping on cylindrical pipe by universal swaging machine using crimping rollers**
- **form ogee bead on cylindrical pipe by universal swaging machine using beading rollers**
- **join the pipes of equal diameter by crimping.**



–	–	1-3-10 ◄—	–		2	–
1	ISSH 220 x 0.61 - 85	–	G.I. SHEET		1	60
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	PROJECT: EQUAL DIA "T" PIPE JOINT WITH CRIMPING & OGEE BEADING	DEVIATIONS ±1	TIME 10h
	PART: 1 & 2	CODE NO. SM20N1760E1	

Job sequence

- Develop and layout the pattern for the 90^0 "T" of equal diameter as per the job drawing, with locked grooved joint allowances, by parallel line method.
- Cut the patterns for main pipe and branch pipe by straight and bend snips and 6" flat cold Chisel.
- Form the patterns to cylindrical shape and join by locked grooved joint using a round mandrel, a mallet 4 mm. groover and a Ball Pane Hammer.
- Join the main pipe and branch pipe at an angle of 90^0 by soldered butt joint using a hand forge, a soldering iron, a soft solder and flux.
- Take a pipe of ϕ60 - 100 mm length.
- Form crimping on one end upto 20 mm length, on universal swaging machine using crimping roller.
- Form ogee beading just adjacent to the crimping end on universal swaging machine using beading rollers.
- Insert and fix crimped section of the pipe in 'T' pipe as shown in job drawing.
- Tight the joint by using suitable mandrel and mallet.

Skill sequence

Equal dia `T' pipe with crimping and ogee bead

Objectives: This shall help you to

- **form crimping to required depth on cylindrical pipe by universal swaging machine using suitable crimping rollers**
- **form ogee beading to required depth on cylindrical pipe by universal swaging machine using suitable beading rollers**
- **join two pipes of equal diameter by crimping.**

Crimping

Lubricate all moving parts with oil/greese.

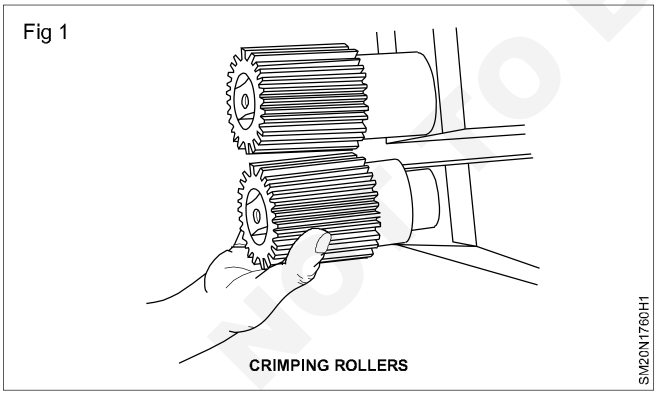
Clean spindles, apron gauge and other parts using rag.

Checking the operating condition by turning the handle.

Select the crimping rollers according to the dia of the pipe and length of the crimp.

Mount the crimping rollers on both the spindles of the universal swaging machine as shown in Fig 1.

Fig 1

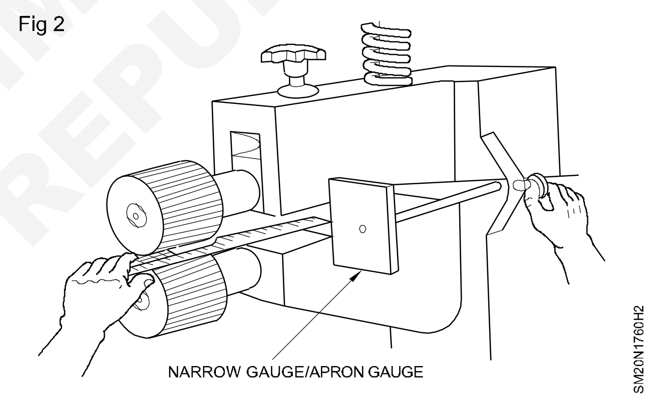


Align and set both the crimping rollers properly.

Adjust the narrow gauge/apron gauge according to the length of the crimp.(Fig 2)

Insert the cylinder in between the crimping rollers and slightly tighten the upper roller by the roll adjusting handle and form a slight crimping as a first step.

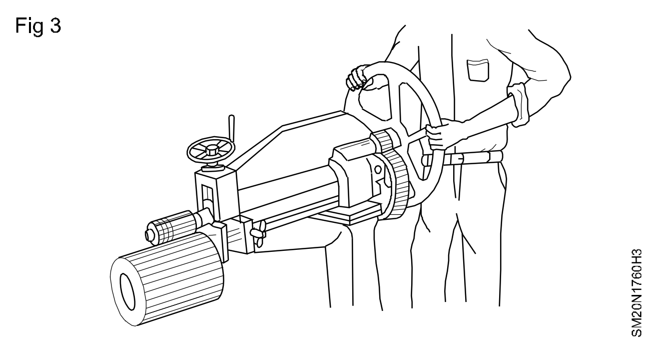
Fig 2



If you find crimping formed perfect again tighten the rollers by roll adjusting handle and increase the depth of the crimping by rotating the wheels in second stage.

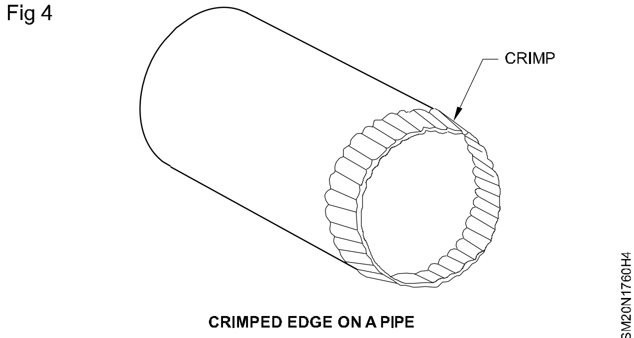
Continue this process till crimping is formed to required depth. (Fig 3)

Fig 3



After the completion of the crimping operation, loosen the rollers and remove the job from the machine. Fig 4 shows crimped edge on a pipe.

Fig 4

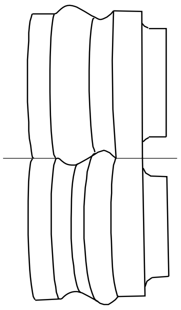


CRIMPED EDGE ON A PIPE

Beading

Select the suitable beading rollers. Set the rollers on the spindles of the universal swaging machine as is done previously. (Fig 5).

Fig 5



Adjust the narrow gauge/apron according to the requirement as per the job drawing as shown in Figure.

Insert the cylinder in between the beading rollers and complete the beading, in steps as is done previously.

After the completion of the beading operation, loosen the rollers and remove the job from the machine.

Joining two pipes of equal diameter by crimping

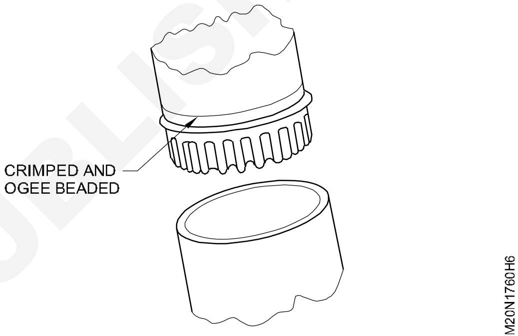
Take two pipes of equal diameter.

Form crimping on one end of one pipe. While crimping, see that the diameter of crimped section is slightly larger than the inner diameter of the pipe to be fitted on it.

After crimping one end of the pipe, the diameter of the pipe gets reduced at crimped section.

Insert crimped pipe in other pipe (Fig 6). To make the joint tight, flatten the crimped portion slightly from all sides using suitable mandrel and mallet.

Fig 6



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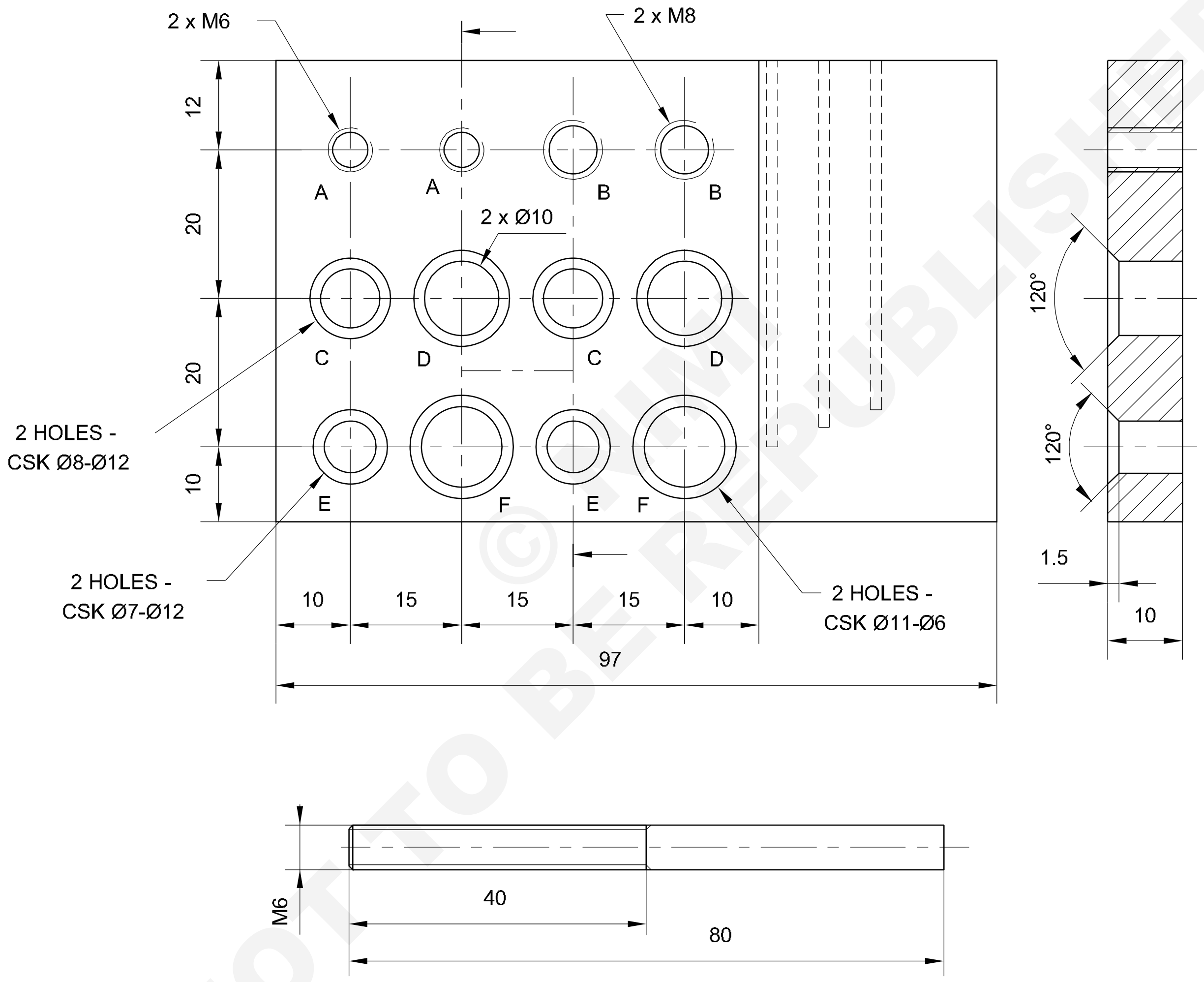
Drilling, tapping counter boring & Cutting external threads

Objectives: At the end of this exercise you shall be able to
- **operate a bench drilling machine safely**
- **drill through holes on a bench drilling machine**
- **countersink holes to fit standard screw heads on a bench drilling machine**
- **cut internal threads using hand taps**
- **cut external threads using dies.**



–	STD BOLT M6	–	Fe310	–	–	61
–	STD BOLT M8	–	Fe310	–	–	61
–	STD NUT M6	–	Fe310	–	–	61
1	ISRO 6 x 80	BF-1-03 ←	Fe310	–	–	61
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1

**DRILLING,TAPPING, COUNTERBORING
AND CUTTING EXTERNAL THREADS**

DEVIATIONS ±0.8
TIME 10h
CODE NO. SM20N1761E1

Job sequence

Part - 1

- Mark and punch the centre points of holes as per drawing using a surface gauge and centre punch.
- Drill ϕ 5 mm - 2 hole for M6 tapping at point ‘A’ using a straight shank drill ϕ 5 mm.
- Drillϕ 6.8 mm 2 holes for M8 tapping at point B using a straight shank drill ϕ 6.8 mm.
- Drill ϕ 8 mm 4 through holes at points ‘C’ & ‘D’ using a straight shank drill ϕ 8 mm.
- Enlarge ϕ 8 mm - 2 holes by drilling ϕ 10 mm at points ‘D’ using a straight shank drill ϕ 10 mm.
- Drill ϕ 7 mm 4 through holes at points E & F using a straight shank drill ϕ 7 mm.
- Enlarge ϕ 7 mm - 2 holes by drilling ϕ 11 mm at point F using a S.S.T drill f 11 mm.
- Countersink ϕ 8 & ϕ 7 holes to 120^0 x 1.5 mm depth using a Taper shank drill ϕ 12 at point ‘C’ and 'E'.
- Countersink ϕ 11 mm and ϕ 10 holes to 120^0 x 1.5 mm depth using a Taper shank drill ϕ 16 at point ‘F’and 'D'.
- Deburr all drilled holes by rotating a larger sized drill by hand.
- Cut internal threads M6 - 2 holes at point ‘A’ using a hand tap set M6.
- Cut internal threads M8 - 2 holes at point ‘B’ using a hand tap set M8.
- Check M6 & M8 tapped holes with the standard M6 and M8 screws.
- Hold M.S rod of ϕ 6 x 80 mm length in the benchvice.

Part 2

- Cut M6 external thread to 30 mm length by using M6 die set by hand.
- Check M6 external threads with the standard M6 nut.

Skill sequence

Drilling through hole on bench drilling machine

Objectives: This shall help you to
- **operate a bench drilling machine safely**
- **drill through holes to the required size on a bench drilling machine.**

Ensure that the floor and area around the drilling machine is clear and clean.

Remove all loose tools, parts, rags etc from drilling table.

Clean the bed, column and spindle of the drilling machine and lubricate with proper oil. Place the machine guards in their places.

Wear safety goggles. Ensure that the drilling machine is in working condition and coolant is filled in the cooling tank.

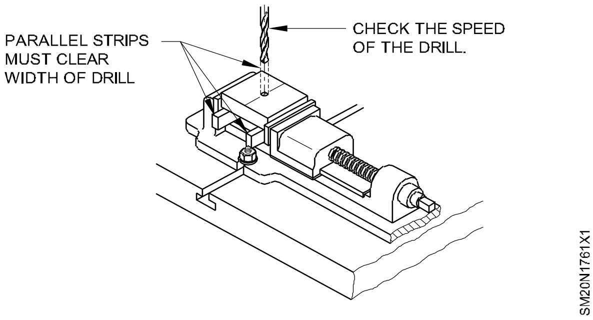
Centre punch the holes to be drilled.

Clean the machine vice jaws and place it on the bed of the machine.

Open the vice jaws so as to accommodate the workpiece in it.

Fix the workpiece in the machine vice, supporting on parallel plates on both sides such that the through holes can be drilled clearly. (Fig 1)

Fig 1



Select the given size and correctly ground drill.

Insert the drill in the drill chuck and tighten the jaws of the chuck with the key.

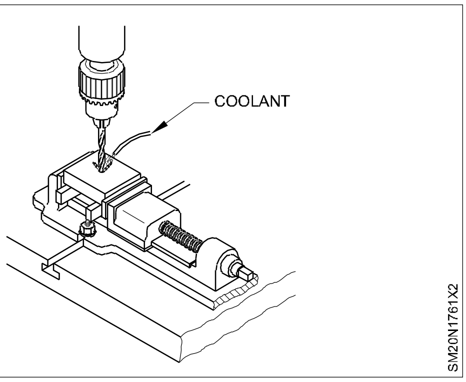
Select proper speed of the drill.

Use high speed for the small size drills and lower speed for big size drills.

Switch on the machine and lower the spindle slowly until it touches the workpiece. Ensure that the drill locates the punched centre point of hole. If not, move the machine vice so as to locate the drill at centre point. Start drilling lowering the spindle.

Feed the coolant at drill point by opening the coolant pipe tap. Feed the drill till the hole is drilled through. (Fig 2)

Fig 2



External threading using dies

Objective : This shall help you to
- **cut external threads using dies.**

Select a correct size round bar as blank and chamfer the ends.

Blank size = Thread size - 0.1 pitch of the thread

Grip the blank in the vice using soft jaws, projecting the blank above the vice jaws 5 mm more than the required length of thread. Fix the die in the die stock. The leading side of the die must be opposite to the step of the die stock. (Figs 1 & 2)

Fig 1

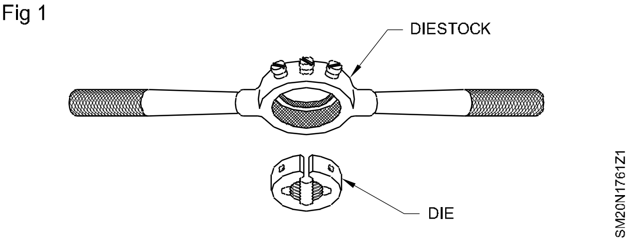
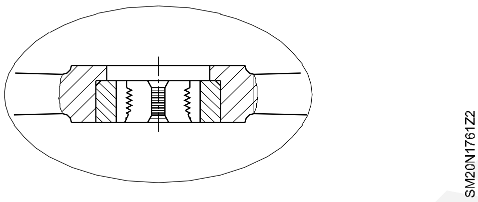
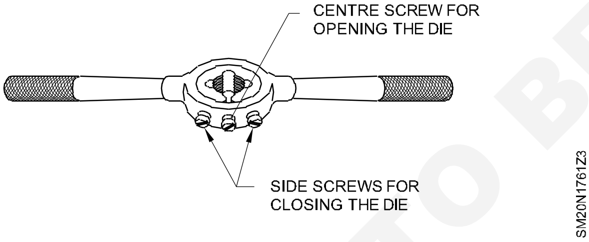


Fig 2



Open the die fully by tightening the centre screw of the die stock. (Fig 3)

Fig 3



Place the leading side of the die on the chamfer of the job.

Start the die, square to the bolt centre line. (Figs 4 & 5)

Fig 4

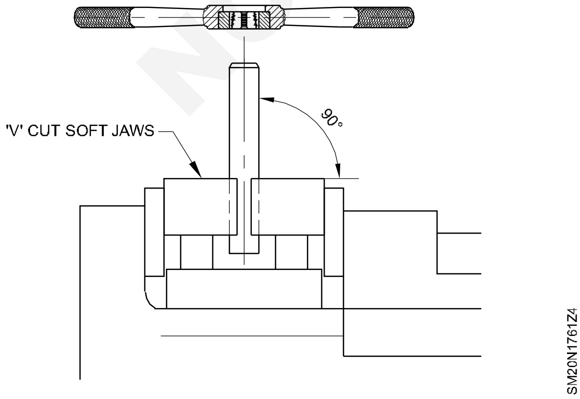
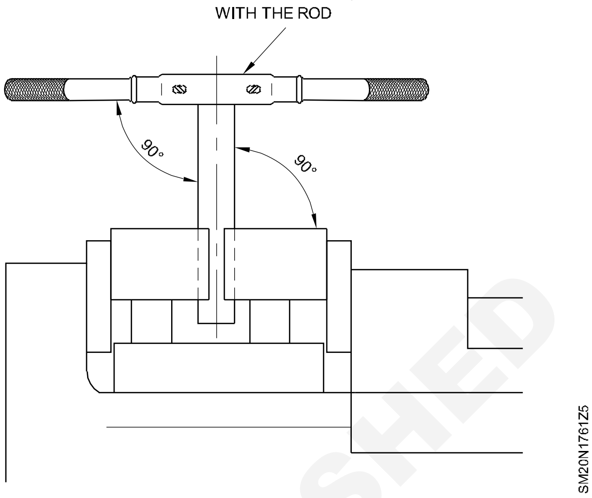


Fig 5



Turn in the clockwise direction to advance the die on the blank, with even pressure on both ends of the die stock.

Cut thread slowly and reverse the die for a short distance in order to break the chips.

Use a cutting lubricant.

Clean the die frequently with a brush to prevent the chips from clogging and also from spoiling the thread.

Reverse and remove the die after the full height is reached.

Increase the depth of the cut gradually by loosening the centre screw and tightening the side screws.

Too much depth of cut at one time will spoil the threads. It can also spoil the die.

Check the fit of threads with a matching nut.

Tighten the side screws by hand and repeat the cutting, until the standard nut matches with the external and without undue ‘play’ between the threads.

Internal threading of through holes using hand taps

Objectives : This shall help you to
- **determine the tap drill sizes for internal threading**
- **cut internal threads using hand taps.**

Determine the tap drill size

- For cutting internal threads, it is necessary to determine the size of the hole (tap drill size). This can be calculated using the formula or can be chosen from the table of drill sizes.
- Drill the hole to the required tap drill size. (Fig 1) Do not forget to give the chamfer required for aligning and starting the tap (Fig 2).

Fig 1

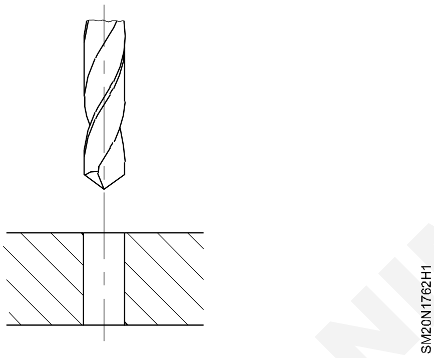
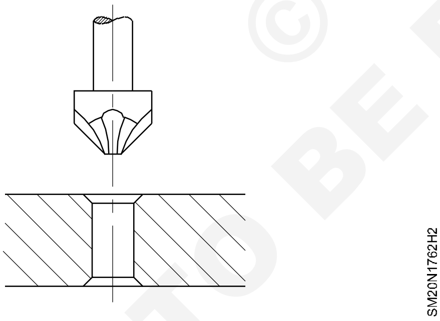
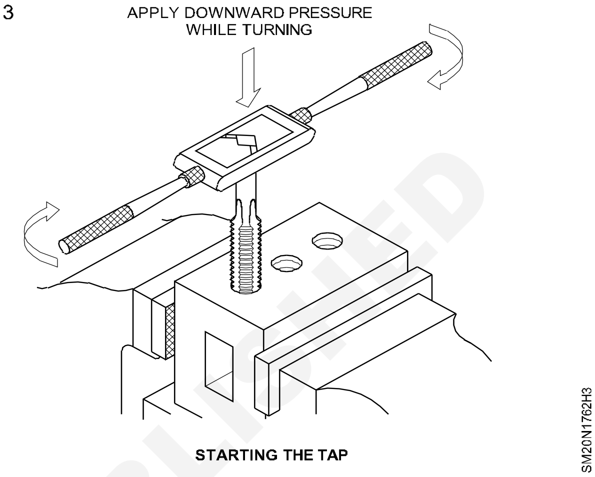


Fig 2



- Hold the work firmly and horizontally in the vice. The top surface should be slightly above the level of the vice jaws. This will help in using a try- square without any obstruction while aligning the tap. Use soft jaws while holding the finished surface on the vice.
- Select suitable tap wrench. Too small a wrench will need a greater force to turn the tap. Very large and heavy tap wrenches will not give the feel required to turn the tap slowly as it cuts. Fix the first tap (Taper tap) in the wrench.
- Position the tap in the chamfered hole vertically by ensuring the wrench is in the horizontal plane.
- Exert steady downward pressure and turn the tap wrench slowly in the clockwise direction to start the thread.

Fig 3



- Remove the wrench from the tap when you are sure of starting of the thread. Remove the tap wrench without disturbing the tap alignment. Check and make sure the tap is vertical. Use a small try-square for checking perpendicularity. Place the try-square in two positions 90^0 to each other. (Fig 4 & 5)

Fig 4

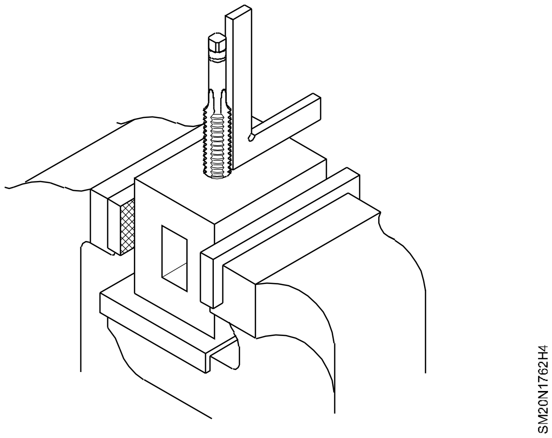


Fig 5

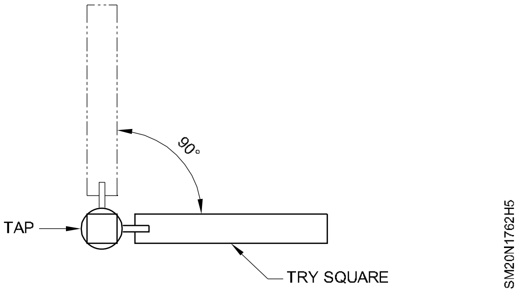
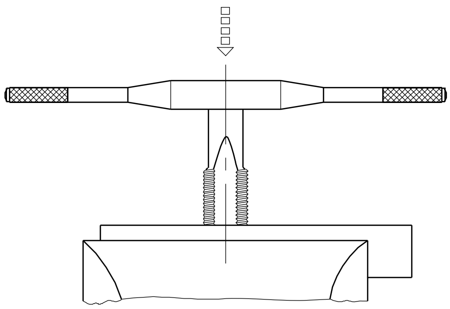


Fig 6



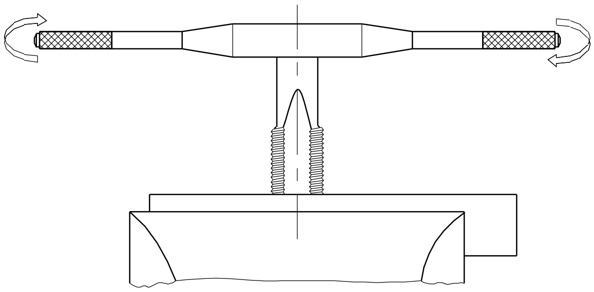
SQUARING UP THE TAP

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

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

- Check the tap alignment again with a try-square. Fit the tap wrench, and tighten without disturbing the tap alignment.
- Make one or two turns and check alignment. The tap alignment should be corrected within the first few turns.
- After the tap is positioned vertically, turn the wrench lightly by holding the ends of the wrenche's handles without exerting any downward pressure.
- While turning the wrench the movement should be well balanced. Any extra pressure on one side will spoil the tap alignment and can cause breakage of the tap. (Fig 7)

Fig 7 APPLY CONSTANT BALANCED TURNING PRESSURE

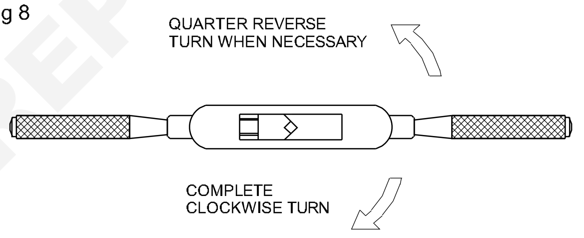


- Continue cutting the thread. Turn backward frequently about quarter turn to break the chip. Stop and turn backward also when some obstruction to movement is felt. (Fig 8)

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

- Cut the thread until the tap enters the hole fully. Finish and clean up using the intermediate and plug tap.
- The intermediate and plug tap will not cut any thread if the tap has entered the hole fully.
- Remove chips from the work with a brush. Check the threaded hole with a matching screw.
- Clean the tap with a brush, and place it back on the stand.

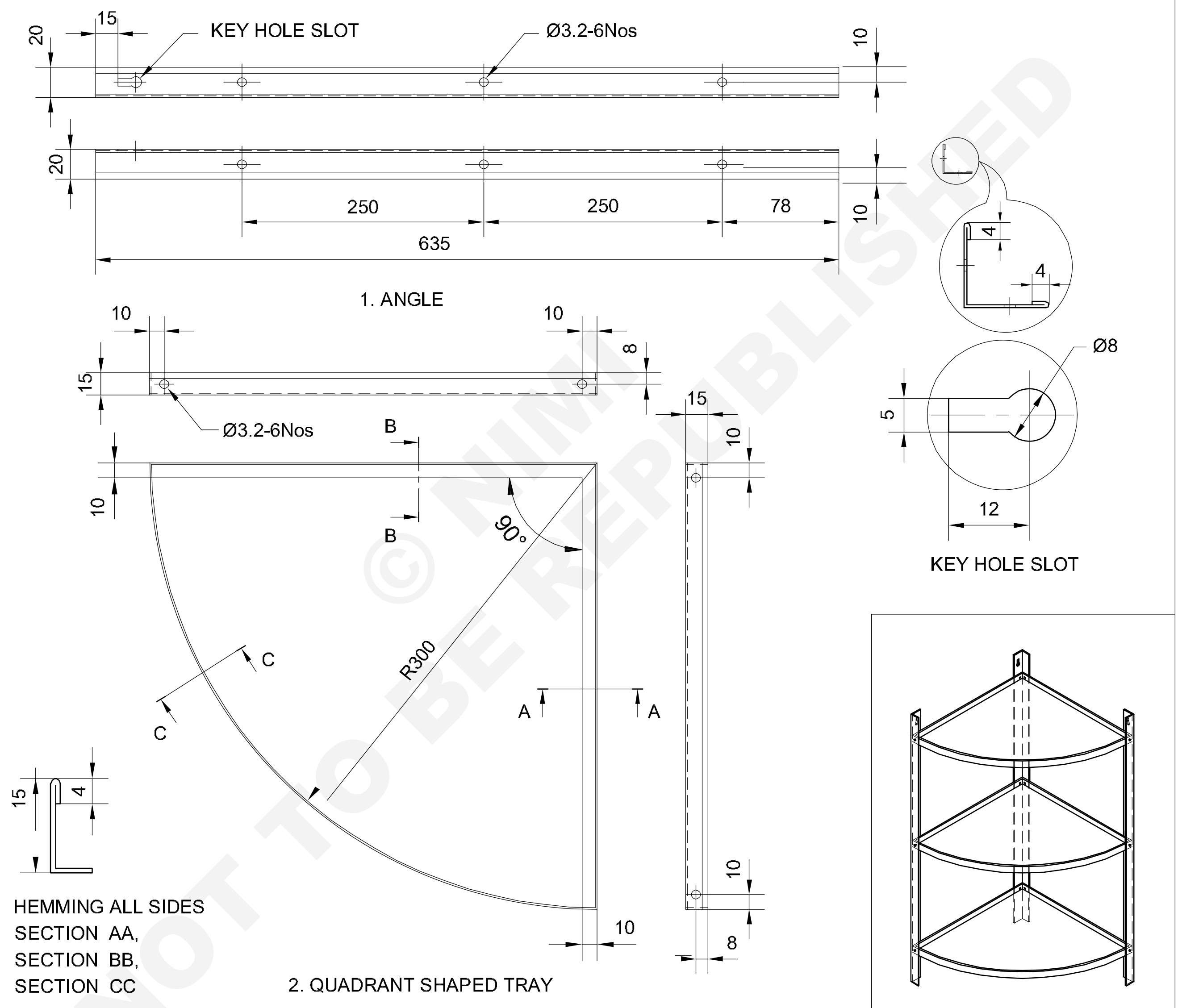
Fig 8



Make a steel rack by Alu. sheet

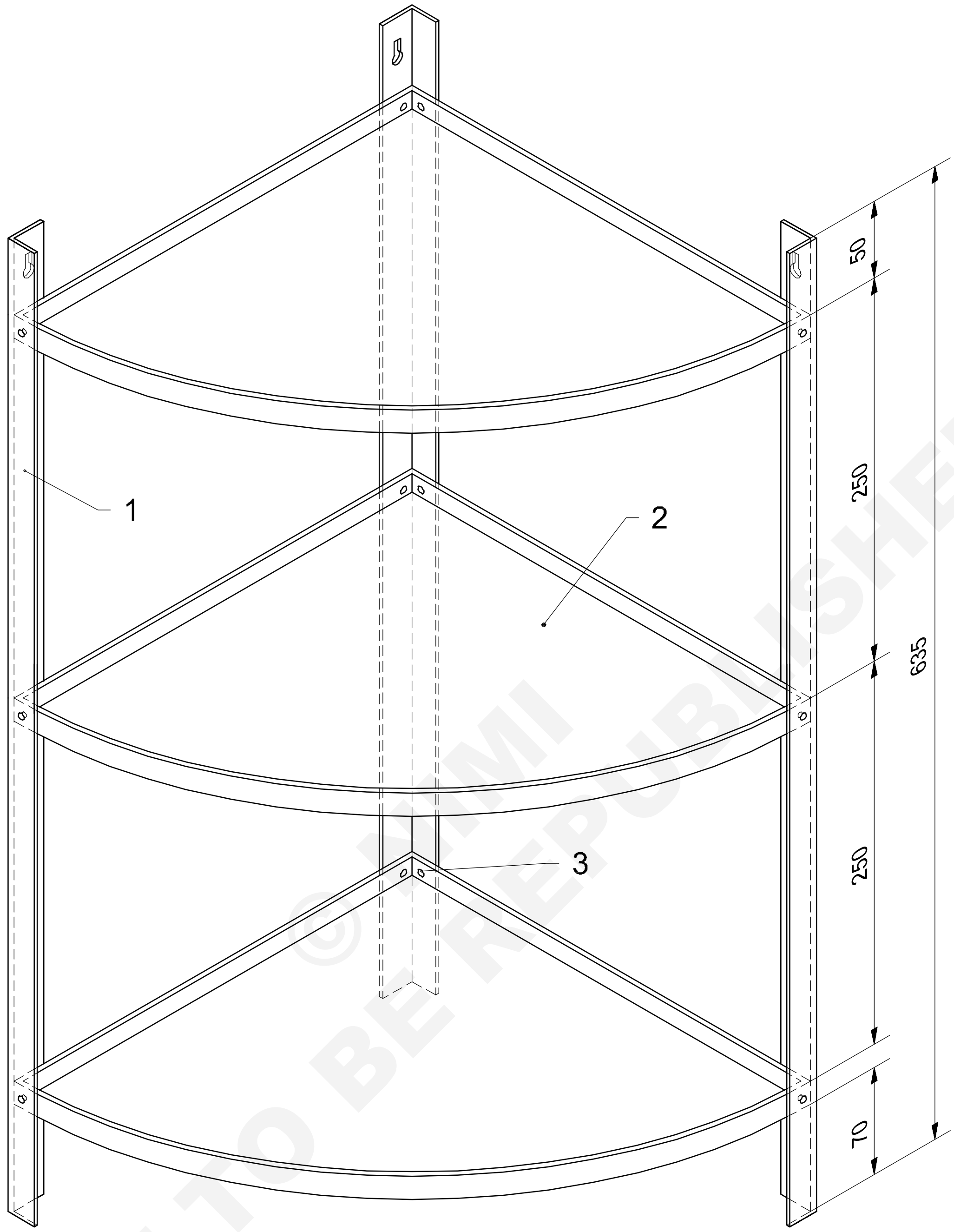
Objectives : At the end of this exercise you shall be able to

- **develop and layout the pattern for a quadrant shaped tray by geometrical construction method**
- **fold along a curved edge using a wooden former, a hand dolly and a mallet**
- **cut key hole slots on the sheet metal by drilling and chiselling**
- **assemble the corner rack by riveting as per the drawing.**



18	IS: 2155 - Ø3 - 6	--	ALU SNAP HEAD RIVET		3	63
3	370 x 370 x 0.6	--	ALU		2	63
3	640 x 55 x 0.3		--		1	63
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**MAKE A STEEL RACK BY ALU. SHEET**	DEVIATIONS ±1	TIME 10h
		CODE NO. SM20N1763E1	



18	IS: 2155 - Ø3 - 6	--	ALU SNAP HEAD RIVET		3	63
3	370 x 370 x 0.6	--	ALU SHEET		2	63
3	640 x 55 x 0.3		ALU SHEET		1	63
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:4

PARTS:

1. ANGLE 2. QUADRANT SHAPED TRAY
3. SNAP HEAD RIVET

DEVIATIONS ±1

TIME 10h

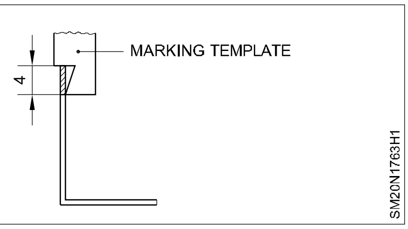
CODE NO. SM20N1763E2

Job sequence

Angle

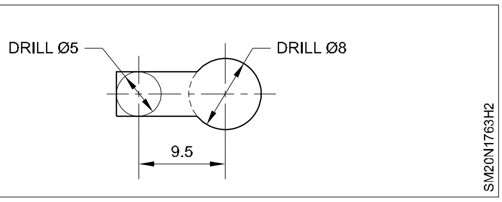
- Mark 4 mm hemming allowance on the edges of both sides using a marking template. (Fig 1)

Fig 1



- Make a single hem on the edges of both sides on bar folder.
- Now mark a key hole slot on angle as per drawing.
- Drill ϕ 8 mm and ϕ5 mm hole using a portable power operated drilling machine as shown in Fig 2.

Fig 2



- Cut the key slots using a chisel and a ball peen hammer.
- Finish the key hole slot by filing.
- Mark and drill ϕ3.2 rivet holes as per the drawing.
- Repeat using the portable power operated drilling machine for other two pieces.

Quadrant shaped tray

Mark and cut the material to size 370 x 370 using a straight snip.

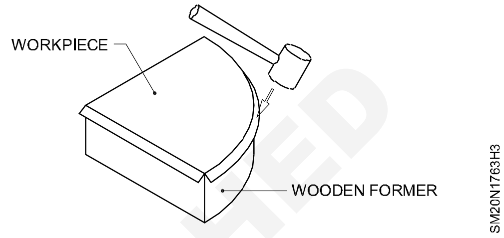
Develop and layout the pattern for the tray by geometric construction method. (Fig 1 of skill sequence)

Cut the unwanted portion using straight snips. (Fig 1 of skill sequence)

Hem the straight edges of the two sides on the bar folder and the curved edge of one side on the half moon stake using a ball peen hammer.

Fold 15 mm straight edges of two sides on the bar folder and 15 mm curved edge on a wooden former (Fig 3) using a hand dolly and a mallet.

Fig 3



Similarly, make the remaining two trays.

Assembly

Mark the lines on angle for the position of the trays as per the drawing.

Place the bottom tray in position and transfer the holes markings from the angle to the trays.

Similarly, transfer the holes markings from the angle to the remaining two trays one after the other.

Drill ϕ3.2 holes, on the markings on all trays using a portable power operated drilling machine.

Place the bottom trays in position as per the marking, align the drilled rivet holes and assemble by riveting ϕ 3 x 6 mm snap head rivets.

Accordingly, assemble the remaining two trays by riveting.

Skill sequence

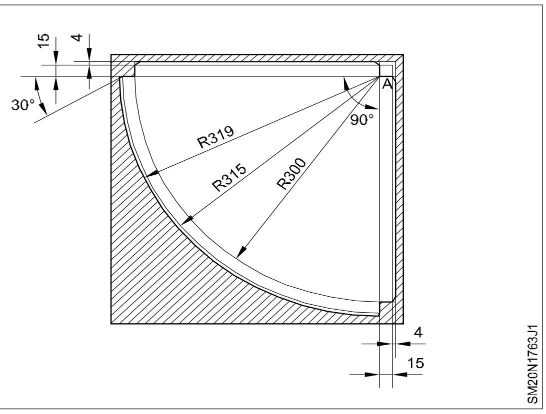
Developing the pattern using geometrical construction method

Objective: This shall help you to

- **develop and layout the pattern for the quadrant shaped tray using geometrical construction method.**

Take the job drawing of the same quadrant shaped tray for better illustration. First draw two perpendicular lines meeting at any one corner. (Fig 1) Draw parallel lines at a distance of 4 mm (hemming allowance) and 15 mm (edge) parallel to these lines as shown in Fig 1. Now from point ‘A’ draw radii 300, 315 (for 15 mm edge) and 319 (4 mm hemming allowance) as shown in Fig 1. Draw 30^0 lines for notches at all corners as shown in Fig 1. Now cut the unwanted portion using a straight snip. In Fig 1 the unwanted portion is shown by the hatching lines.

Fig 1



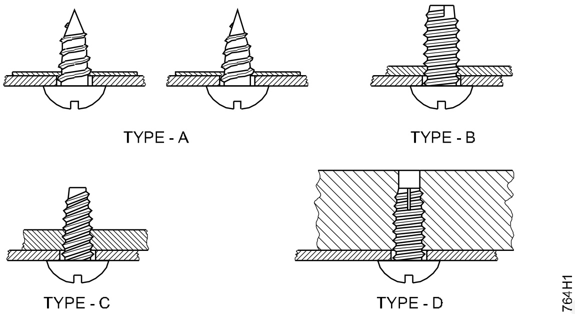
Use of soft taping screws and other fasteners

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.

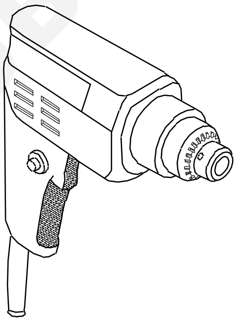
Fig 1



SELF TAPPING SHEET METAL SCREWS

- 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.
- 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 o f 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

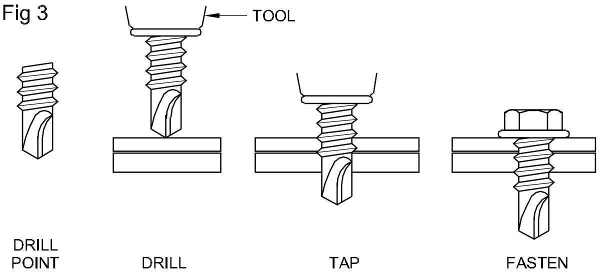


PORTABLE ELECTRIC DRILL

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



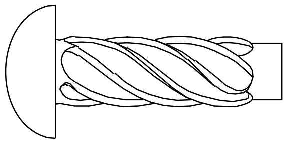
SELF DRILLING AND TAPPING SCREWS

- 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.

Fig 4



SHEET METAL DRIVE SCREW

- 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.

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.

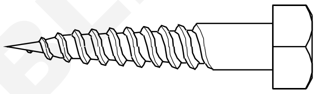
Nails

- 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

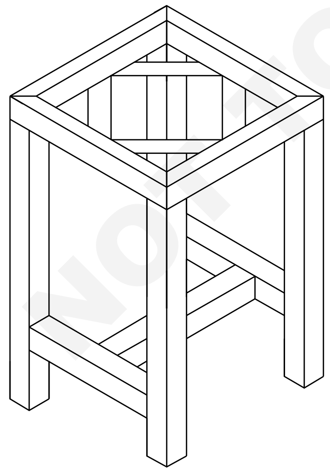
Project work such as steal stool. (aluminium ladder)

Objectives: At the end of this exercise you shall be able to
- **able to make a model drawing using geometric drafting**
- **method make a steel stool using steel frames.**
- **make a ladder using aluminium frame..**

Job sequence

- The stool 1 designed is 23 tall by 14 on each 'side' Each leg is 17 square tubing cut to 22. To complete one of these stool end tables you will need the following length of steel
- 4x22"1" long 16 ga cold rolled mild steel square tube for legs 3x 12 long16ga cold rolled mild steel square tube for cross beams 4 x 4 45 degree miter length 1x 16 ga cold rolled mild steel quarry pipe for cross beams 4x8 5 45 degree mitered length of 2x 1/8 hot rolled flat bar steel. Check the top of the wood square nicely with a steel square as well as with a measuring tape. You know you ve got your pieces square when each of your corner diameters out to the same value. Your accessories are the same. Make sure the planers are aligned WELDING LINER MATERIAL Once your cut the material it will be a piece of cake. Once you make sure your parts are properly seated and square and flush weld to 16 ga with the correct setting Put a tack weld on the outer corners on the material Tap the inner corners Tap the outer nipples to get the inner nipples So the last end we work this eay before starting to from the weld bead (weld beed) around our cuts we can reduce heat distortion To creates the cross frame we will weld a 3.12 length of 1 square tube measuring 5.5 from the side and mark the spot with a center punch.

Fig 1



- Pipe vertically so it's punched closed and secured with tools and magnets check your squareness Make sure both sides are completed Make sure your material is flush and square Ta[the top of the cut pieces at diagonal points check for squareness when tapping the top of the stove to distribute heat evenly.

Fig 2

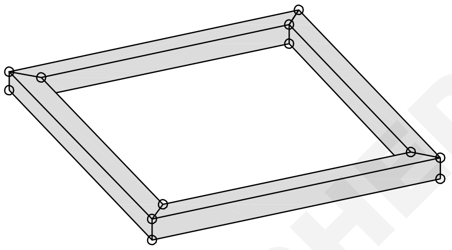
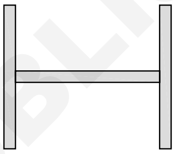
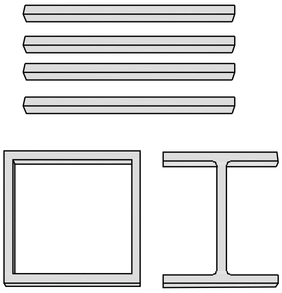


Fig 3



- For these welds you don't' need to weld all four sides of the pipe, because these are butts that never need to go out, so you don't need to tag the entire pipe
- Once you have finished tapping the top and cross frame you are ready to add the pieces
- Begin by taping the squares and wedging the arms only

Fig 4



- Make sure tour welds even with the planes on each side and at the corners
- Finish the pieces flat with two edges two bead outer edges. Once the legs are welded in place weld the cross beam together.
- 1 ended up welding the 1 4'down at the base and making the chariot.
- Once this process is complete, nugget (sheet) stum e for seating

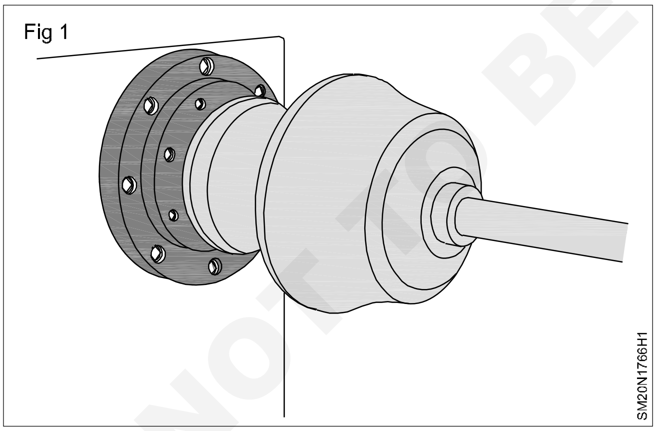
Metal spinning making a cylindrical medicine Container of aluminium sheet by spinning lathe

Objectives: At the end of this exercise you shall be able to
- **prepare an aluminium plate of the required size for the aluminium plate getting done.**
- **knowing how to operate a Aluminium spinning container lathe.**

Job sequence

- The Process for clinical is very simple .A machined block is formed in the drive section of the lathe .A pre-sized aluminium metal disk is then clamped against the block with a brush pad. Simple work pieces used are removed from the block but more complex shapes may require several pieces of block. The work piece must be thick enough that the final diameter of the work piece is always less than the starting diameter. To exdend radically or circumferentially.
- Reduction or neck is called high involvement process, Rotating workpiece again involving geometry surface and is if form is not important .No mandrel is used where the workpiece is exposed to the wind, coating (a) A wide - mounted mandrel is used if shape is crictical .
- Hot spinning involves spinning a piece of metal from a torch at high heat to shape the metal as it heats up.
- The tool on the lathe vibrates against the surface forcing it to deform as it comes off to shape parts or force them down to smaller diameters to provide seamless Nepalese.

Fig 1

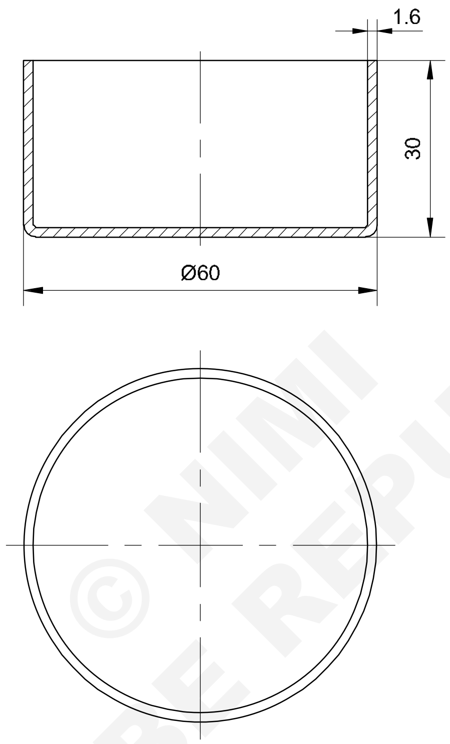


- Tools the basic hand spinning core is so called spoon, although many cores can be made from hardened steel, not stainless steel, or mild stel for spinning.
- Some D.loka spinning tools are allowed to slip on the bearing rollers during operation. This reduces the humidity the heat of the instrument . extents tool life and improves surface finish tool life longer tools ceramic can be thin coated Rotary tools general C.N.C (C.N.C) are used in metallurgical operations.
- Commercially at the end of the Neambu thon (fifted rollers) are usually both spiral and CNC metal lathes used to form the material below the mandrel.
- The rollers vary in diameter and thickness to smooth the powder surface .
- Metal cutting done with hand - cut cutters , usually foot-long hallow bars with shaped / pointed flutes, carbide or tool steel cut in C.N.C applications.
- The mandrel is not subject to excessive forces as seen in other metalwork and therefore it can be made from wood, plywood or snow.

Make a cup (copper/brass/stainless steel) using a drawing tool on a power press

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

- **determine the blank size for the cup to be drawn**
- **set the drawing tool on power press for drawing operation**
- **operate the power press safely**
- **draw a copper cup on the power press.**



Job sequence

- Determine the blank size by using the formula $D = \sqrt{d^2 + 4dh}$ plus trimming allowances which will be equal to 150 mm diameter.
- Prepare the metal blank using a circle cutting machine.
- Check and clean the power press.
- Select the tool and clean it.
- Set and clamp the forming tool on the power press.
- Form the component on the power press.
- Trim off the extra metal and finish it to the required size.

1	IS 2378 - 160 x 1.6 - 160	–	CUDPA (COPPER SHEET)	–	–	67
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**DRAW A CUP (COPPER) USING A DRAWING TOOL ON A POWER PRESS**	DEVIATIONS ±1	TIME 10h
		CODE NO. SM20N1867E1	

Skill sequence

Calculating the blank size for forming a cup shaped article

Objective : This shall help you to

- **calculate the blank size of sheet metal for a cup shaped article by calculation.**

The blank size for a cup shaped article can be calculated by the formula given below.

$$D = \sqrt{d^2 + 4dh}$$

where D = The diameter of the blank

d = The diameter of the cup

h = height of the cup.

Let us calculate the blank diameter for the cup shown in Fig 1.

Formula $D = \sqrt{d^2 + 4dh}$

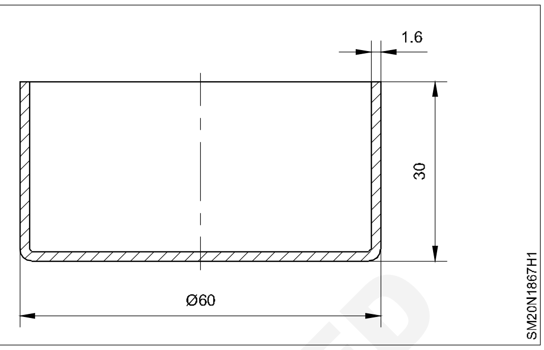
Here d = 6 cms, h = 3 cms

$$D = \sqrt{6^2 + 4 \times 6 \times 3}$$

$$= \sqrt{36 + 72}$$

$$= \sqrt{108}$$

Fig 1



$= 10.3$

Trimming allowance: A Trimming allowance of 0.06 mm per mm of cup diameter.

= 60 x 0.06 = 3.6mm

Total blank size is 103 + 3.6 mm = 106.6 mm, Rounded off the 107 mm.

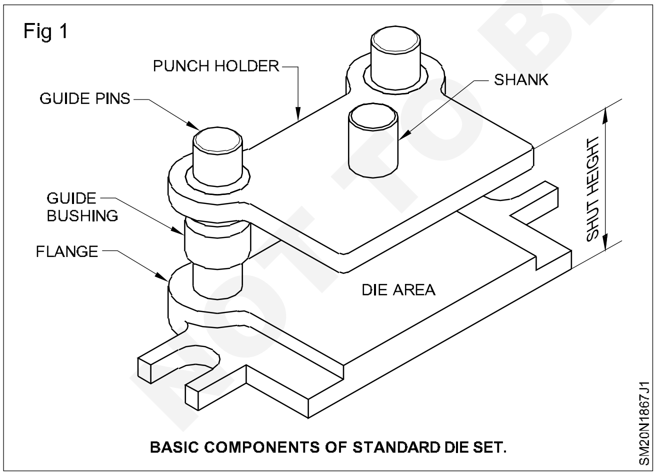
Setting a forming tool on the power press

Objective: This shall help you to

- **set a forming tool on the power press.**

A standard die with basic components is shown in Fig 1. Select the forming tool. Clean it and measure the height of the tool. Clean the bolster plate (Bed) and the bottom face of the ram.

Fig 1



BASIC COMPONENTS OF STANDARD DIE SET.

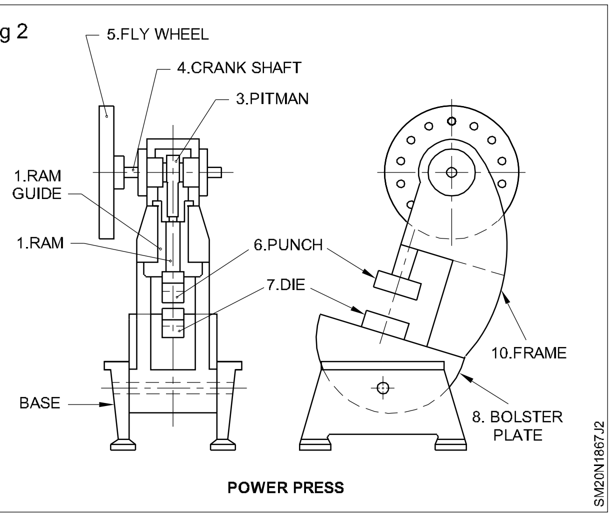
Sketch of a power press is shown in Fig 2.

Insert a round rod into the holes provided on the fly wheel and rotate the fly wheel in clockwise direction and press the foot treadle of the machine.

The position of the ram is now at the Top Dead Centre. (TDC)

The clutch will get engaged and the ram will move downwards.

Fig 2



POWER PRESS

Rotate the fly wheel till the ram comes down to its maximum down position.

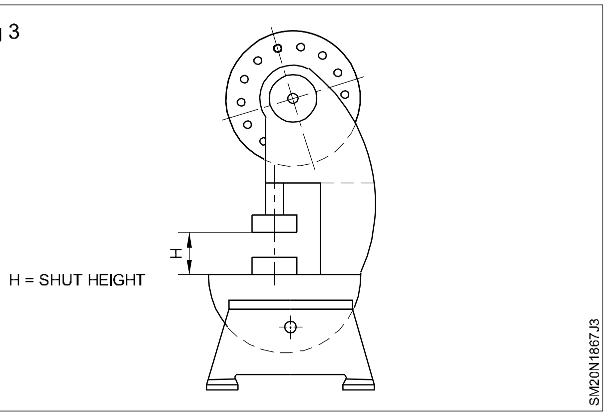
If you further rotate the ram starts moving upwards.

This position of the ram is called its Bottom Dead Centre. (BDC)

The distance now measured from the bottom face of the ram to the top surface of the bed is called the sheet height. (Fig 3)

The sheet height of the machine must be slightly more than the height of the tool.

Fig 3



Raise the ram to TDC by rotating the fly wheel.

Mount the forming tool on the bed.

Lower the ram by rotating the fly wheel and set the shank of the tool into the space provided for the shank in the ram.

A slight gap will be observed between the bottom face of the ram and the top surface of the tool when the ram is at BDC.

Lower the ram to seat on the top surface of the tool by the screw rod adjusting mechanism provided on the machine.

Tighten the punch holder bolts.

Set clamps for the die and slightly hand tighten the clamping bolts.

If the tool is designed with guide pins and bushed (as in Fig 1) the clamping bolts of the die can be tightened.

If the tool is not designed with pins and bushes then place small strips of metal of the same thickness as that of the component to be formed at four places opposite to each other on the die opening for centering the punch and die.

Lower the ram slowly by rotating the fly wheel with the rod, as the punch enters the die it will get self centered because of the metal strips kept all around.

Now tighten the die clamps and raise the slide up.

Switch on the machine and operate the machine with foot treadle.

The movement of the ram from TDC to BDC and from BDC to TDC is called ‘STROKE’.

Set the stroke to the required depth of the component to be formed by the screw rod adjusting mechanism.

Apply a thin film of oil on the punch, die and on the guide pins.

When setting the tool on the power press never switch on the machine without determining the sheet height of the machine and the tool.

If the sheet height of the machine is lesser than the tool height then the ram of the machine will get jammed with the tool causing a major break down of the machine.

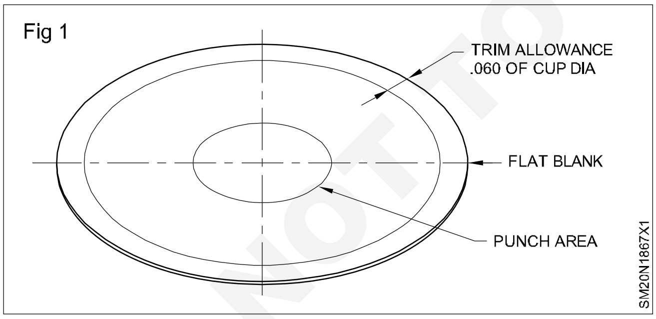
Hence always rotate the fly wheel manually while setting a press tool on the power press.

Draw a cup (copper) using drawing tool on a power press

Objectives: This shall help you to
- **draw a cup (copper) on the power press using the draw tool**
- **set a drawing tool on a power press**
- **operate the machine safely.**

Check the metal blank to be formed for its size with trimming allowance. (Fig 1)

Fig 1



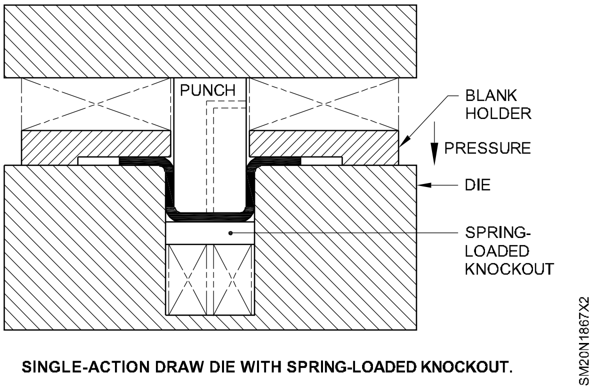
Check that all the tool clamping bolts are tightened. Never switch on the machine while cleaning or checking the tool because if the clutch is engaged the machine will operate causing an accident. Hence check and ensure that the clutch is not engaged before switching on the machine.

After ensuring that everything is alright switch on the machine. Operate the machine and ensure that the stroke is correct. Apply a thin film of oil on the face of the die and punch with the help of a brush. Place the metal blank on the face of the die, so that it is located exactly in the centre of the die.

Press the foot treadle, the ram will come down and the punch will form the metal blank into a component. (Fig 2)

Keep your hands away from the working area of the punch and die for safety. Adjust the stroke to the required depth by the screw rod adjusting mechanism. Lock the foot treadle after completing the forming operation. Switch off the machine.

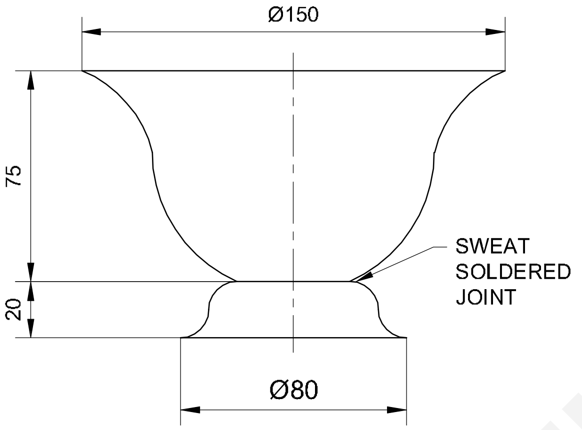
Fig 2



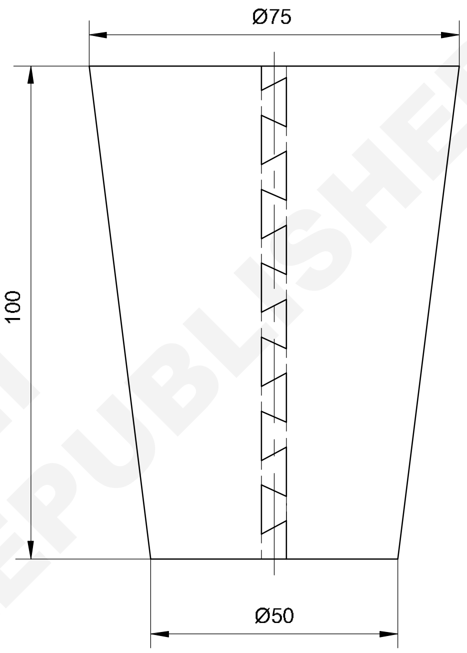
SINGLE-ACTION DRAW DIE WITH SPRING-LOADED KNOCKOUT.

Buffing & polishing practice

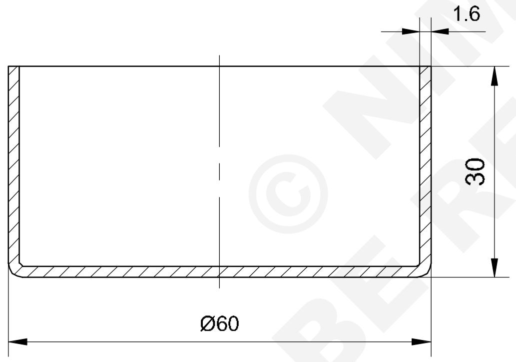
Objectives : At the end of this exercise you shall be able to
- **operate polishing machine with various types of polishing wheels**
- **polish brass bowl, tumbler and copper cup.**



BRASS BOWL



BRASS TUMBLER



COPPER CUP

Job sequence

- Clean article before polishing.
- Apply the polishing vax, solution over the body of the job and finish it over a buffing wheel for polishing.

1	COPPER CUP	2-1-19 ←	–	–		68
1	BRASS TUMBLER	2-1-12 ←	–	–		68
1	BRASS BOWL	2-1-11 ←	–	–		68
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	BUFFING & POLISHING PRACTICE	DEVIATIONS ±1	TIME 5h
		CODE NO. SM20N1868E1	

Skill sequence

Buffing process

Objectives: This shall help you to

- **buff the surface of a metal and give it a mirror finish and attractive appearance**
- **finish the surface with a satin finish using wire wheels.**

Check the surface to be buffed. It should be free from scratches and rough surface. Mount the wheel on the buffing head or other power machine. Hold the compound stick lightly against the outer surface of the wheel as it turns in Fig 1. Wear safety goggles and tuck in loose clothing when buffing.

Fig 1

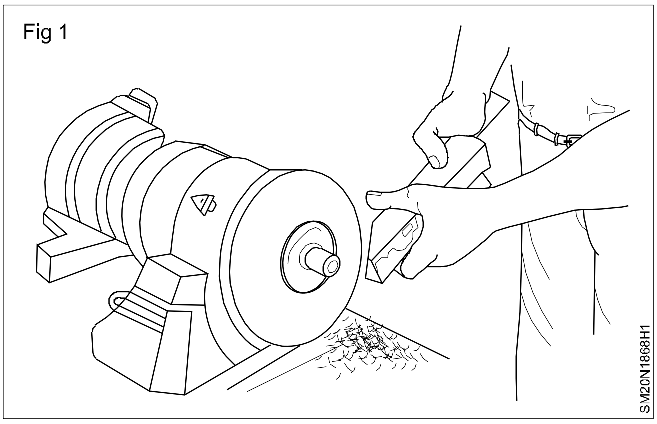
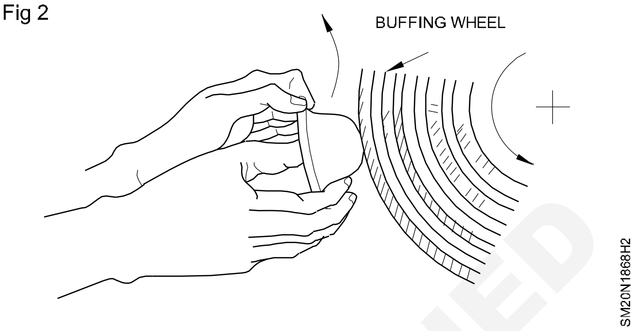


Fig 2



Feed the article to be buffed below the centre line of the buffing wheel for safety. Move the project back and forth against the wheel below the centre as shown in Fig 2.

Put sufficient compound on the wheel as needed, wipe and clean the article. Change to another wheel and a finer compound to finish the buffing operation. Wash the project in hot water and dry it. Do not touch with hand. To preserve the high lusture, coat at once with lacquer, wax or plastic spray.

Polishing and Buffing

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

- **state the difference between polishing and buffing**
- **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.**

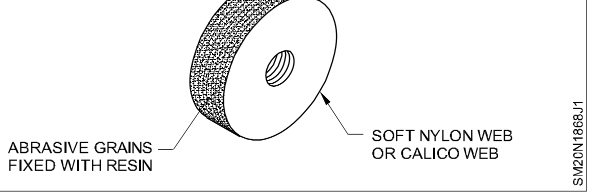
Polishing is a process of making a clean and scratch free surface. Polishing is done by holding the surface of a workpiece against an abrasive coated wheel or belt and moving the workpiece back and forth till the scratches and defects on the surface of the metal is removed.

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) 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.

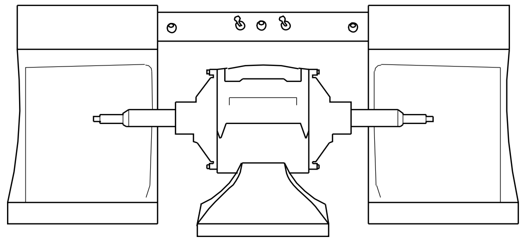
Fig 1



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.

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)

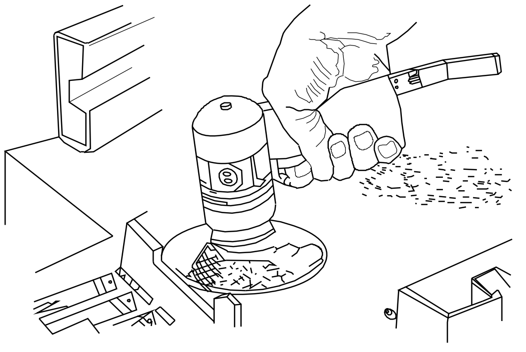
Fig 2



POLISHING MACHINE

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.

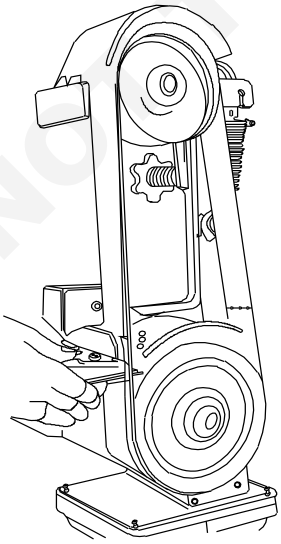
Fig 3



A POLISHING DISK IS HANDY FOR ROUNDING EDGES AND CORNERS.

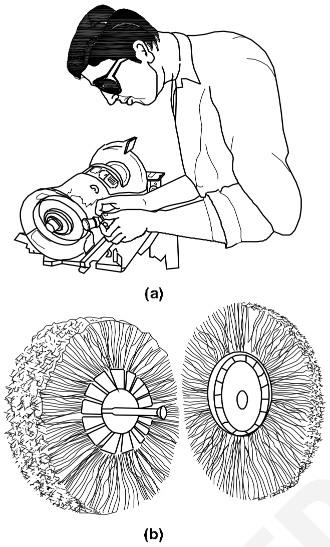
Polishing with Coated Abrasives: Coated abrasives are available in belt, disc, sheets and drum forms. Flexible abrasive belts operate around two or three pulleys (Fig 4). These belts are covered with an Aluminium oxide abrasive use on steel and silicon carbide, to use on non-ferrous metals. To do the 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 4



AN ABRASIVE BELT CAN BE USED FOR POLISHING 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.

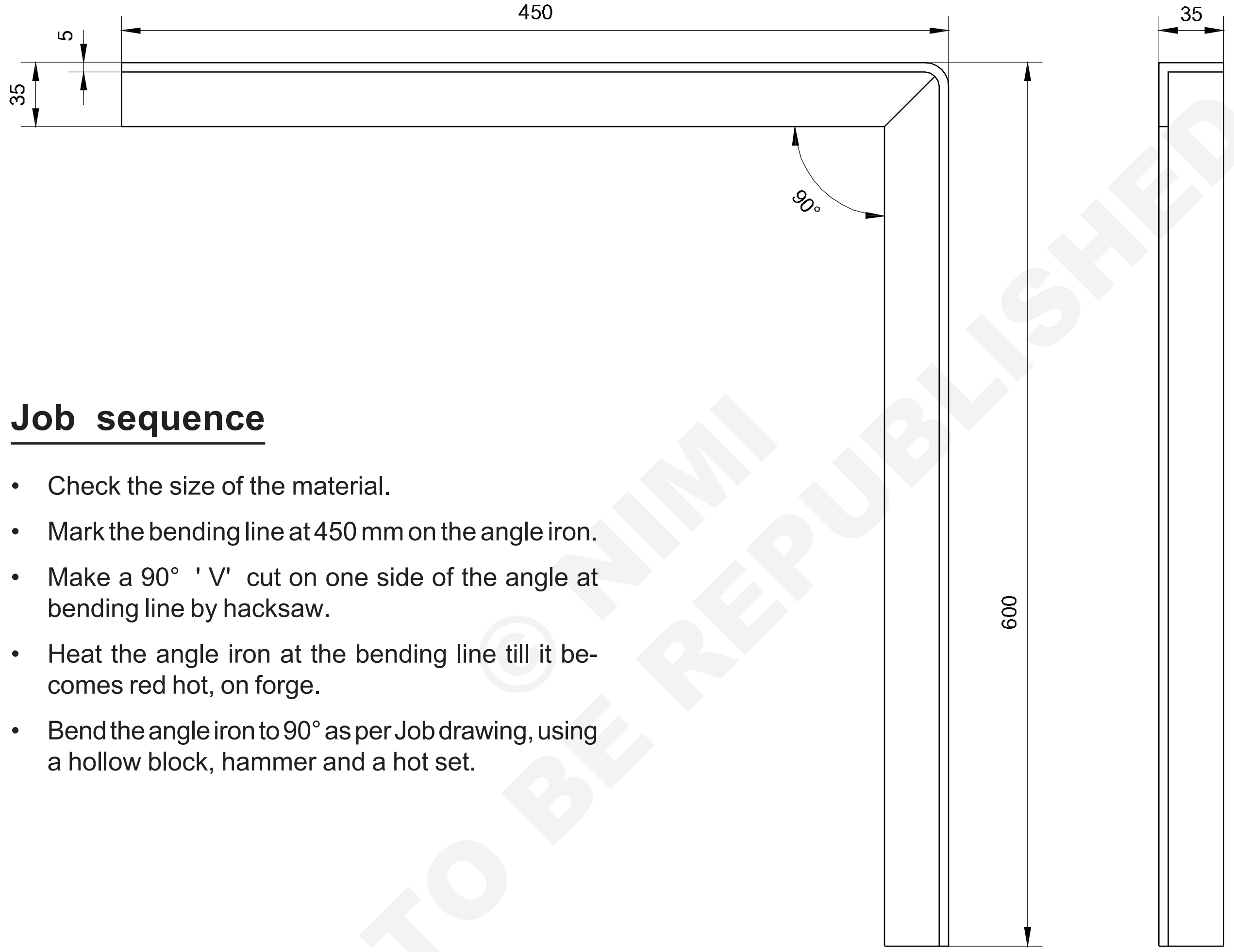
Satin finish: The surface of the metal can be given a satin finish by finishing the surface against a wire wheel. (Fig 1)

- 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.

Making a angle iron bending

Objective : At the end of this exercise you shall be able to
- **bend the angle iron to 90^0 in hot condition by hand process.**



Job sequence

- Check the size of the material.
- Mark the bending line at 450 mm on the angle iron.
- Make a 90° 'V' cut on one side of the angle at bending line by hacksaw.
- Heat the angle iron at the bending line till it becomes red hot, on forge.
- Bend the angle iron to 90° as per Job drawing, using a hollow block, hammer and a hot set.

1	ISA 35 x 35 x 5 - 1070	–	Fe310	–	–	69
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:4	ANGLE IRON BENDING	DEVIATIONS ±1	TIME 5h
		CODE NO. SM20N1869E1	

Skill sequence

Bending the angle iron at 90^0

Objective : This shall help you to

- **bend the angle iron at 90^0 in hot condition by hand process.**

Check the size of the material.

Mark the bending line on the angle iron.

Make a 90° 'V' cut on one side of the angle at 45^0.

Prepare the forge.

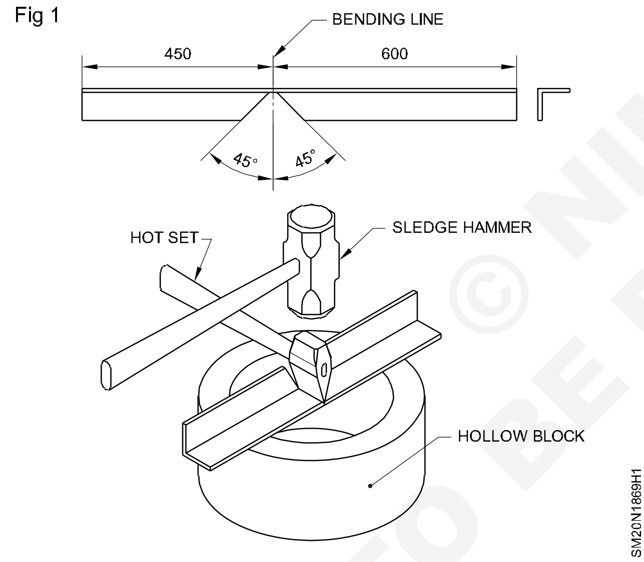
Lighten the forge using kerosene.

Place the angle iron on the forge, ensuring bending line at the centre and heat till it becomes red hot.

Place the heated portion of the angle iron on the hollow block.

Hold the hot set in one hand and position at the bending line and apply blows on it by a sledge hammer held in other hand. (Fig 1)

Fig 1



Continue hammering till the angle iron bends to 90^0.

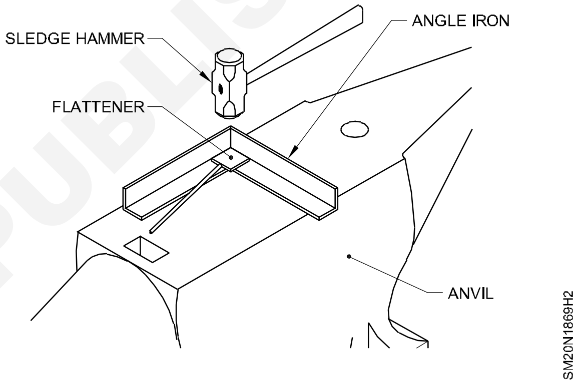
Check the 90^0 angle using Tinman's square and rectify if required.

After bending, the corner portion of angle iron gets deformed from outside.

Heat the angle iron on forge if required and place the angle iron on anvil as shown in Fig 2, hold the flattener in position at the corner of the angle iron and apply blows by sledge hammer. This will flatten the deformed metal at the corner.

Allow the bent angle iron to cool.

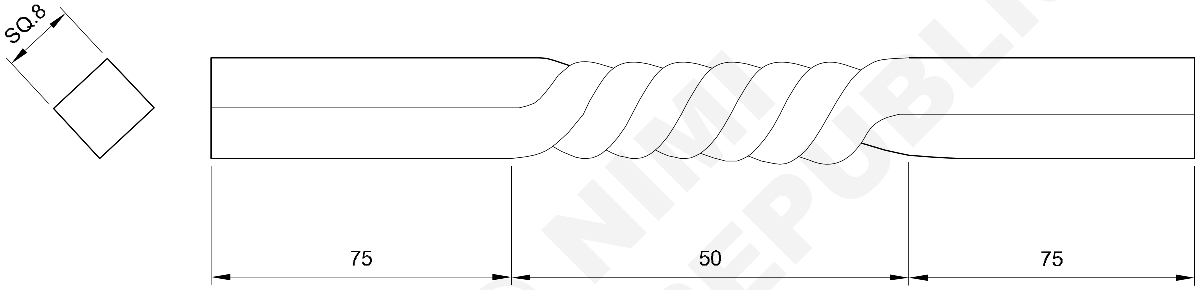
Fig 2



Making a twisting M.S.square rod and flats

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

- **straighten the square rod**
- **twist the rod to the required length.**



Job sequence

- Check the rod size and material cut to required length & straighten.
- Make arrangement for heating of rod. It may be on hand forge or by blow lamp.
- Heating must be done evenly by twisting portion in red hot condition.
- Fix it in a vice, where twisting portion must be outside of the jaws [up to 75mm one side]
- By twisting wrench , twist to one or one and half turn with uniform pressure on both hands to achieve the required twist to length.
- Cool the rod by poring water
- Remove the scales by using wire brush.
- Remove the bar from the vice check the straightness of the bar by eye sight or using straight edge and correct if required.

1	SQ8 x 205	–	M.S	–	–	70
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	MAKING A TWISTING M.S.SQUARE ROD AND FLATS	DEVIATIONS ±1	TIME 5h
		CODE NO. SM20N1870E1	

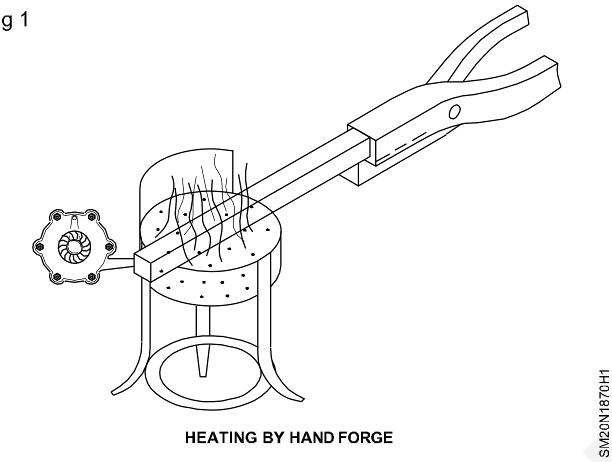
Skill sequence

Heating of rod to be twisted

Objectives: This shall help you to
- **heating of rods of different sections**
- **use of different heating accessories like hand forge and blow lamp.**

Heating of rod to be twisted may be decided according to the section size. If size above 8mm sq./dia heating process on hand forge (Fig 1) is desirable. For less than 8mm it is preferred to be by blow lamp (Fig 2)

Fig 1

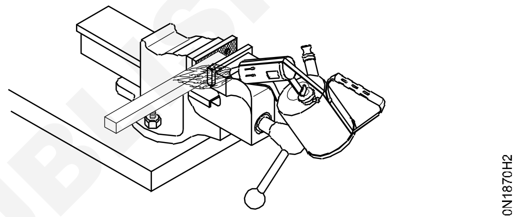


HEATING BY HAND FORGE

Keep raw material on fire, where the portion to be twisted. Heat the portion either side to excess length than the area to be twisted . The bar to be heated to medium orange colour. Remove bar from fire and check the temperature. Ensure heated portion is uniform on where rod to be twisted.

Improper heating of the bar may result to uneven twist. Ensure heating of bar to the recommended temperature. The excess heat may result to crack while twisting.

Fig 2



HEATING BY BLOW LAMP

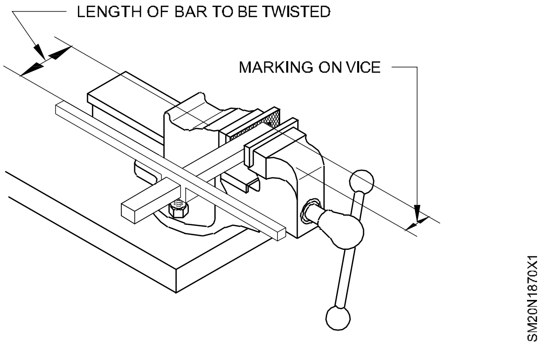
Set up for twisting

Objective : This shall help you to
- **setting the bar to be twisted in vice.**

Fix the bar in vice as shown Fig 3. While fixing the twisting bar the length to be twisted wrench at the other end. For setting the bar various methods are adopted according to the quantity requirement. a) marking on vice b) using template c) using calipet.

While setting bar do not allow to rest twisting wrench, which may cause deformation during heating of bar.

Fig 1



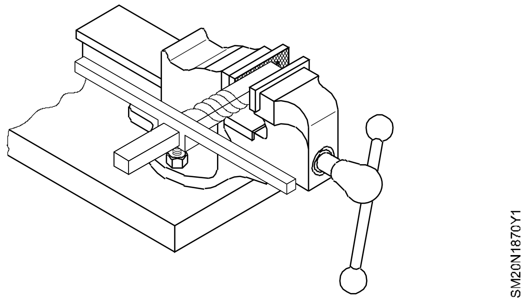
Twisting of bar

Objective : This shall help you to
- **make twist the bar to required length.**

Begin twisting by both bands with even pressure. The twist must be one turn or 1½ turn according to requirement and shape. Avoid bending bar up, down or sideways . Twisting should be of same direction, unless otherwise design calls for.

While twisting use gloves to protect from falling of scales and heat.

Fig 1



Cool the water by pouring water and immediately brush off the scaling from the rod. Water pouring must be slow and should be of sprinkling method. Learn by practise.

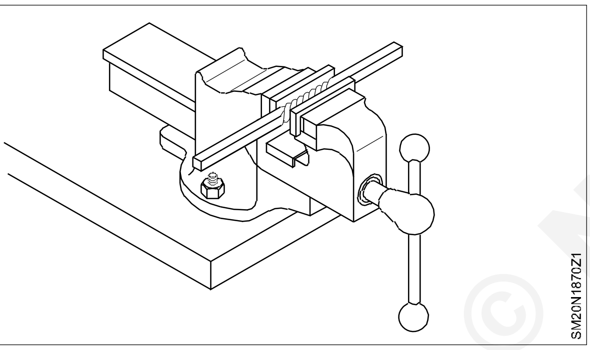
Removing bend on twisted bar

Objectives: This shall help you to
- **rectify the bend**
- **check the straightness.**

Various methods on practice to remove bend on the twisted bar according to the condition of the deformation as well the bar size.

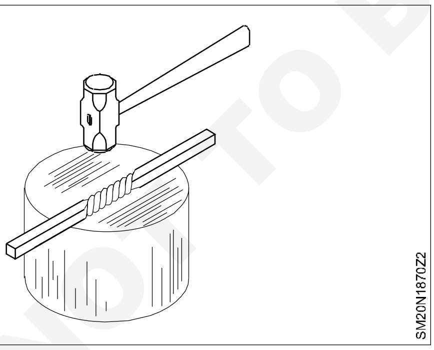
a) removing simple bends by vice. (Fig 1)

Fig 1



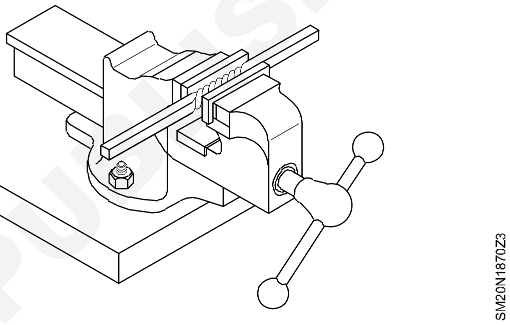
b) removing bend by using mallet on hand wood support.(Fig 2)

Fig 2



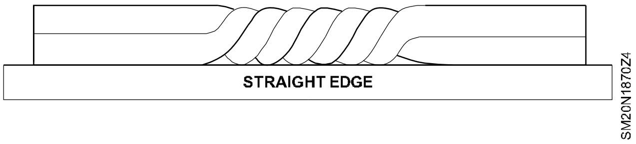
c) removing offset bend by hammering holding bar on vice.(Fig 3)

Fig 3



The straightness of twisted bar should be checked with straight edge as shown figure. The corner of the untwisted portion and corner of the twisted should be in one line. (Fig 4)

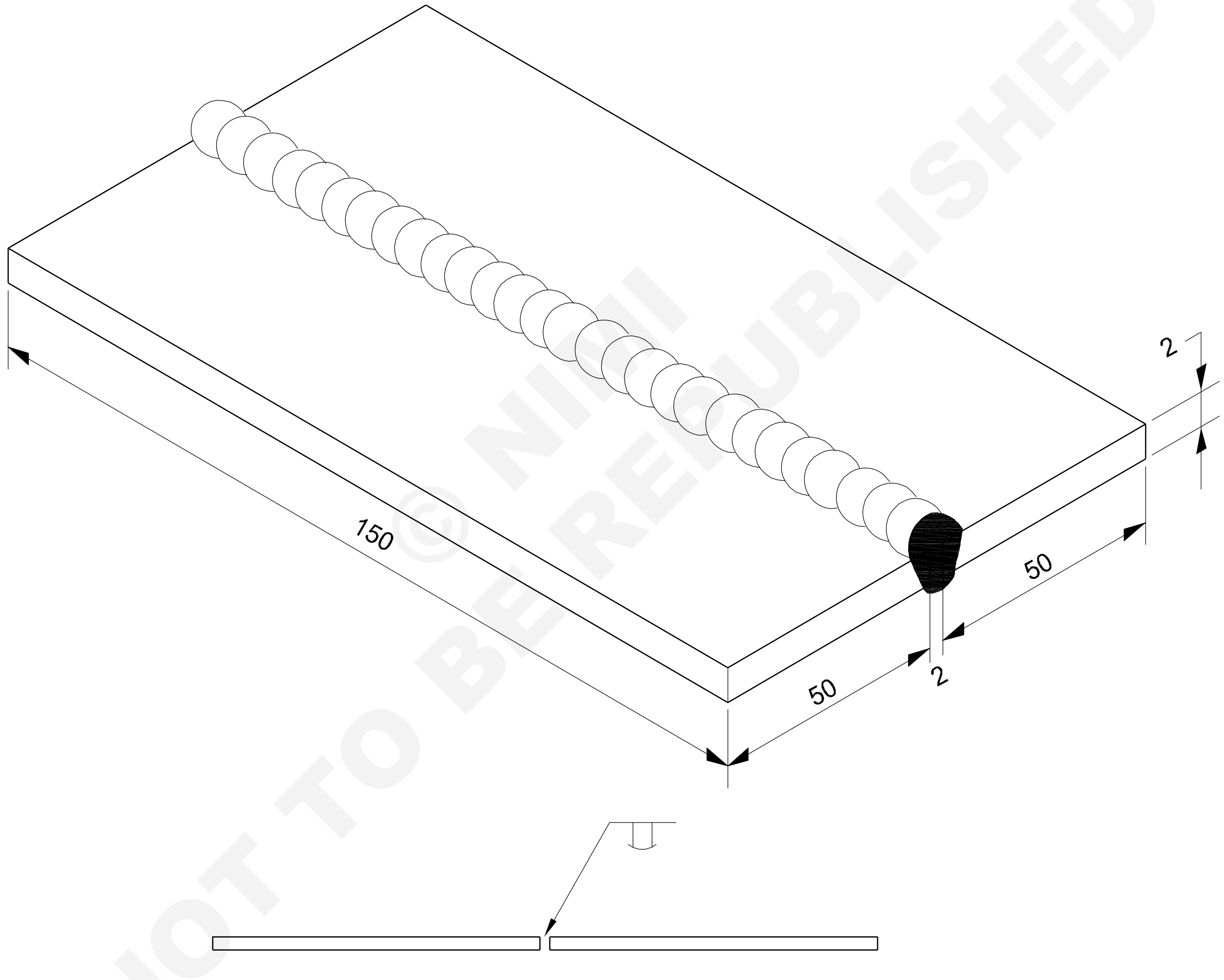
Fig 4



Square butt joint on MS sheet 2 mm thick in flat position (1G) (OAW-04)

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

- **prepare the job to the given size as per drawing**
- **file the edges of the plate to square without burr**
- **set the job as a square butt joint with proper root gap and tack weld them**
- **weld the square butt joint in flat position using leftward technique in one run**
- **clean and inspect the butt weld for root penetration and surface uniformity.**



2	ISST 100 x 2 - 150		Fe 310 - W			1.8.71
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**SQUARE BUTT JOINT ON M.S SHEET2mm THICK IN FLAT POSITION (1G) (OAW-04)**	TOLERANCE ±1	TIME 8 Hrs
		CODE NO. SM20N1871E1	

Job Sequence

- Prepare the job pieces as per drawing.
- File the edges to square and ensure thorough cleaning of the joining edges.
- Set the job pieces on the welding table to form a square butt joint with a root gap of 2 mm.
- Set the gas welding plant, fix nozzle No. 7 and set the gas pressure of 0.15 kg/cm^2 for both gases.
- Select C.C.M.S. filler rod 3 mm ø for tacking and welding.

Wear safety apparels and gas welding goggles.

- Set neutral flame.
- Tack the pieces at both ends and at center, using 1.6 mm ø filler rod with 2mm root gap at right end and 3mm root gap at the left end.

Tacks should be well fused and penetrated and done on the bottom side of the joint.

- Check the alignment and root gap and reset if necessary.
- Clean the tacks and set the job on the welding table in a flat position, over fire brick supports.

Turn the tack weld side down.

- Start the weld at the right end of the job.
- Direct the flame at the beginning of the seam (welding line) with the blowpipe nozzle at an angle of 60° - 70° towards right.
- Hold the filler rod at an angle of 30° - 40° with the seam towards left.
- Fuse the edges uniformly and add filler metal by up and down (piston like) motion and proceed to weld towards left.
- Maintain a uniform speed of the blowpipe with slight circular motion.
- Stop at the left end, fill the crater and complete the weld.
- Extinguish the flame, cool the nozzle in water and keep it on the cylinder trolley.
- Clean the welded joint and remove distortion.
- Inspect the joint by visual inspection for:
  - slight convexity with uniform width and height of bead without undercut.
  - uniform ripples without porosity.
  - uniform root penetration.
- Repeat the exercise till you get good results.

Skill Sequence

Square butt joint

Objective: This shall help you to

- **prepare and gas weld the square butt joint.**

Preparation: Prepare the job pieces of size 150×50×2.0 mm by shearing and then by filing.

Setting and tacking: Set the prepared job pieces on the welding table with a root gap of 2mm at the right end and 3mm at the left end and in alignment. (Fig 1)

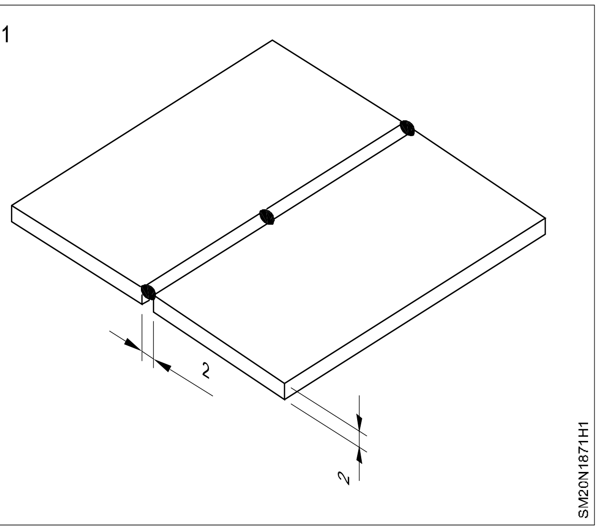
The root gap is increasing from right end to the left end because the gap will get closed as the weld proceeds towards the left end, due to expansion of the base metal.

Tack-weld the joint at equal intervals to hold them together, maintaining the alignment. (Fig 1)

Ensure that the

- distance between the tack-welds is 75 mm.
- length of the tack-weld is 6 mm.

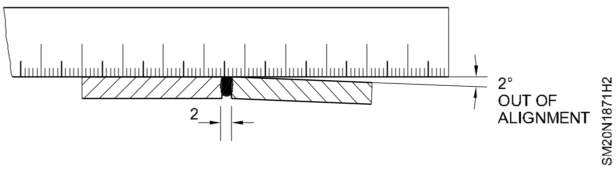
Fig 1



Tack welds should be on the back side of the joint to be welded and in line with the joint.

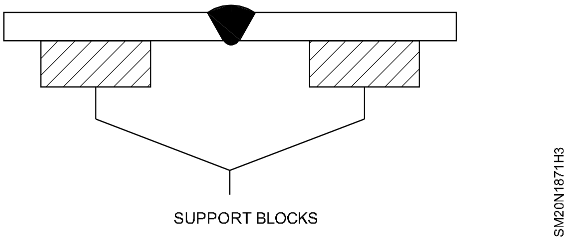
Check the alignment after tacking, and reset, if the sheets are out of alignment. (Fig 2)

Fig 2



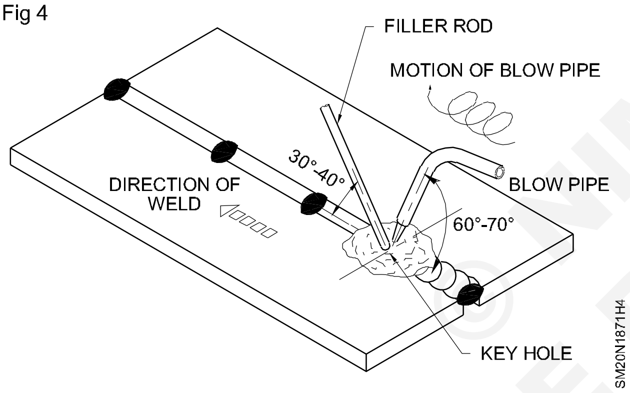
Welding: Keep free space under the joint for complete penetration. (Fig 3)

Fig 3



Start the weld at the right end of the joint. (Fig 4)

Fig 4



Weld a well fused uniform bead with complete penetration using leftward technique. (Fig 4)

Manipulate the blowpipe to maintain necessary motion to the blow pipe and the filler rod and the recommended angle of blowpipe and the filler rod.

Maintain uniform travel speed and feed to the flame and the filler rod.

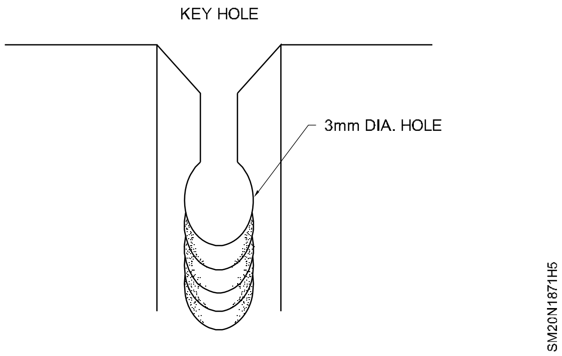
Maintain a keyhole which is a clear indication that the melting is taking place up to the bottom of the root of the joint ensuring better root penetration. (Fig 5)

Clean the deposited bead using wire brush.

Inspect the quality of weld by:

– checking the finish of the job

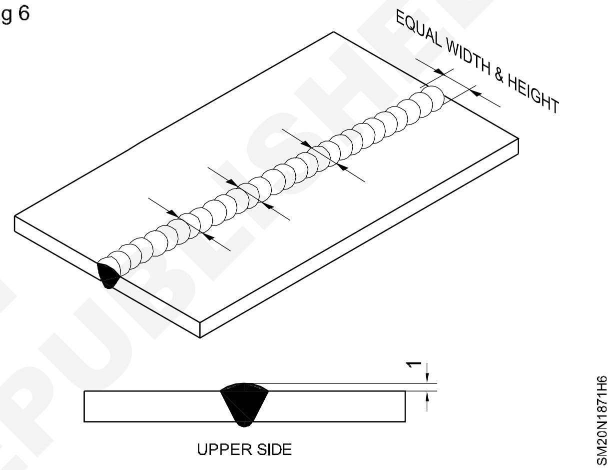
Fig 5



– checking the alignment (remove distortion if required)

– checking the uniformity of width and height of the weld bead in size (Fig 6)

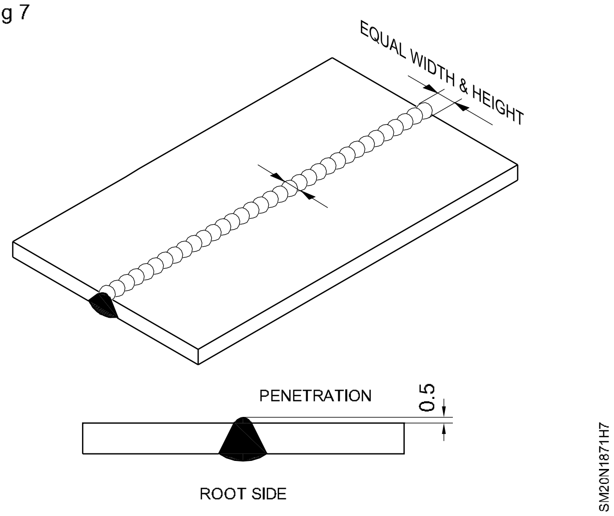
Fig 6



– checking the uniformity of the ripples, fusion and complete penetration (Fig 7)

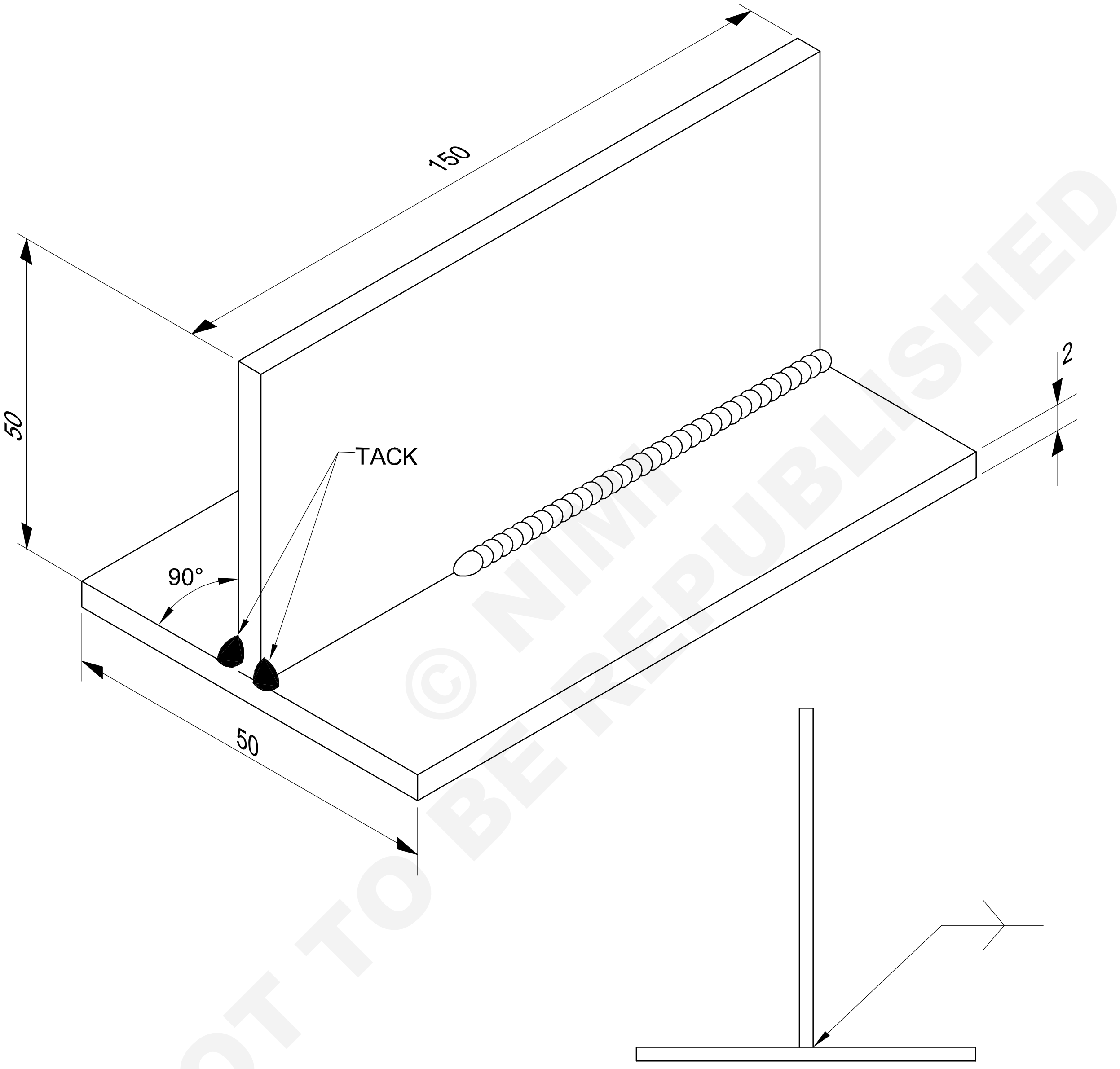
– checking that the weld is free from faults such as porosity, undercut, lack of fusion, unfilled crater etc.

Fig 7



Fillet 'T' joint on M.S. sheet 2mm thick in flat position (1F)-(OAW-06)

Objectives: At the end of this exercise you shall be able to
- **set and tack the job to form ‘T’ fillet joint and manipulate the blow pipe and the filler rod properly**
- **weld a ‘T’ fillet joint using recommended filler rod and nozzle size**
- **clean and inspect the weldments for defects.**



1	ISST 50 x 2 - 150		Fe 310 - W			71
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	FILLET "T" JOINT ON M.S. SHEET 2mm IN FLAT POSITION	TOLERANCE ±0.5	TIME : 8 Hrs
		CODE NO. SM20N1871E2	

Job Sequence

- Prepare job pieces as per drawing.
- Clean the surface and edges of the sheets to be welded.
- Set the sheets in the form of a 'T' joint on the welding table.
- Wear safety apparels and gas welding goggles.
- Set the gas welding plant, fix nozzle No. 5 and set pressure at 0.15 kg/cm for both gases.
- Set the neutral flame, tack at both ends of the joint also in the center with a 1.6 mm C.C.M.S. rod.
- Check the alignment of the joint with a try square and clean the tacked portion.
- Keep the job on the welding table in a flat position.
- Start welding with the leftward technique and melt the right hand end of the joint.
- Fuse the area to be welded (i.e. equally the part of the horizontal sheet and the vertical sheet) and apply the filler rod in the molten pool to form a fillet weld at the joint.
- Maintain correct travel speed, manipulate the blowpipe and filler rod to produce a uniform weld bead.
- Stop the weld at the left hand end of the joint after filling up the crater at the end of the weld.
- Extinguish the flame, cool the nozzle and place the blowpipe at its place.
- Clean the weldment and inspect for defects in the fillet weld.

Visual inspection

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

Skill Sequence

Fillet weld 'T' joint on MS sheet 2.00mm in flat position

Objective: This shall help you to

- **prepare and fillet weld 'T' joint on MS 2.00mm in flat position.**

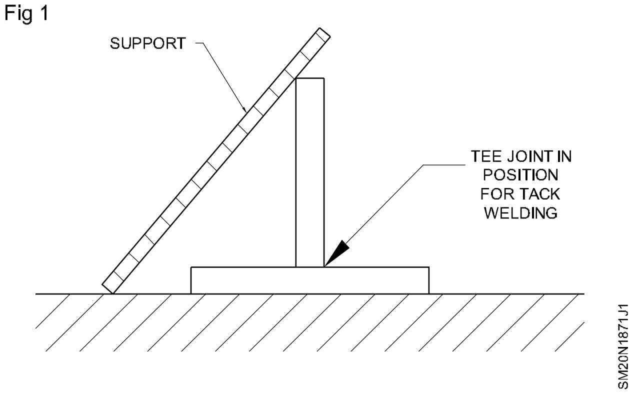
'T' fillet joints are used extensively in industry i.e., Capital Goods & Manufacturing of underframes, vertical supporters for oil and water containers and other similar structural work.

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

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

Setting and tacking the job pieces

Fig 1



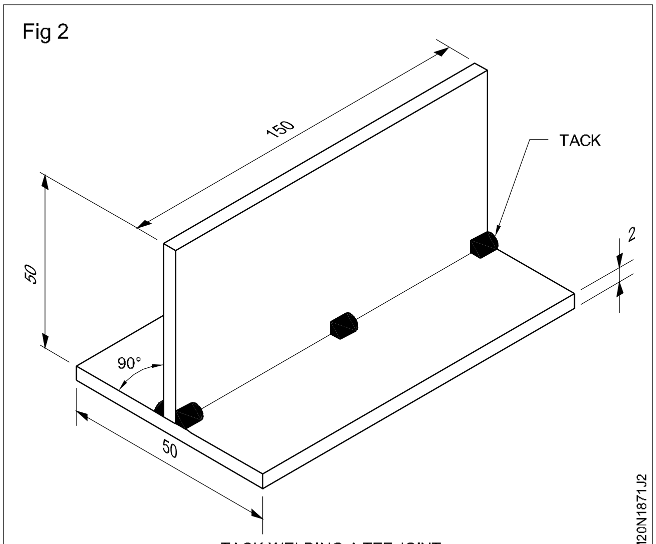
Place the pieces on the welding table as ‘T’ joint.

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

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

Check with a try square for perpendicularity.

Fig 2

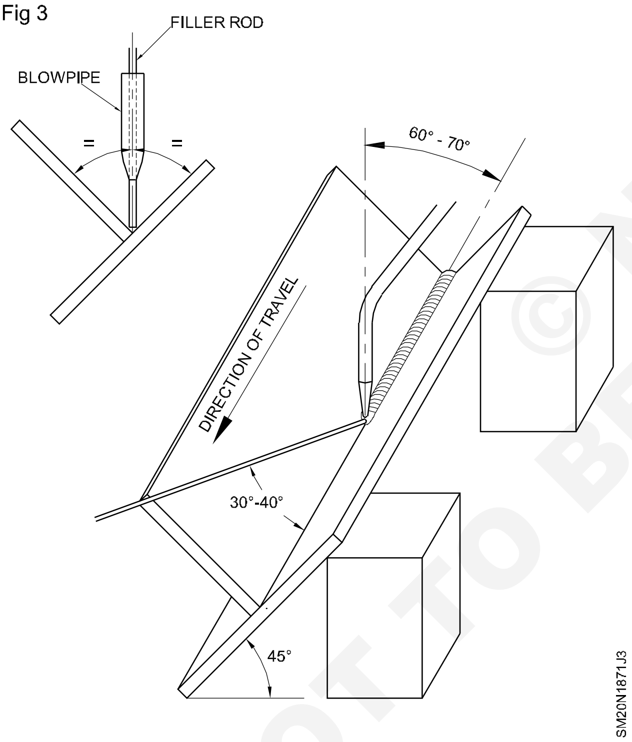


TACK WELDING A TEE JOINT

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

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

Fig 3



Place the tack welded in flat position by tilting and supporting it. Fig 3.

Start welding at the right hand end of the joint by fusing the tack weld and the parent metal to form a molten pool. Keep the blowpipe in the leftward direction at an angle of 60° to 70° and the filler rod at an angle of 30° to 40° to the line of travel. The blow pipe and filler rod should be held at 45° between the 2 surfaces of the joint. This will ensure root penetration. Watch the molten metal closely to make sure that both pieces melt uniformly. Change the angle of the blowpipe if the pieces do not melt uniformly. When the molten pool is formed add the filler rod in the center of molten pool. Give slight side-to-side movement to the flame (blowpipe) and a piston like motion to the filler rod.

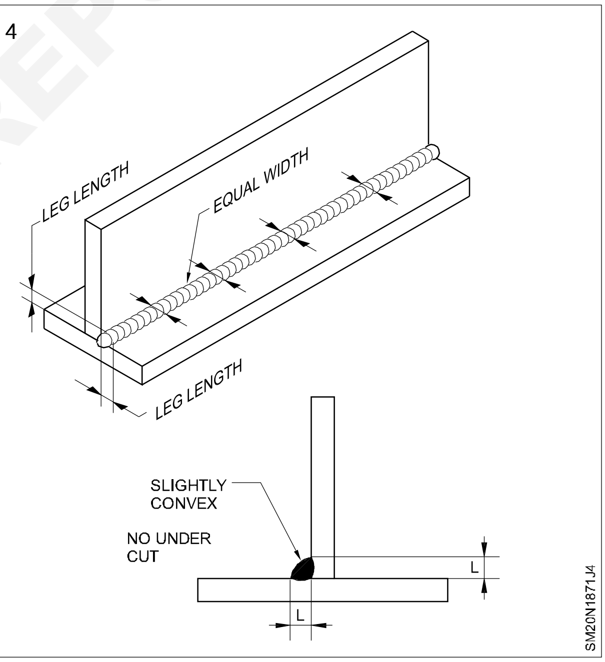
Adjust the rate of travel of the blowpipe and the filler rod to secure even penetration at the root and into both sheets, and to produce a fillet weld of equal leg length.

Visual inspection (Fig 4)

Clean the weldment and inspect for:

- uniform weld size and shape of bead (reinforcement and contour slightly convex)
- equal leg length, no undercut at the toes of the weld.
- no porosity, overlap.

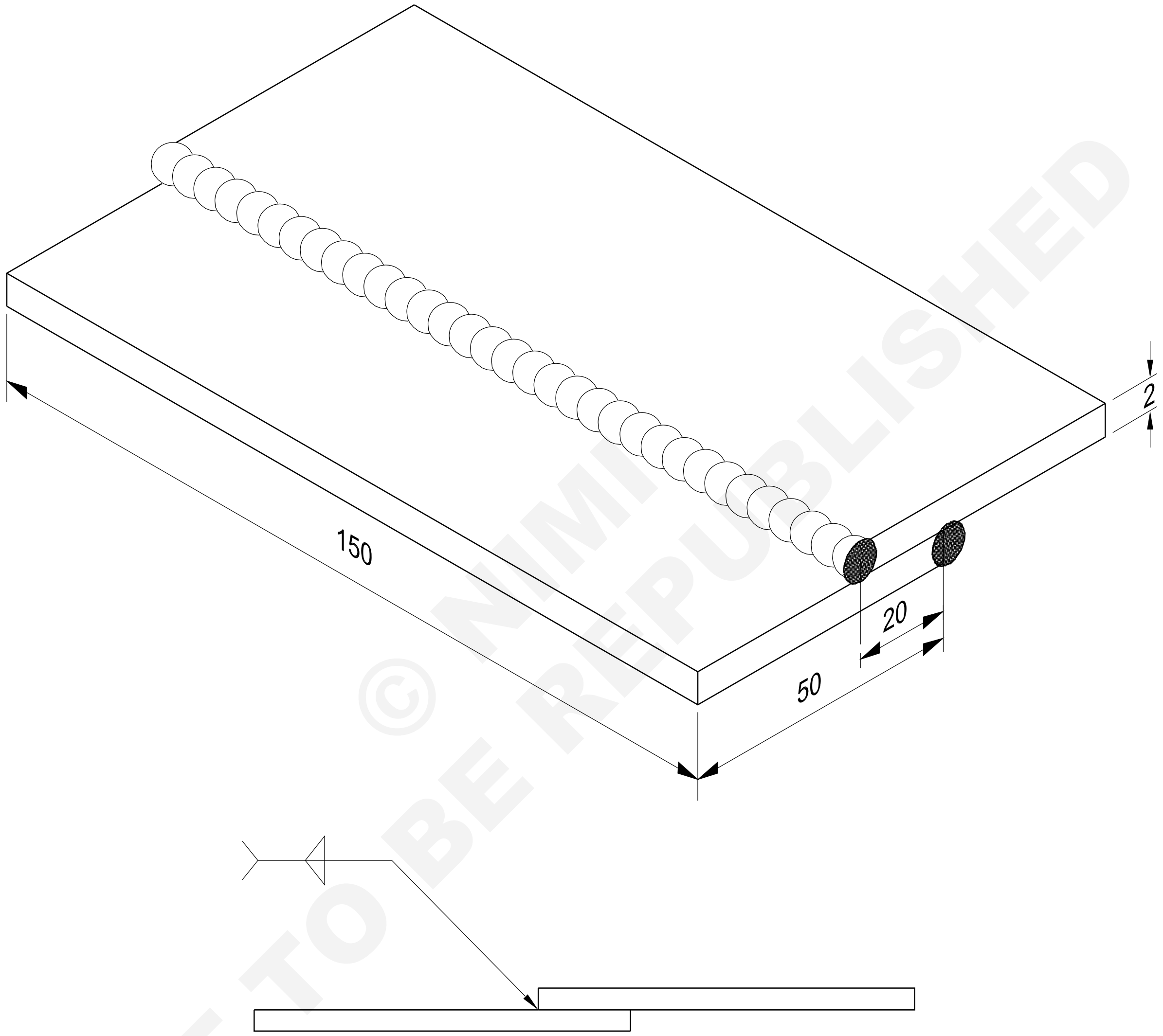
Fig 4



Fillet lap joint on MS sheet 2mm thick in flat position (1F)-(OAW-07)

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

- **set and tack the job to form a lap fillet joint with recommended overlap**
- **weld lap fillet joint using correct size filler rod and nozzle in flat position**
- **clean and inspect the weldments of the lap fillet for weld defects.**



2	ISST 50 x 2 - 150		Fe 310 - W			1.8.71
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**FILLET LAP JOINT ON M.S.SHEET 2mm THICK IN FLAT POSITION (1F)-(OAW-07)**	TOLERANCE ±1	TIME 10Hrs
		CODE NO. SM20N1871E3	

Job Sequence

- Prepare the job as per drawing and clean the edges.
- Set the job on the welding table to form a lap joint.
- Set the gas welding plant, fix nozzle No. 5 and set a pressure of 0.15 kg/cm for both gases.
- Select a C.C.M.S. filler rod 1.6 mm ø for tacking and 3.00 mm ø for welding.

Wear safety apparels and use gas welding goggles.

- Set the neutral flame.
- Tack the pieces at both ends and also in the center using a 1.6 mm ø filler rod.
- Check the alignment of pieces, clean the tacks, and place on the welding table in a flat position.
- Start welding, using leftward technique with the correct angle of the blowpipe and (3mm ø) filler rod.
- Fuse the edges uniformly, add filler metal to obtain correct root fusion and reinforcement, and proceed towards left. Don't concentrate the flame on the top member in the lap joint.
- Maintain correct travel speed, manipulation of blowpipe and filler rod to produce uniform weld bead.
- Stop at the left end, after filling the crater and complete the weld.
- Extinguish the flame, cool the nozzle in water and place the blowpipe at its place on the cylinder trolley.
- Clean the welded joint with a wire brush.

Visual inspection: Inspect for correct size of fillet weld, slight convexity, uniform width and height, uniform ripples without edge of plate melted off defect and other surface defects.

Weld the job from the other side also following the same steps.

Repeat the exercise till you get good results.

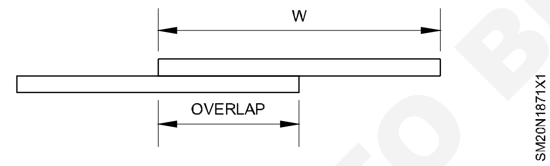
Skill Sequence

Lap weld joint on MS sheet 2.00 mm in flat position

Objective: This shall help you to
- **prepare and lap weld joint on MS plate 2.00mm in flat position.**

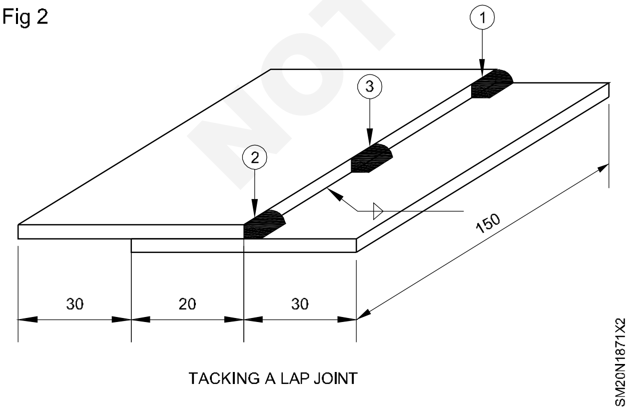
Set and tack the job pieces in correct alignment with proper overlapping of pieces. (Fig 1)

Fig 1



Place the tack welds at correct locations. (Fig 2)

Fig 2

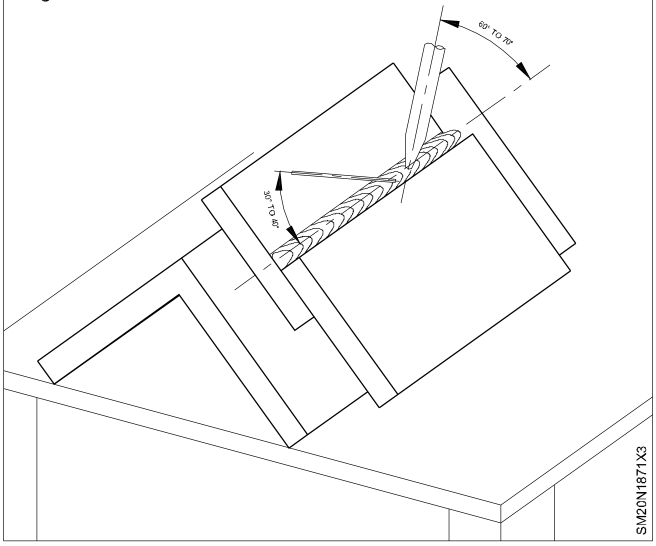


TACKING A LAP JOINT

Weld a uniform, well penetrated, correct size fillet lap weld in flat position by

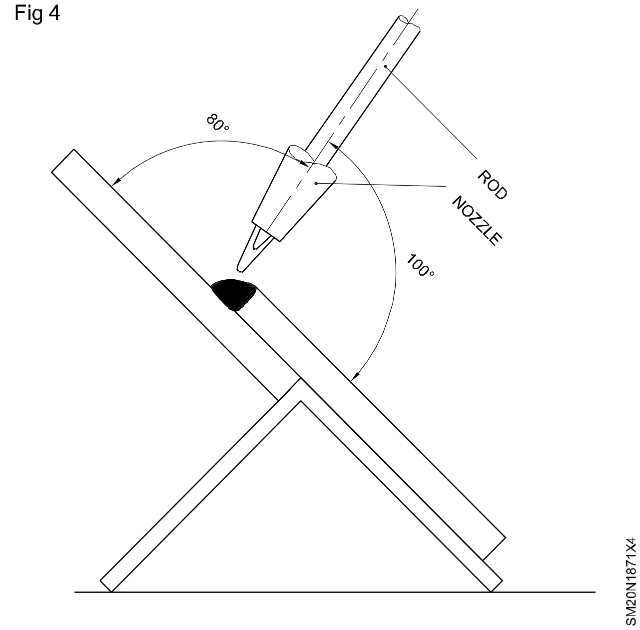
- – proper positioning of the joint (Fig 2)
- – proper angle of the blowpipe and filler rod (Figs 3 & 4)

Fig 3



- – proper manipulation of the blowpipe and filler rod.
- – using leftward welding technique.

Fig 4



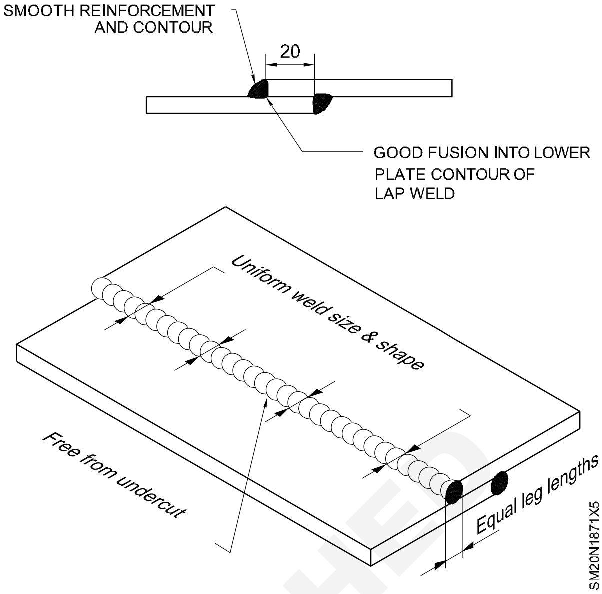
Avoid movement of blow pipe flame nearer to the edge of the top plate. This will avoid edge of the plate melted off defect.

- maintaining uniform travel speed and feed.

Clean the weldment and inspect for: (Fig 5)

- uniform weld size and shape of whole length (reinforcement and contour) of the joint.

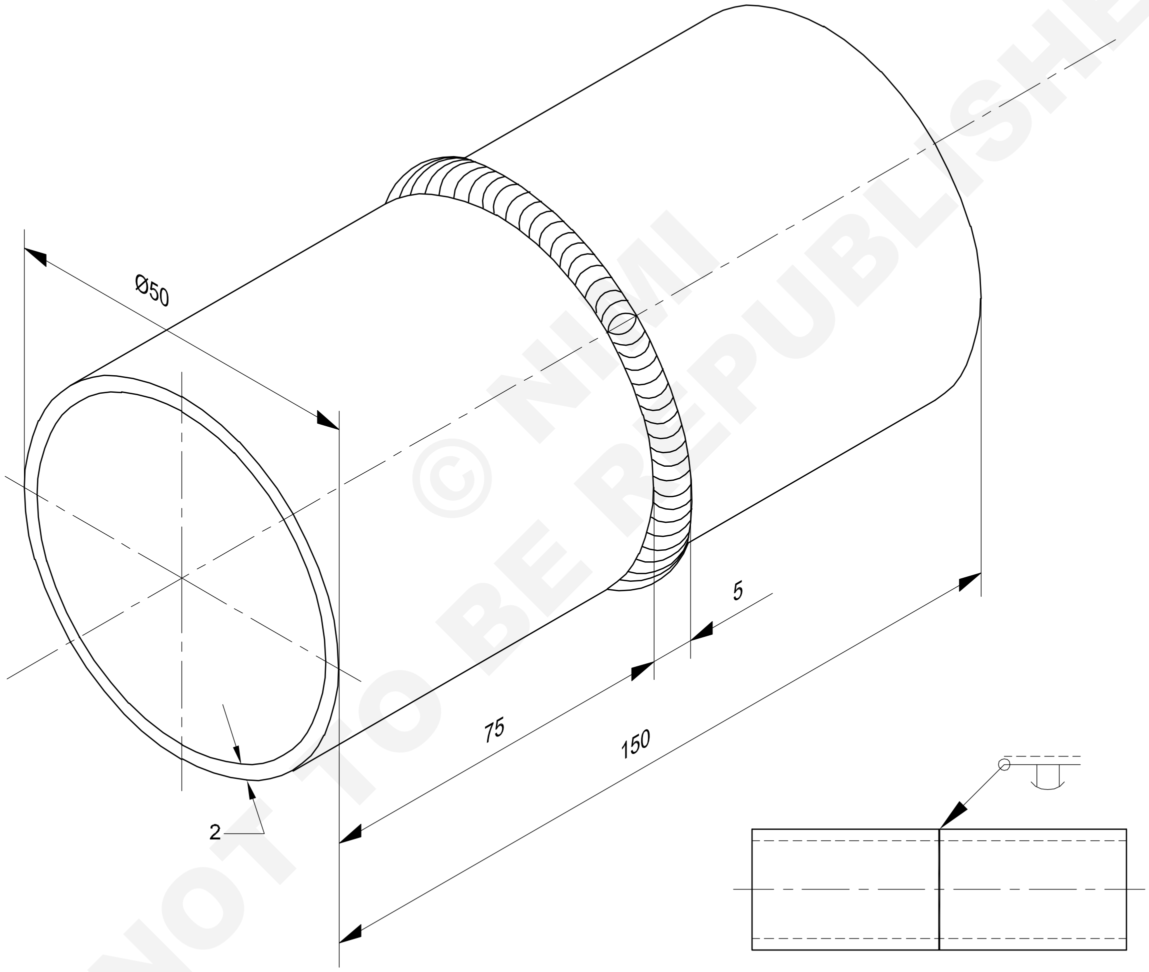
Fig 5



- equal leg length
- no undercut at the toe of weld
- no fusing of the top plate edge to undersize
- smooth ripple appearance
- proper crater filling.

Pipe butt joint in down hand position

Objectives : At the end of this exercise you shall be able to
- **cut and prepare the MS pipe as per the dimension given in the drawing**
- **align the axis of the pipes in flat position as a pipe butt joint**
- **select nozzle, filler rod sizes, gas pressures and flame**
- **set the root gap and tack weld the pipes**
- **set the tack welded pipes with their axes horizontal**
- **weld the butt joint in segments ensuring proper root penetration, bead size, profile and reinforcement**
- **clean and inspect for surface defects.**



2	Ø50 x 2 - 77	–	Fe 310 - W	–	–	72
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PIPE BUTT JOINT ON DOWN HAND POSITION	TOLERANCE ±1	TIME :15 Hrs
		CODE NO. SM20N1872E1	

Job sequence

- Cut the pipes to 77mm length by hacksaw and file its end square to 75mm length. Chamfer the outside edge of the pipe to 30 - 35^0 angle leaving a root face/land of 1.5mm at the bottom edge of the pipe.
- Clean the inside and outside surfaces of the cut pipes after deburring.
- Fix no.5 size nozzle, select 1.6mmø CCMS filler rod and set 0.15 kg/cm^2 pressure for both gases.
- Set the 2 pipes on an angle or channel fixture to form a co-axial pipe butt joint with proper root gap.
- Follow necessary safety precautions.
- Set neutral flame.
- Tack weld in 3 places (120^0 apart) keeping 1.5mm root gap between the pipes.
- Divide the pipe circumference into four segments. Keep the pipe horizontally on the fixture.
- Deposit the root run starting from 3 0'clock position to 12 0'clock position using proper blowpipe and filler rod angles. (I segment)
- Turn the pipe joint in the clockwise direction so that the end of the root run already made in I segment comes to the 3 0'clock position.
- Continue to weld the root run for the second quarter segment as done for the first segment.
- Similarly, complete root run of 3rd and 4th segments.
- Ensure the root penetration by maintaining a keyhole at the root throughout the root run.
- Clean the root run by steel wire brush.
- Fix No.7 size nozzle, select 3mmø CCMS filler rod and set 0.15 kg/cm^2 gas pressure.
- Set neutral flame and fill the V groove by depositing the 2nd run using slight weaving to the blowpipe so that both the faces of the Vee and the root run will fuse properly.
- Ensure proper bead size, profile and weld reinforcement as well as avoid undercut and other weld defects.
- Clean the joint and inspect for external defects.

Skill sequence

Pipe welding is a highly skilled welding operation, which involves correct alignment and good penetration by equally melted edges of the pipes. As the welding is to be done on a curved surface, the position of the blow pipe and filler rod will continuously change as the welding progresses along the joint. To do this you have to put some extra efforts to get the special skill of welding a pipe joint.

Preparation and setting: Check and ensure correct size of pipes. Prepare two M.S. pipes 50 mmø and 75 mm long by hacksaw cutting. As the end faces of a pipe cut by a hacksaw may not be at 90^0 to the pipe axis, file the end faces of the pipe to get the 90^0 angle. Bevel the ends of the pipes by filing.

Clean the pipes and remove burrs, if any. Align the pipes in flat position as shown in Fig 1. Tack the weld joint by inserting 1.5 mm wire to maintain a uniform root gap. (Fig 2a and 2b) Ensure the tack welded pipes are co-axial. (i.e., the axis of both the pipes are the same.)

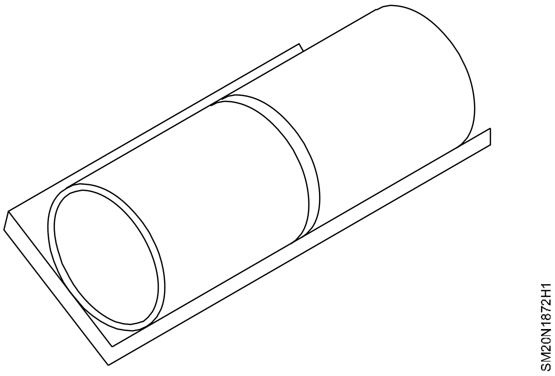
Select the angle iron or channel fixture according to the diameter of the pipe.

Place the tacked pipes on the fixture.

To ensure proper root penetration select nozzle No. 5 and a 1.6 mm C.C.M.S. rod for the root run.

Start welding as shown in the figure and complete the first segment. (Figs 3 and 4) The blowpipe and the filler rod angles are as shown in Fig.4 at the "start of the weld" and have to be changed to those angles shown at the "stop weld" continously and gradually. i.e weld from 3 0'clock position to 12 0'clock position.

Fig 1



After completion of I segment welded, rotate the pipe joint in clockwise direction until the II segment will come to the position of I segment.

Deposit the root run on the II segment similar to the I segment.

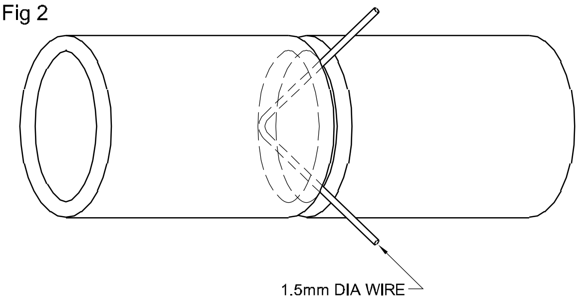
Further welding is done by rotating the pipe to the III and IV segment.

Ensure proper melting of tacks for good penetration and surface appearance.

It is very important to maintain a key-hole ahead of the molten pool at the root of the joint which will ensure root penetration. Refer Fig.2 of skill sequence of the previous Ex.No.G.29 (2.15).

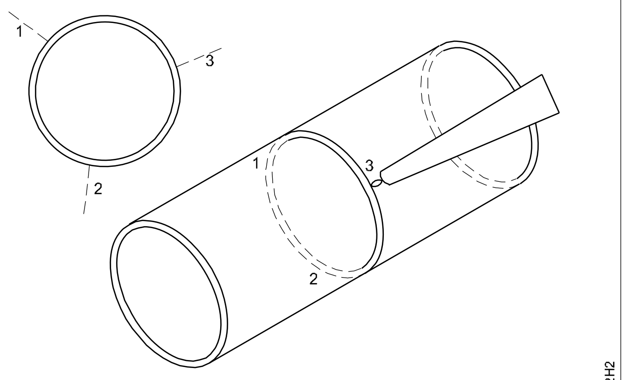
Remove the workpiece from the rotating fixture.

Fig 2



USE OF BENT WIRE OR SUITABLE SPACER TO SET ROOT GAP

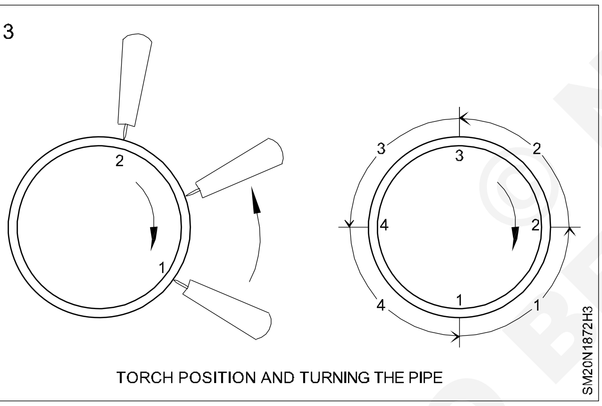
(A)



(B)

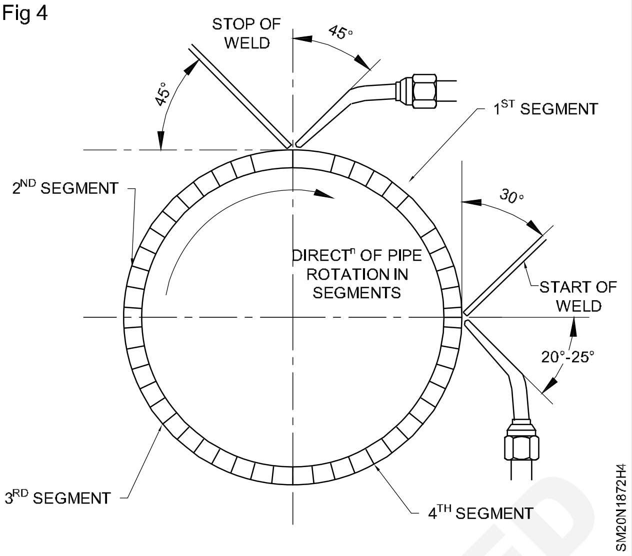
TACK WELDS AT POINTS 1, 2, AND 3

Fig 3



TORCH POSITION AND TURNING THE PIPE

Fig 4



Clean the weld bead and inspect the root run for root penetration and weld defects.

Keep the pipe joint on the rotating fixture and fix no.7 nozzle, set 0.15 kg/cm^2 pressure for the gases and use 3mmø CCMS filler rod.

Deposit the final run over the root run using neutral flame.

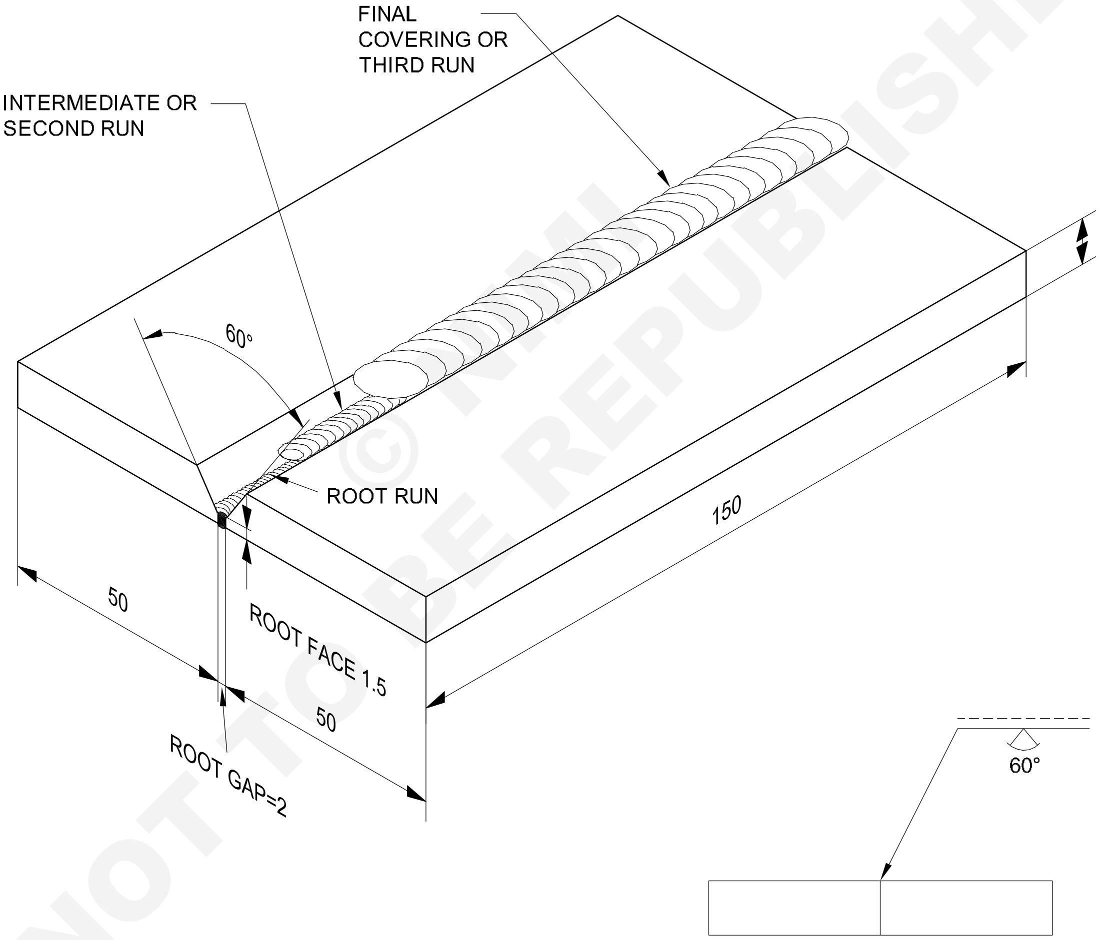
Follow the same welding technique used for the root run except maintaining a keyhole. Ensure proper fusion of the root run and the side walls of the Vee groove by proper movement of blow pipe and filler rod.

Ensure undercuts are avoided and proper bead profile, size and reinforcement is maintained. Clean the joint and inspect for weld defects.

Butt weld single vee butt joint on M.S plate is flatpostion

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

- **bevel the plate edges by gas cutting for single V butt joint**
- **grind the gas-cut bevel edges with proper root face for single V butt joint**
- **set the plates with a root gap of 2mm and proper distortion allowance for single V butt joint**
- **control arc blow**
- **deposit root run in single V butt joint to ensure complete penetration**
- **deposit intermediate and final covering runs in single V butt joint to obtain proper fusion and reinforcement**
- **clean and inspect the groove weld for surface defects and uniform root penetration.**



4	50 ISF 10 - 150		Fe 310 - W			73
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	BUTT WELD SINGLE 'V' BUTT JOINT M.S. PLATE 10mm POSITION FLAT	TOLERANCE ±1	TIME 15 Hrs
		CODE NO. SM20N1873E1	

Job Sequence

- Straight cut two 12mm thick plates by gas cutting as per drawing and grind them to size.
- Bevel the edges of each plate to 30° angle by gas cutting and file the root face as per drawing. Refer Ex.No.2.04 for cutting the bevel.
- Clean the plates from dirt, water, oil, grease, paint etc.
- Keep the plates inverted in the form of a butt joint with proper root gap.
- Maintain a distortion allowance of 1.5° on each side of the joint.
- Wear all protective clothing.
- Use a 3.15mm medium coated MS electrode and set 110 amperes current. In case of DC welding machine connect the electrode cable to the negative terminal of the machine.
- Tack weld on the back side of the plates at the ends. The length of tack should be 20mm.
- Deslag the tack weld and clean.
- Position the tack welded job on the table in flat position (the single V portion facing up)
- Deposit the root run and fill the crater as done for welding square butt joint. (Ex.No.3.06)
- Take special care to maintain key hole to ensure proper melting of root face and root penetration.
- Deposit the second run/intermittent run using 4mm ø medium coated electrode and 150-160 ampere current, short arc and proper weaving of the electrode. Avoid excessive weaving and ensure normal travel speed.
- Fill the crater wherever necessary.
- Deslag.
- Deposit the third run/covering run using the same parameter and technique used for 2nd run. Ensure a proper reinforcement of 1 to 1.5mm and avoid undercut.
- Inspect for any surface weld defect.

Skill Sequence

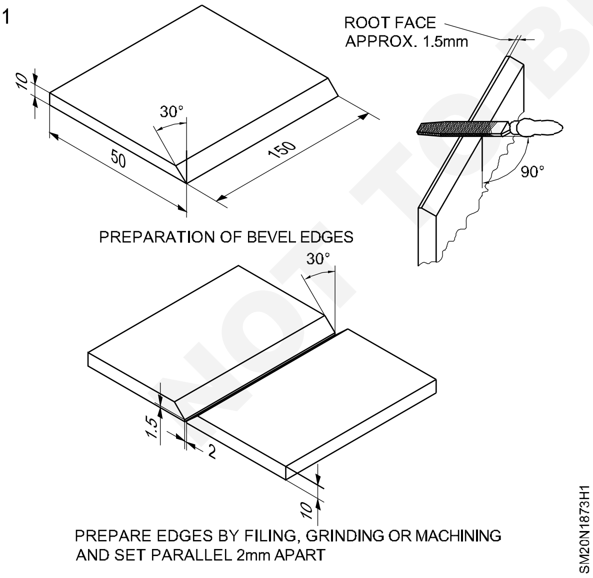
Welding of single 'V' butt joint MS plate 12mm thickness in flat position

Objective: This shall help you to

- **weld single V butt joint MS plate 12mm in flat position (1G).**

Preparation of the pieces (Fig 1)

Fig 1



Cut a 30° bevel on each piece using oxy-acetylene cutting.

Grind the bevel edges to remove oxide deposits on the bevel.

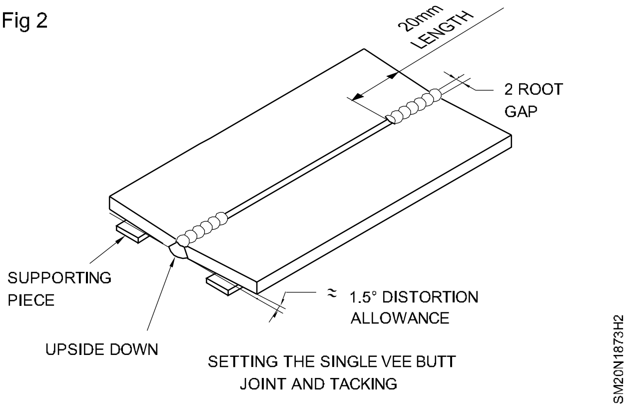
Prepare a uniform root faces 1.5 mm by filing on both the beveled edges.

Setting the single V butt joint and tacking

Keep the bevel edges upside down with a root gap of 2mm, and 3° distortion allowance. (Fig 2) using suitable support. i.e. 1.5° on each side of the joint.

Tack-weld on both ends. (20mm long)

Fig 2

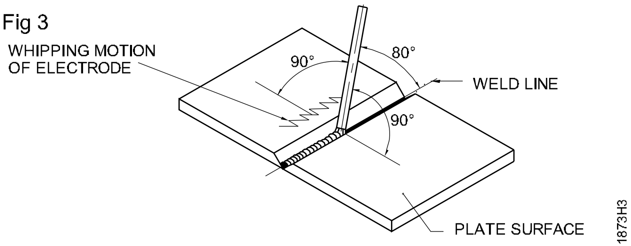


Ensure safety apparels are worn.

Place the joint in flat position after tacking.

Deposition of root bead (Fig 3)

Fig 3



ELECTRODE ANGLE AND MOTION FOR SINGLE VEE BUTT JOINT IN LAYING ROOT BEAD

Deposit root bead using a 3.15 dia. M.S. electrode and 110 amps welding current.

Proceed with a uniform normal speed holding a short arc.

Keep the electrode angle (as shown in Fig 3) at 80° to the line of weld.

Give a whipping motion to the electrode to maintain the size of the KEYHOLE for correct penetration.

Clean the root bead, and observe penetration.

Deposition of hot pass & covering beads (Fig 4)

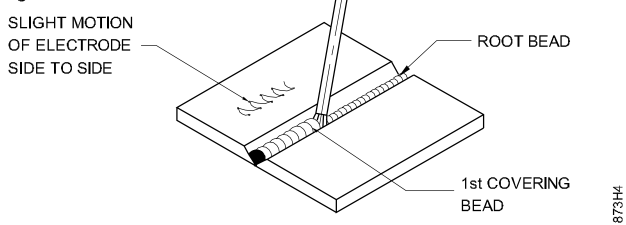
Deposit the 1st covering bead using a 4.00mm dia medium coated M.S. electrode and 160 amps welding current.

Proceed with a uniform speed, holding a normal arc and a side-to-side weaving motion to the electrode.

Ensure the electrode angle is the same as it was for the root bead.

Clean the bead thoroughly and grind the humps in beads (if present).

Fig 4

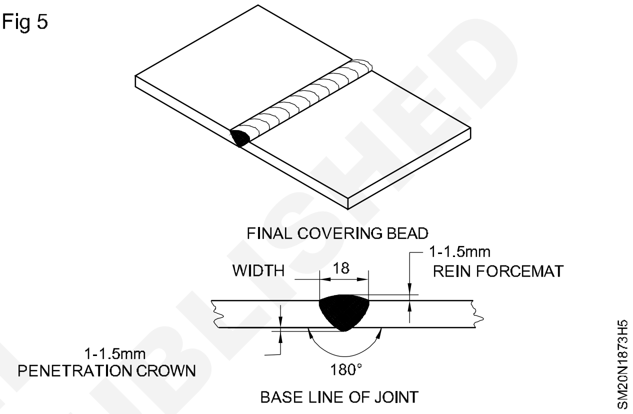


ELECTRODE MOTION IN DEPOSITING 1st COVERING BEAD

Rectify possible defects, if any.

Deposition of final/covering bead (Fig 5)

Fig 5



Deposit the final covering bead using a 5.00mm M.S. electrode, 220 amps welding current, and imparting a wider side-to-side weaving motion to the electrodes. Pause (stop) the electrode weaving at the toes of the weld so that undercut defect will get eliminated.

Follow the other steps as done for the 1st covering bead.

Cleaning and inspection

Clean the welded joint thoroughly from both sides.

Inspect the weld size, surface defects, root penetration and distortion.

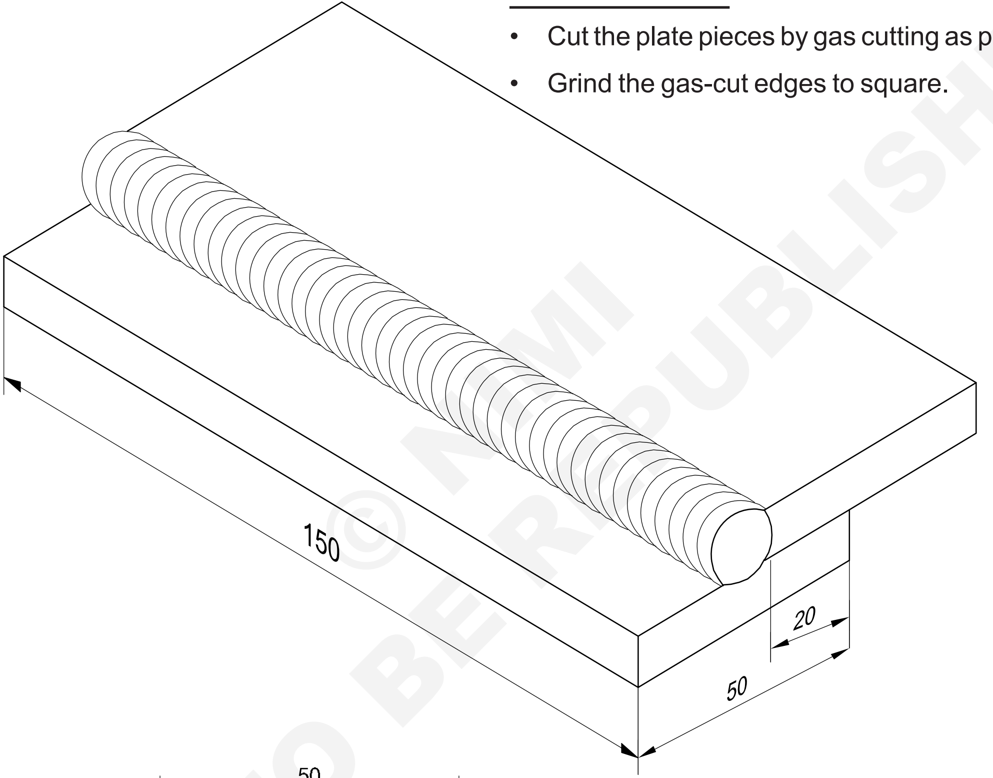
Fill of weld lap joint on M.S plate in flat position

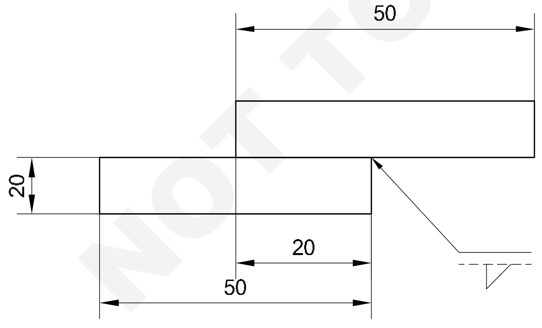
Objectives: At the end of this exercise you shall be able to

- **prepare plate pieces (gas-cut square edges) by grinding to size**
- **set the lap joint with the recommended overlapping of plate pieces**
- **tack the lap joint at both ends and one in the centre**
- **place the lap joint in a flat position for welding**
- **deposit root run in a lap joint of proper size and penetration**
- **deposit the final covering run in the lap joint of proper size**
- **clean and inspect the lap fillet weld for surface defects**

Job Sequence

- Cut the plate pieces by gas cutting as per drawing.
- Grind the gas-cut edges to square.





- Remove the grinding burrs and clean the surfaces by filing.
- Set the pieces in the form of a lap joint as per drawing.

Wear protective clothing.

- Tack-weld on both sides and also one in the centre.
- Set the lap joint in a flat position.

2	50 ISF 10 - 150		Fe 310 - W			74
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	FILLET WELD LAP JOINT ON M.S PLATE IN FLAT POSITION.	TOLERANCE ±1	TIME : 5Hrs
		CODE NO. SM20N1874E1	

- Deposit root run by using a 3.15mm dia. M.S electrode with 130 amps current.

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

- Remove the slag with a chipping hammer and clean with a wire brush.
- Use tongs to hold the job.
- Wear chipping goggle for the protection of eyes.
- Deposit the covering run with a weave motion using a 4.00 mm dia. M.S. electrode with 170 amps welding current.

Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.
- Inspect the lap fillet weld for surface defects and size.

Use a fillet gauge to check the fillet size.

(Refer to Skill Information.)

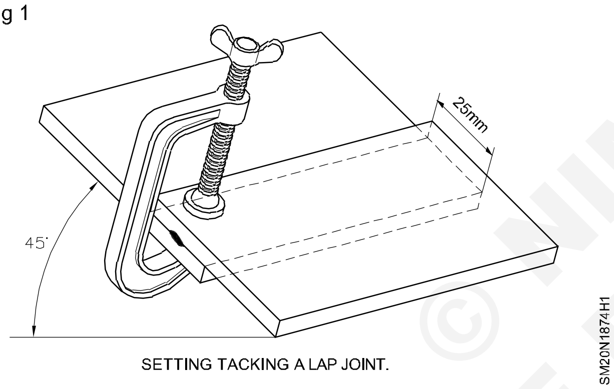
Skill Sequence

Fillet weld in lap joint on M.S. Plate (10 mm) in flat position

Objectives: This shall help you to
- **set and tack the lap joint in correct alignment**
- **weld a lap fillet joint of correct size in flat position**
- **inspect a lap fillet welded joint.**

Setting and tacking the lap joint (Fig 1)

Fig 1



SETTING TACKING A LAP JOINT.

Set the lap joint with an overlap of 20mm.

The overlap may be kept to 2 to 3 times of the plate thickness.

Tack-weld on both ends of the joint and at the centre of the lapping distance. (Fig 1)

Use a 3.15 mm dia. electrode with 130 amps current.

Set the joint in a flat position.

Welding the lap fillet joint in flat position

Deposit root run with a 3.15 mm dia. electrode with 130 amps welding current.

Maintain 80^0 angle to the line of the weld and 45^0 between the weld faces. (Fig 2)

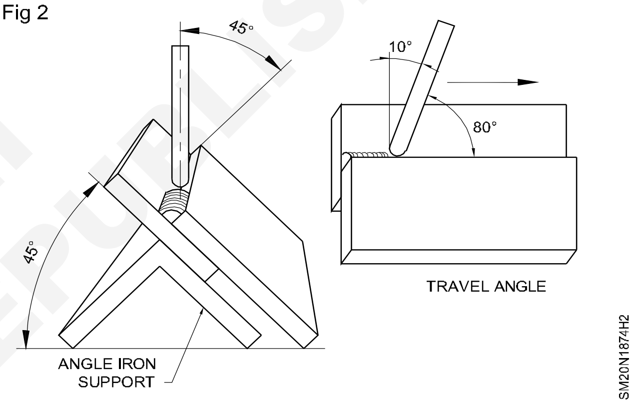
Maintain a short arc to get uniform fusion and root penetration.

Avoid side-to-side movement of the electrode.

De-slag and clean the root bead thoroughly.

Deposit the final covering run with a 4mm electrode and 170 amps welding current.

Fig 2



Give side-to-side movement to the electrode not more than 1.5 times of its dia.

Use the same electrode angle as was used for the root bead.

Prevent the upper edge of the plate from melting off.

Inspection of lap fillet (Fig 3)

Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

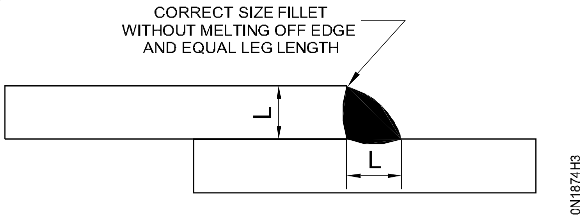
Inspect the lap fillet weld and ensure:

– it has equal leg length with slight convexity

– the upper edge of the plate has not melted off

– it is free from surface defects.

Fig 3

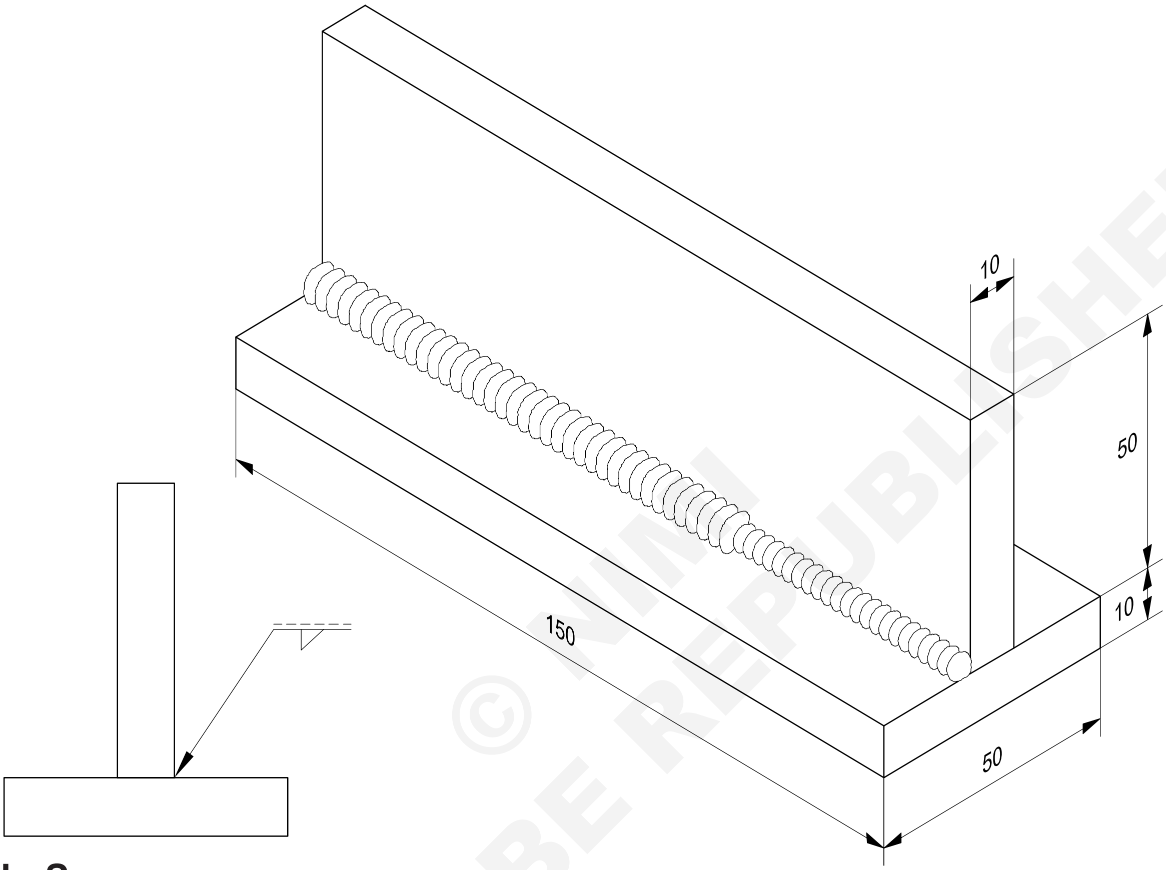


INSPECTION OF LAP FILLET WELD

Fillet weld the joint on M.S Plate in flat position

Objectives: This shall help you to

- **Prepare plate pieces to size (gas-cut square edges) by grinding and filing**
- **set and tack plate pieces in alignment as tee joint and by keeping distortion allowance**
- **set the tee joint in flat position for welding**
- **deposit root run in tee joint of proper size and penetration**
- **deposit final covering run in the tee joint of proper size**
- **Clean the weldment and inspect surface defects on the fillet weld.**



Job Sequence

- Cut the plate by gas cutting as per drawing
- Grind the gas-cut edges to square.

Use goggles while grinding

- Remove the grinding burrs and clean the surface by filling
- Set the pieces in the from of tee as per drawing
- Tack-weld on both sides.

Wear protective clothing

- Preset the pieces to have 92 to 93 angel between Fusion faces @ 1 per run.
- Set the tee joint in a flat position
- Deposit root run using a 3.15mm dia. M.S. Electrode and 130 amps welding current.

Ensure uniform root penetration and an electrode angle of 45 between the plates and 80 with weld line.

- Remove the slag from the root run with a chipping
- hammer and clean with a wire brush.

2	50 ISF 10 - 150		Fe 310 - W			74
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	FILLET WELD TEE JOINT ON M.S PLATE 10mm THICK IN FLAT POSITION.	TOLERANCE ±1	TIME :10Hrs
		CODE NO. SM20N1874E2	

- Wear chipping goggles.
- Deposit covering run with a weave motion using a
- 4mm dia. M.S. electrode and 170 amps welding current.
- Remove the slag from the final bead and clean the weld.
- Inspect the tee fillet weld for defects. (Refer to skill information.)

Skill Sequence

Fillet weld in lap joint on M.S. Plate (10 mm) in flat position

Objectives: This shall help you to

- **set and tack the lap joint in correct alignment**
- **weld a lap fillet joint of correct size in flat position**
- **inspect a lap fillet welded joint.**

Fillet weld in tee joint on mild steel plate (10mm) in flat position

Objective : this shall help you to

Set and tack-weld the tee joint maintaining correct alignment

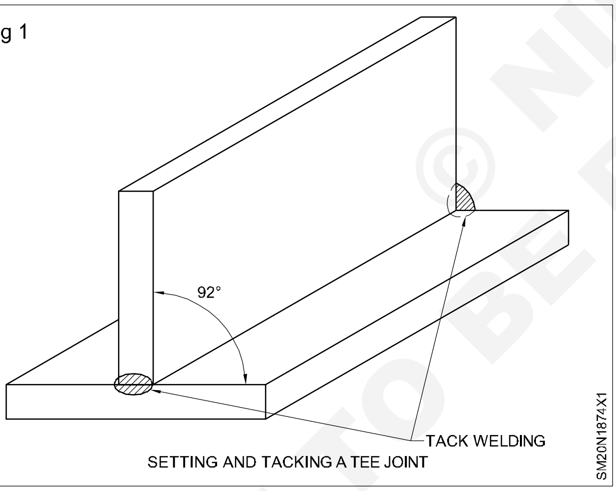
Weld a tee fillet joint with leg length and throat thickness as recommended

Inspect the tee filled weld.

The weld deposited on a tee or lap joint is called fillet weld. Often a tee joint is called a fillet joint. This joint is extensively used in fabrication work.

Setting and tracking of a tee joint (Fig 1)

Fig 1



SETTING AND TACKING A TEE JOINT

Set the pieces in alignment forming a 90 tee

Tack-weld the pieces at both ends of the tee joint by using a 3.15mm dia. M.S. electrode and 130 amps welding current

Ensure the tacks are well fused. Wear safety apparel.

Check the alignment of the tee joint after tacking.

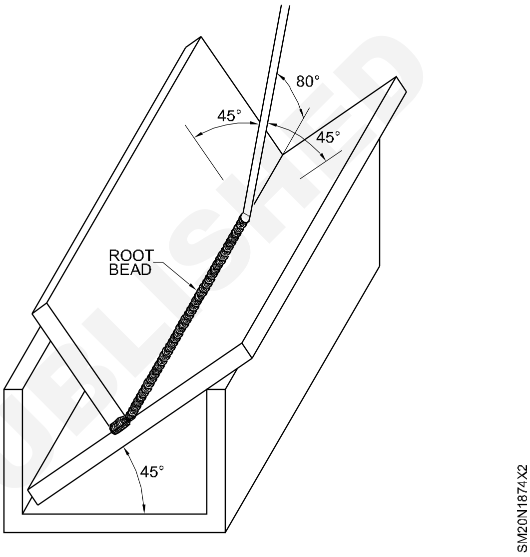
Welding a tee fillet joint: place the in a flat position (Fig 2)

Deposit root run by using a 3.15mm dia. M.S electrode and 130 amps welding current.

Maintain an electro angle 80 with the line of weld towards the direction of travel and 45

Between the plate surface. (Fig2)

Fig 2



Proceed along the welding line with uniform travel speed and short arc to get uniform fusion and root penetration.

De-slag and clean the root (weld) bead thoroughly.

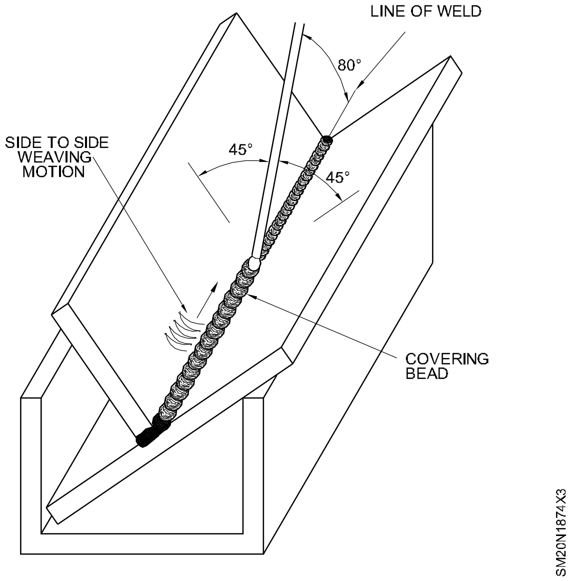
Deposit the final covering run by using a 4mm dia.

Electrode, 170 amps current and giving a slightly side- to-

Maintain the same electrode angle as in the root bead.

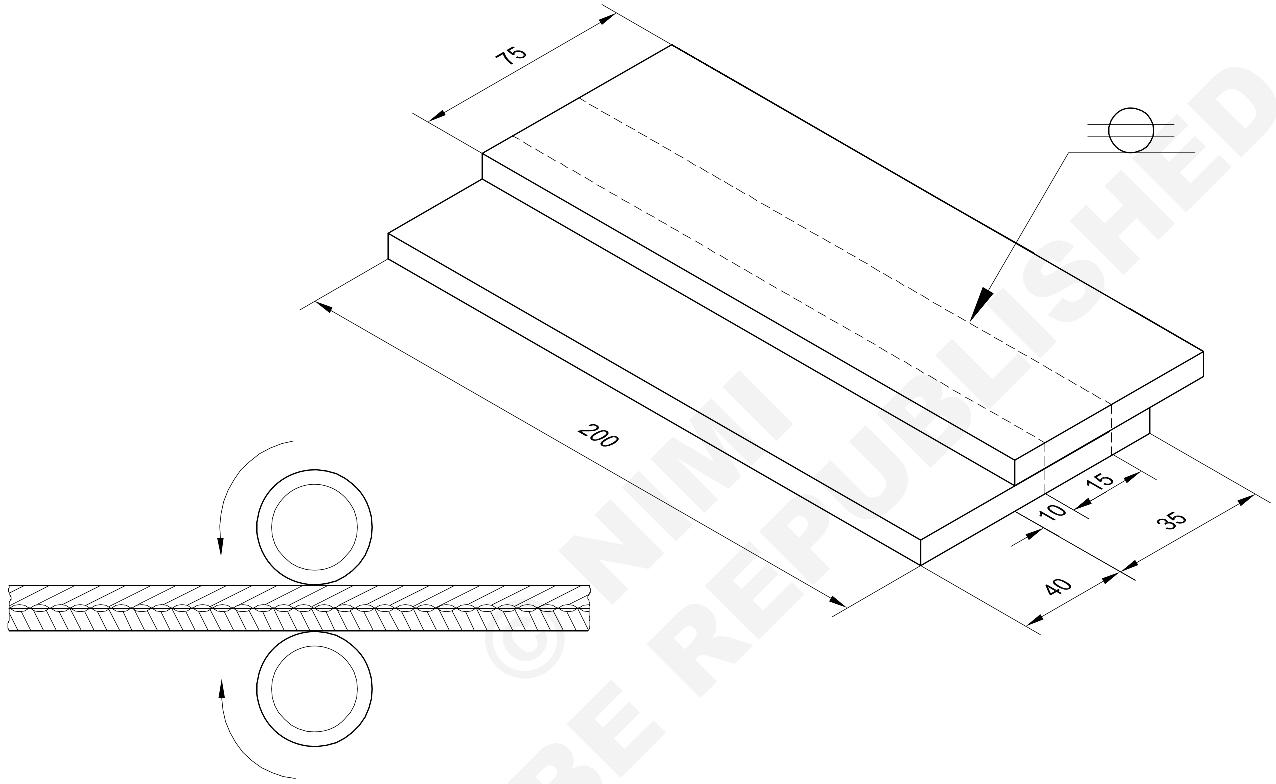
Clean the final covering bead thoroughly.

Fig 3



Resistance seam welding practice

Objectives: At the end of this exercise you shall be able to
- **set two sheets for seam welding**
- **use distortion control and arc blow control methods**
- **weld the 'T' joint with a short arc and uniform travel speed**
- **inspect the weldments for external defects.**



Job sequence

- Prepare job as per drawing and clean sheets.
- Mark lines for guiding electrode rollers for seam welding.
- Set the sheet one over the other aligned to lap to adequate width, using clamps on the sheet.
- Set the seam welding machine, fix both electrode rollers and select the current for seam welding w.r.t sheet thickness.
- Feed the sheets between rollers along the marked lines.
- Adjust the rollers for proper welding effect.
- Check the effectiveness of the seam welded joint.

2	200 x 75 x 0.61		G.I SHEET			75
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	PRACTICE ON SEAM WELDING	TOLERANCE ±1	TIME 5Hrs
		CODE NO. SM20N1975E1	

Skill sequence

Seam welding machine

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

- **operate seam welding machine**
- **select current and electrode rollers w.r.t. sheet thickness.**

1 Check the seam welding machine functions.

2 Check the electrode rollers and clean them.

3 Fit the electrode rollers in position.

4 Set and check the current setting the current regulator.

5 Ensure the sheets are properly aligned.

6 Using adequate supports for holding the work while welding.

7 After inserting sheets between rollers apply appropriate pressure to rollers.

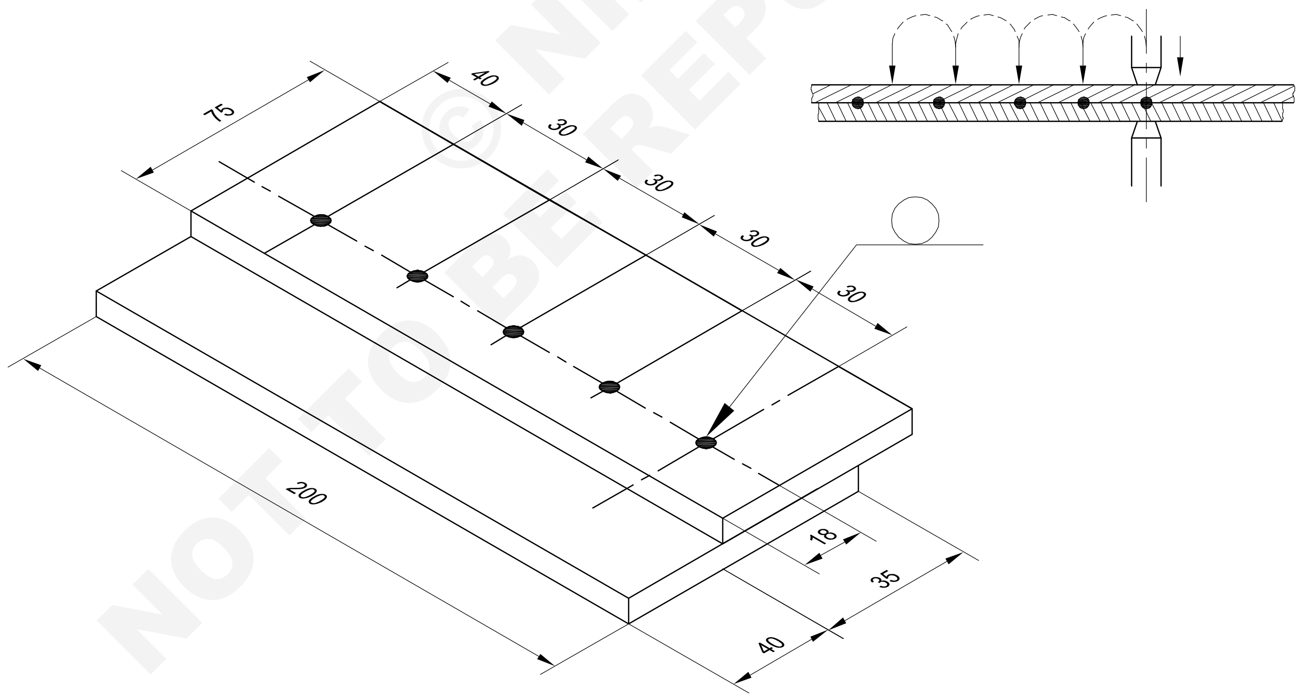
8 Feed the sheets along marked lines.

9 After completion of welding, check the effectiveness of the joint.

Resistance spot welding on M.S.Sheet

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

- **select electrode, current, polarity and arc length**
- **use distortion control and arc blow control methods**
- **weld the 'T' joint with a short arc and uniform travel speed**
- **inspect the weldments for external defects.**



2	200 x 75 x 1.6		G.I SHEET			75
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PRACTICE ON SPOT WELDING	TOLERANCE ±1	TIME 5Hrs
		CODE NO. SM20N1975E2	

Job sequence

- Prepare job as per drawing and clean the sheet.
- Mark line on the sheets for the spot welding & also pitch for spot welding.
- Set the sheet one over the other aligned to lap to adequate width, using clamps on the sheet.
- Set the spot welding machine fix electrode tips in fixed & movable arm in the electrode holder. Set the current with respect to sheet thickness.
- Insert the sheet between the electrode and adjust the sheet to bring the electrode to marked spot.
- Press the foot pedal and effect the weld.
- After few seconds of applying pressure, release the pedal.
- Check the effectiveness of the spot welded joint.

Skill sequence

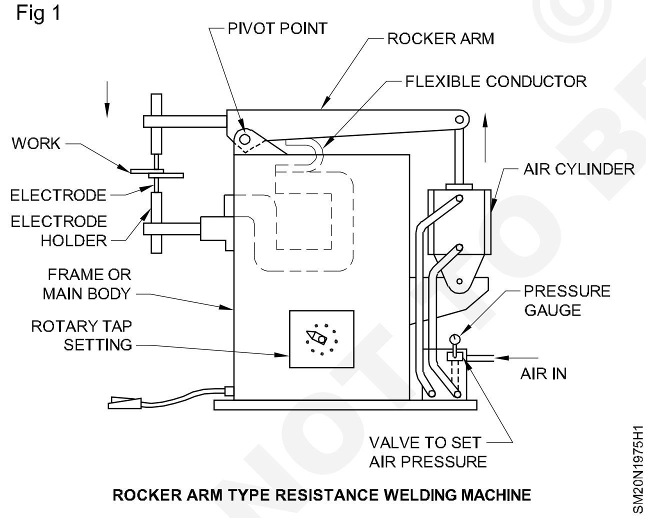
Operate spot welding machine

Objectives : At the end of this exercise you shall be able to
- **select electrode tips**
- **select current w.r.t. sheet thickness.**

- Check the electrode tips and clean them.
- Check the movement of electrode by pressing the foot pedal.
- Check the current setting through the current regulator.
- Ensure the sheets are properly aligned.

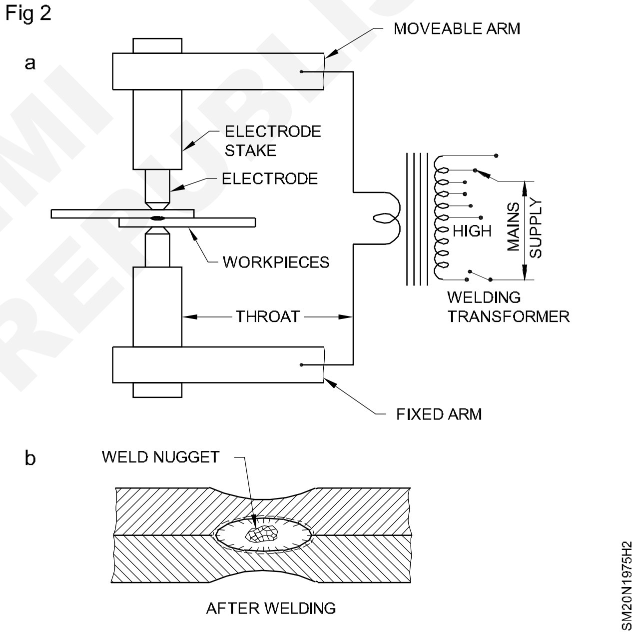
Wear apron and safety googles. Use hand glovse while handling the sheet.

Fig 1



ROCKER ARM TYPE RESISTANCE WELDING MACHINE

Fig 2

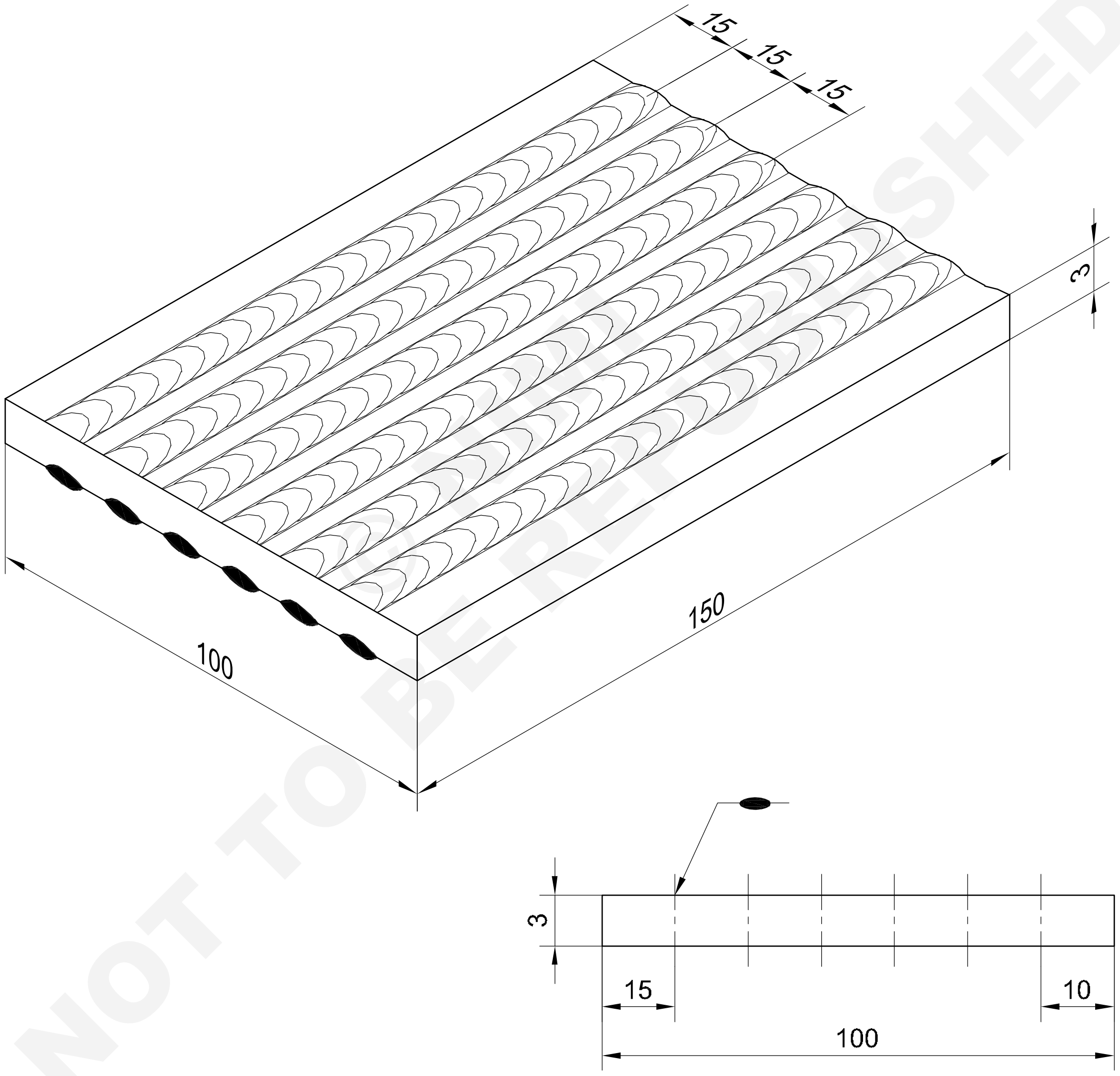


- Use adequate support for holding the workpiece while welding.
- After locating the electrode on the marked line(marking) press the foot pedal to complete the weld.
- Follow the same procedure to effect spot weld at selected pitch distances.
- Check the workpiece for effectiveness of the joint.

Deposit bed on M.S flat in down hand position by CO_2 welding

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

- **set up the CO_2 welding machine and set welding parameters.**
- **strike and maintain the electric arc without freezing of the electrode wire with the job**
- **deposit uniform straight bead in flat position without weld defects.**
- **inspect weld bead for finish and weld defects.**



2	100 ISF 10 - 150		Fe 310			76
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**STRAIGHT LINE BEADS ON M.S.PLATE POSITION FLAT**	TOLERANCE ±1	TIME 15h
		CODE NO. SM20N1976E1	

Job sequence

- Prepare the job to size as per drawing.
- Clean the job surface with Carbon Steel wire brush.
- Mark parallel lines on the job surface as per drawing and punch the lines.
- Set the workpiece (job) on the work table in Flat position.
- Fix the 0.8mm diameter wire spool in position, lock it up and pull the wire through the guide tube, rollers, spiral and Contact Tip of the Torch.
- Start the welding machine. Connect the Torch to the positive (DC +ve) terminal (DCRP) of the machine.
- Connect the Co_2 gas heater to the electrical supply 5-10 minutes before starting of the weld.
- Set the arc voltage at 19-21 volt as required for Dip Transfer mode.
- Set the Gas Flow Rate at 8-10 LPM (Litres Per Minute).
- Set the wire feed rate so as to get 90-100 Amp by striking the arc on a scrap plate.
- Use DIN 11 or 12 black/green filter glass on Hand Shield/Helmet for above current setting.
- Wear the protective clothing as required.
- Switch over to Weld Mode as indicated in the machine.
- Strike the arc, maintain a filler wire stick out of 8-10mm from the end of the contact tip to the job as required for Dip Transfer Mode.
- Deposit the bead on punched lines of the job from one end to other.
- Remove spatters with chipping hammer and clean the joint using Carbon Steel Wire Brush.
- Self inspect the weld bead for finish and defects.

Skill sequence

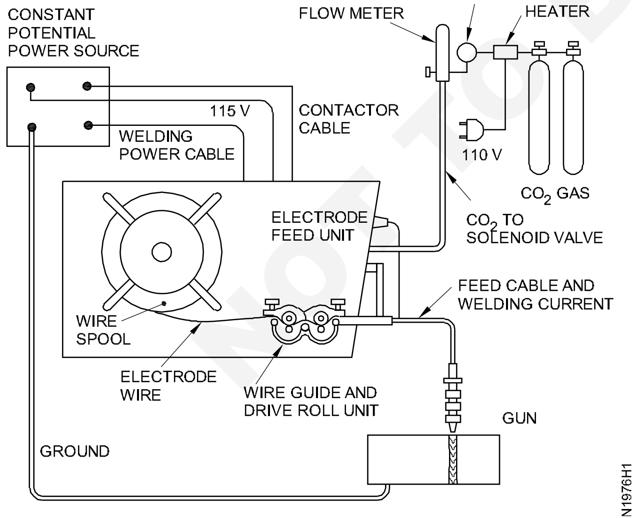
Preparation and setting of the job: Prepare a M.S plate piece of size 150 x 100 x 10mm thick.

Mark striaght lines with punch marks spaced at 15mm.

Set the job on the welding table in a Flat position as done in earlier exercises.

Setting up of the Co_2 welding machine: Fix the wire spool and take the wire through the guide tube, rollers, spiral and contact tip at the end of the torch/gun.Fig.1.

Fig 1



COMPONENTS OD THE CO_2 MIG WELDING SYSTEM

Draw the wire from the spool, pass it on through the Inlet wire guide, driver rollers and outlet wire guide. Fig.2 and Fig.3.

Fig 2

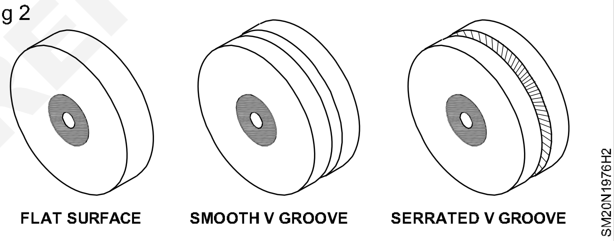
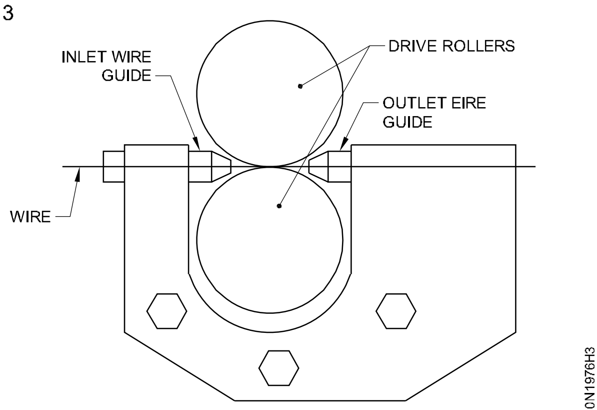


Fig 3

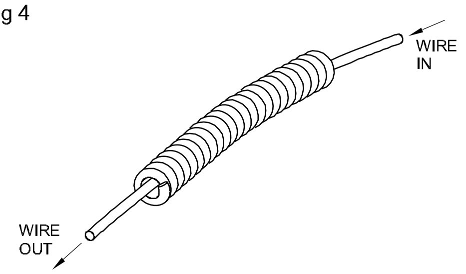


DRIVE ROLLS AND WIRE GUIDES PEOPERLY ALIGNED

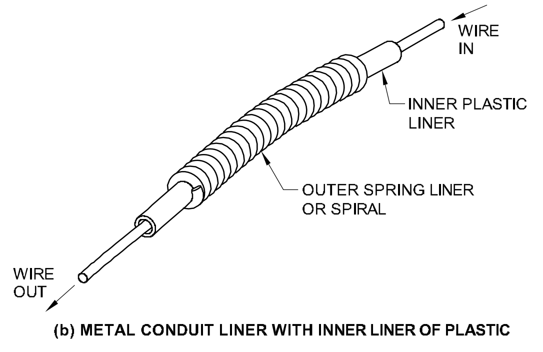
The roller should not be over tightned to avoid flattening and peeling of copper coating on the wire.

The wire is further passed through the conduit liners with spring liners called spiral Fig.4 to the welding torch outlet through the contact tip. Fig.5.

Fig 4

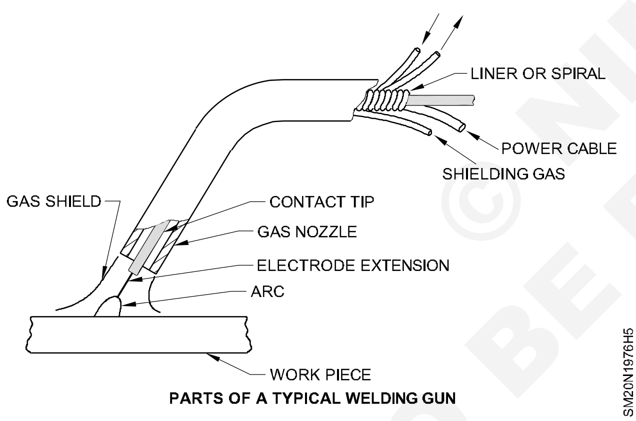


(a) SPIRAL (SPRING) METAL CONDUIT LINER



(b) METAL CONDUIT LINER WITH INNER LINER OF PLASTIC

Fig 5



PARTS OF A TYPICAL WELDING GUN

The wire should not develop any bends (or) kinks while inserting.

The Contact Tip should be removed to facilitate easy flow of the wire from the Spiral and put in position into the Torch later.

Start the Co_2 welding machine after the machine is connected to the 3 phase supply mains.

Connect the welding torch to the Positive terminal.

The positive terminal influences deeper, wider weld penetration with a good ripple formation.

Connecting the heater, regulator and flow meter: The inlet end of the Co_2 gas heater is connected to the Co_2 cylinder. (Fig.1) The heater should be connected to either 110V supply from the Welding Machine (or) 230V supply from the mains.

This will help to avoid ice-forming (freezing) of the Co_2 gas at regulator and flow meter.

Fix a two stage regulator using a flat spanner to the outlet end of the gas heater and ensure proper functioning of the dial gauges.

Connect finally the Flow Meter, Gas Hose to the welding torch/gun.

Set an outflow pressure for Co_2 gas to get a gas flow of 8 to 10 LPM as required for the Dip Transfer mode.

Ensure to avoid leakage at all connections so as to get correct pressure at the nozzle end. This could be checked by using soap-water solution. When used with correct gas flow rate a rapid cracking and hissing sound shall be heard. Too little flow results in porosity and too high flow rate creates turbulances and in turn contaminates weld.

Setting up arc voltage, stickout and wire feed rate for Dip Transfer

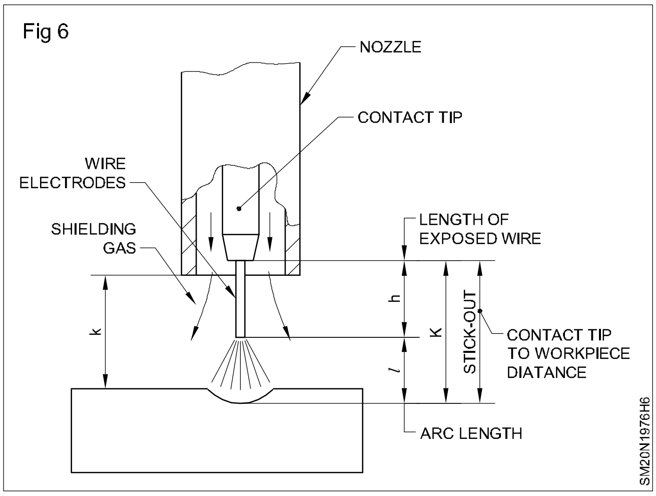
Setting the current level by selecting proper wire feed rate: For this exercise of depositing straightline beads it is desirable to select a smaller diameter wire i.e. 0.8mm dia wire and Dip Transfer method. Accordingly a current range of 80-100A is to be set for the 0.8mm dia wire. The current to be set has a direct relationship with the wire feed rate in Co_2 welding/GMAW process. So the correct wire feed rate corresponding to the 80-100A current is set on the Electrode Feed unit of the machine.

Setting appropriate arc voltage for the corresponding current used: The Arc Voltage to be set depends on the filler wire diameter, the type of metal transfer and the current selected. The thumb rule to select arc voltage for DIP transfer mode in GMAW process is calculated by using an imperical formula i.e. Arc voltage = $14 + 0.05\,(I) \pm 2$ where I is the current selected for the diameter of the wire. This can be up further by +2 volts for globular and spray transfer mode and depending upon bead finish. For laying straight line beads on 10mm thick mild steel plate set an voltage of 23 to 24 volts using set voltage control knob of Co_2 welding machine. This set voltage will drop down and settle at 19-21 volts after Arc initiation. The reduction in voltage from set to Arc voltage is due to length of the cable and other factors.

The welder should select 19 to 21 volts, strike the arc without changing the current; The right arc voltage is selected by Trial and Error method to get a uniform bead profile.

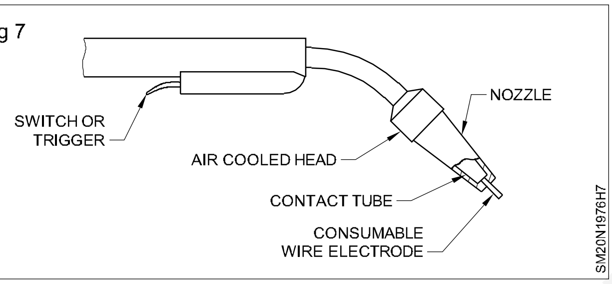
Setting the stick-out: This is the distance between the end of the contact tip and the outer tip of the electrode till it touches the base metal [refer (k) in the Fig 6]. The stickout recommended is 5 to 10 mm for Dip Transfer. If the stickout is too short then excessive spatters will get deposited at the end of the nozzle which in turn restricts the shielding gas flow and may cause porosity. If the stickout is too large, arc voltage will shoot up, current diminishes, the arc will tend to become weaker and the metal deposition will become irregular.

Fig 6



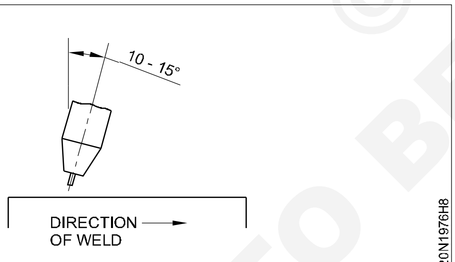
Welding procedure (Depositing the Beads): Strike the arc by pressing the trigger in the welding torch(refer Fig.7) and at the same time touching the tip of the electrode wire to the job at the starting of the marked line.

Fig 7



Hold the torch 15mm above the work piece at an angle of 10 to 15^0 to the vertical in the direction of welding as shown in the Fig.8.

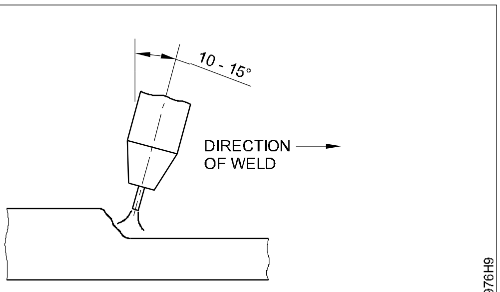
Fig 8



TORCH ANGLE

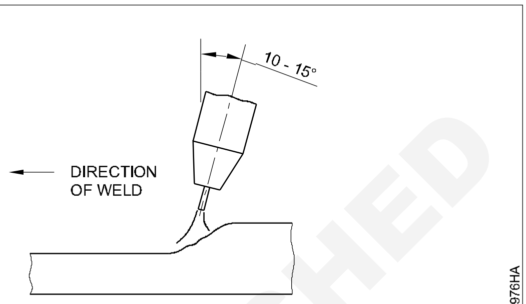
Move the torch uniformly starting from the left end of the job towards the right end or from the right end to the left end of the job Fig.9 and 10. Based on the welding direction, the welding technique is called as Backhand or Backward or Pulling technique Fig.9 and Forehand or Forward or Pushing technique (Fig.10).

Fig 9



BACK HAND OR BACKWARD OR PULLING WELDING TECHNIQUE

Fig 10



FORE HAND OR FORWARD OR PUSHING WELDING TECHNIQUE

Use anti spatter spray or Gel periodically to avoid the sticking of the spatter at the mouth of the torch nozzle.

Ensure the crater is filled properly at the end of the bead as done in shielded metal arc welding.

Avoid excessive travel speeds for the torch to get correct bead width, height and ripple formation and to avoid undercut.

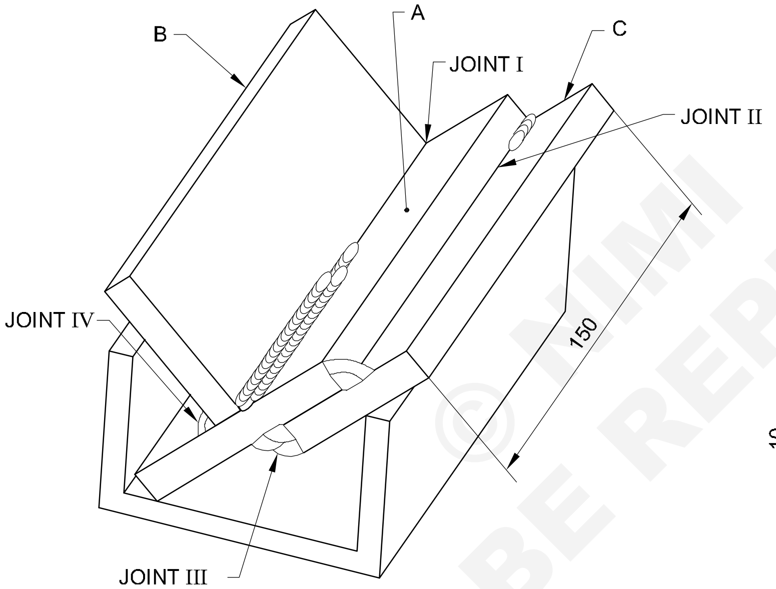
Cleaning the weld bead: The spatters, if present, on the surface of the bead and base metal are to be removed by using a chipping hammer. Also use protective goggles for safety. Further the bead has to be cleaned by carbon steel wire brush to remove any non-metallic deposits on the bead.

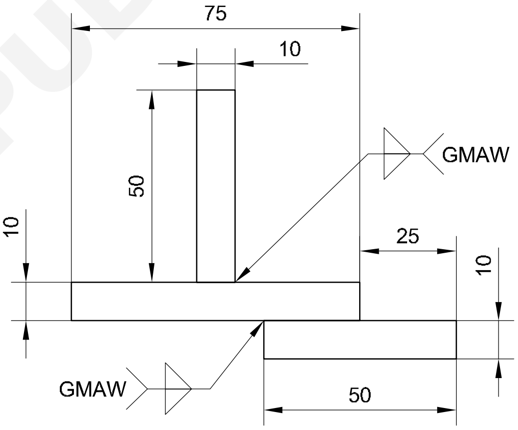
Repeat the above procedure for other runs done alternately by both Forehand and Backhand techniques (push and pull welding).

Inspecting the finished welded job: Use visual inspection method to verify whether any weld defects such as undercut, uneven bead width, height, ripple formation and wavy line of bead are there.

Fillet weld LAP & TEE on MS FLAT (10mm) in flat position by CO$_2$ welding

Objectives: At the end of this exercise you shall be able to
- **prepare plate pieces to size as per drawing**
- **set and tack weld the plates in alignment as Tee joint and Lap joint as per drawing, after taking care to control distortion in the joint**
- **set the Tee and Lap joints in flat position for welding**
- **deposit the root runs in the joints so as to get 4mm leg size and good penetration**
- **deposit the 2nd and 3rd run by stringer bead method as shown in the sketch for joint I and III**
- **deposit the 2nd/covering run by weaved bead method for joints II and IV**
- **clean the beads and the finished welded job**
- **inspect for surface defects on the weld and bead appearance.**





Job sequence

- Cut the plates by gas cutting as per drawing.
- Grind the gas cut edges to square.
- Use plain goggles while grinding and welding goggles while gas cutting.
- Deburr and clean the surface of the plates by carbon steel wire brush and filing.

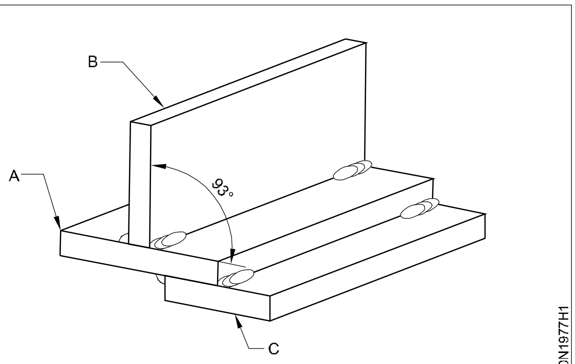
2	50 ISF 10 - 150		Fe 310 - W		B & C	
1	75 ISF 10 - 150		Fe 310 - W		A	77
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	FILLET WELD TEE AND LAP JOINT ON M.S. PLATE 10mm POSITION FLAT				TOLERANCE ±1	TIME 10h
					CODE NO. SM20N1977E1	

- Set the plate B on the plate A in the form of 'inverted' Tee as per drawing (Fig.1).

Wear protective clothing.

- Tack weld (min 10mm length) on both ends of the Tee joint as shown in the Fig.1.
- Set the plate C as lap joint as per drawing Fig.1 on the 75mm wide plate A.

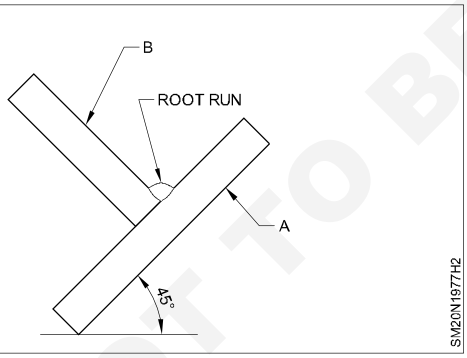
Fig 1



SETTING AND TACKING A TEE JOINT AND LAP JOINT

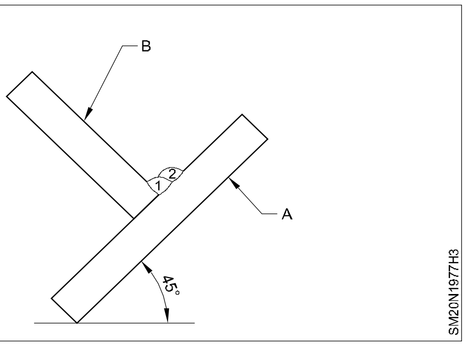
- Tack weld (keeping min. length of 10mm) on both sides of the Lap joint as shown in the Fig.1.
- Keep the tack welded job in the channel at 45^0 from the horizontal plane so that the welding can be done in flat/ downhand position. (Refer job drawing on the previous page)
- Connect the torch to the +ve terminal of the machine.
- Weld the root run of joint I using 0.8mm dia. mild steel filler wire and using stringer bead welding technique Fig.2.

Fig 2



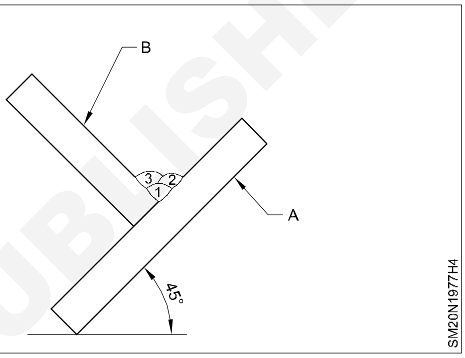
- Set 90-100A current/corresponding wire feed rate, 19 to 20 arc voltage and deposit the root run using Dip transfer mode.
- Ensure proper root penetration and even fusion of plate A and B with suitable welding gun/torch angle and arc travel speed.
- Clean the root run using Carbon Steel wire brush.
- Deposit the 2nd run using stringer bead as shown in Fig.3 covering the bottom plate A and 2/3rds of the width of root run. Adopt the same welding parameters and techniques used for the root run.

Fig 3



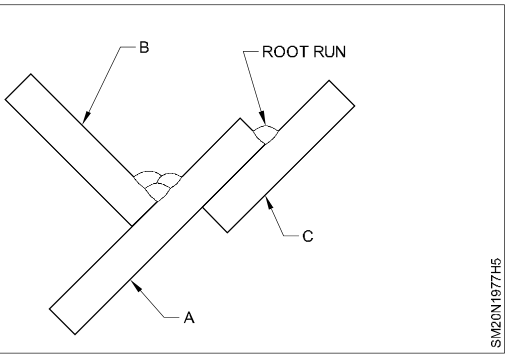
- Ensure that undercut in bottom plate is avoided and a leg length of plate thickness 10mm is obtained.
- Clean the 2nd run by wire brush.
- Deposit the 3rd run similar to 2nd run, except that deposit covers the vertical plate B, the root run and the 2rd run.Fig.4

Fig 4



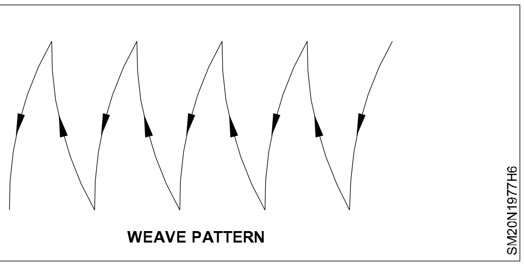
- Ensure undercut on the vertical plate is avoided and a leg lenth of 10mm is obtained.
- Clean the welded joint by wire brush.
- Use tongs while handling the hot job.
- Deposit the root run on the lap joint (Joint II) with the same parameters and technique used for the Tee joint.
- Ensure good root penetration, and even fusion of plates A and C with suitable torch angle and arc travel speed.Fig.5

Fig 5



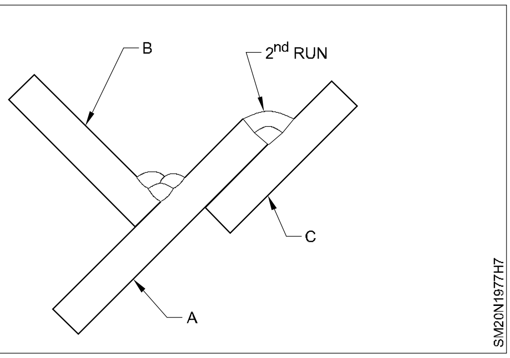
- Avoid undercut on plate C.
- Clean the root run.
- Deposit the 2nd run using weaving bead technique.Fig.6
- Set 80-90 A and 18-19 volts to avoid over spilling of hot weld metal over the edges while welding.

Fig 6



- Ensure the edge of the plate A (at the toe of the weld) is not melted off due to excessive weaving.
- Ensure there is no undercut at the other toe of the lap weld on plate C.Fig 7

Fig 7



- Clean the bead and the lap joint with wire brush.
- Reverse the welded joint on the channel such that the Joint no.III and IV are kept in flat/down hand position as shown in Fig 8 and Fig 9
- Weld the tee Joint IV using weaving method after root run is deposited.Fig 8

Fig 8

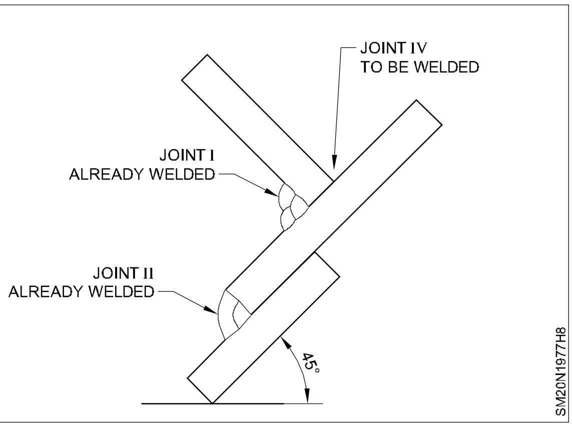
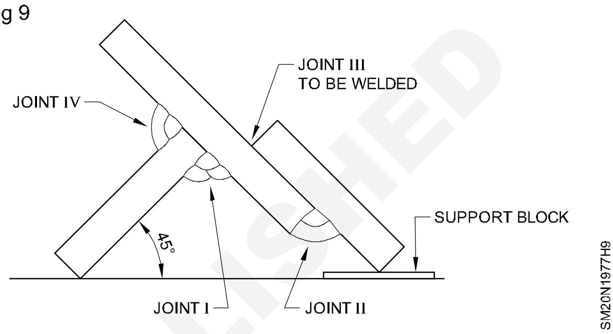


Fig 9



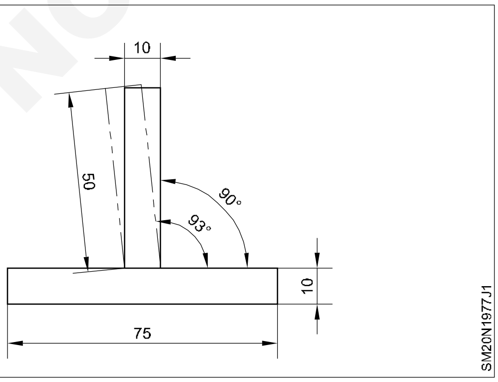
- Weld the lap Joint III using the stringer bead technique. Fig 9
- Clean the Joint III and IV using wire brush.
- Inspect the welded joints for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile.

Skill sequence

While tack welding plates A and B for the Tee joint I, the angle between them is to be kept at 93^0 initially as shown in Fig.1(i.e a distortion allowance of 1^0 per run) so as to control the angular distortion which ultimately settles to 90^0 after welding.

For the lap fillet joints II and III no distortion allowance is recommended. Also for joint IV no distortion allowance is required as the vertical plate B is rigidly held by the weld bead at joint I.

Fig 1



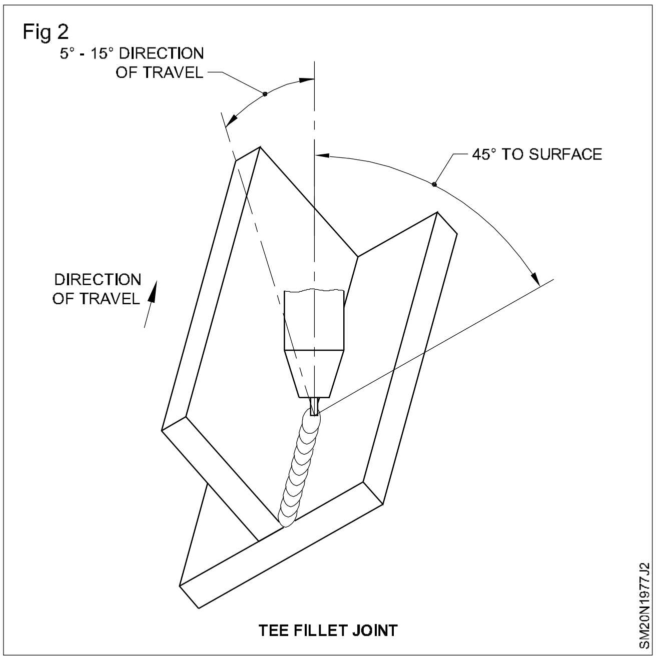
Since the Co_2 welding process does not have the ability to remove many impurities, it is very important to clean the mill scale, rust, paint, oil or grease from the plate surface.

For welding the joints in flat (downhand) position it is convenient to use the channel to position the joints. This will permit the tack welded job to be kept at 45^0 angle with the horizontal plane.

For depositing the root run for the Tee joint I hold the torch perpendicular to the joint and move the torch at a steady rate from left to right side (Backhand technique) of the joint. The gun should be held between 5-15 degrees forward from the vertical line to the metal surface and 45^0 to the surface Fig 2.

Uniform travel speed will ensure even weld reinforcement, bead height and ripple formation, smooth joining of the weld bead with the base metal at the toes. Fill the crater properly.

Fig 2



TEE FILLET JOINT

The bead placement for the 2nd and 3rd stringer bead are made as shown in the Fig.3. This is done to ensure that a leg length (L) of 10mm is obtained. Ensure that the concavity between the beads 2 and 3 is kept to the minimum. This will ensure to obtain the required throat thickness(Fig.4).

Fig 3

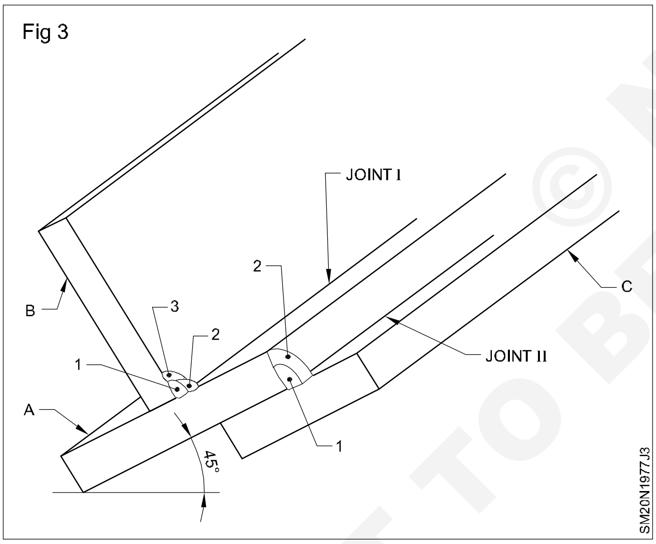
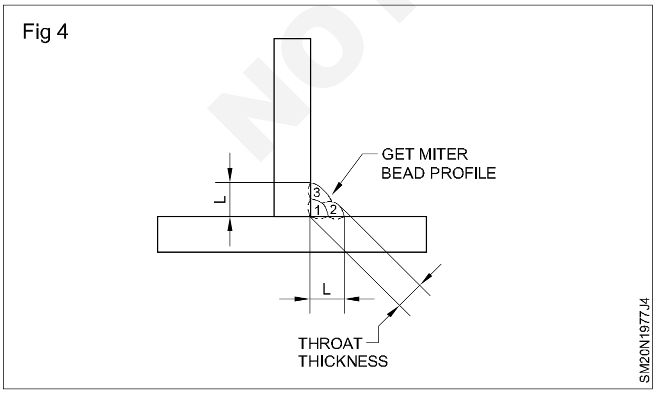


Fig 4



For the Lap joint II the root run 1 is deposited similar to the root run for T joint I.

The joint is completed by depositing the 2nd run also called as the covering run using weaved bead as shown in the Fig.5.

The gun is held perpendicular to the joint and an angle of

The weaving motion to the torch is crescent motion.

The torch movement at the edge of the top plate of the Lap joint should be so controlled that the edge is not melted off. Also the torch has to be paused when reaching the bottom toe of the weld for a short period so that the undercut, if developed, at the toe is properly filled with filler metal. 5 to 15 degrees forward to the direction of travel as shown in the Fig.5.

Maintain a uniform travel speed for the torch to get the required bead reinforcement, height and appearance.

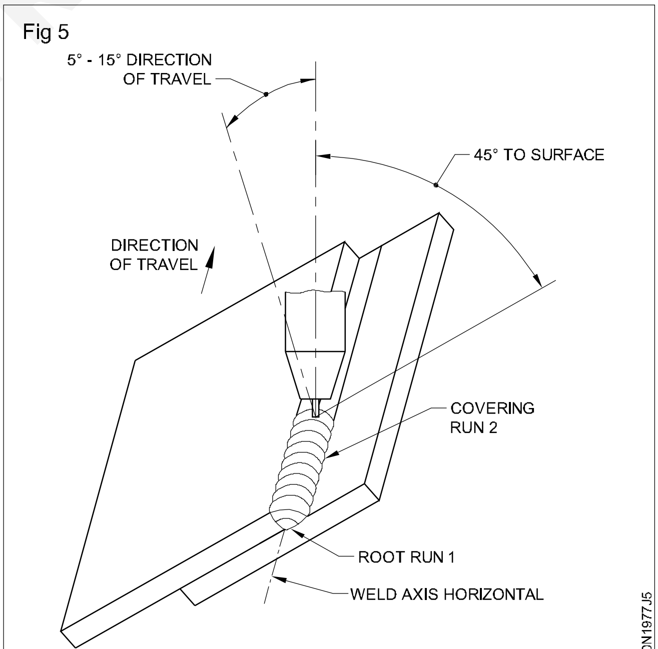
Caution: To avoid edge of the plate melted off defect, reduce the arc voltage by 1 volt and the current by 5A from that used for the root run.

To complete the joint III and IV repeat the same procedure used for joint I and II.

Use the anti spatter spray as and when the torch nozzle gets clogged with weld spatters. Note that if this is not done, the wire feed may be irregular causing unstabilised arc and the Co_2 gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

Clean each bead after deposition and the complete the job using carbon steel wire brush.

Fig 5

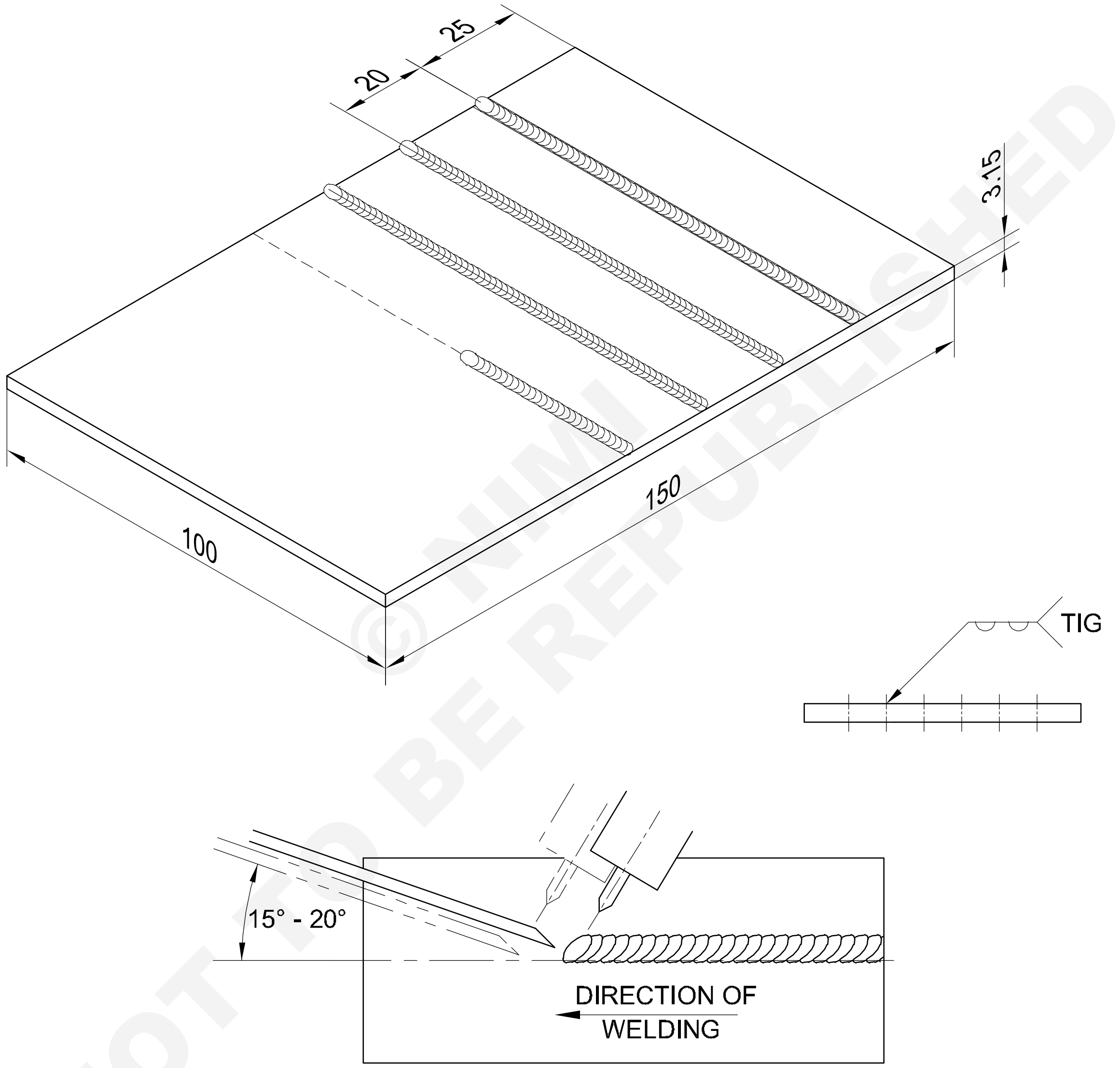


A FILLET WELD ON A LAP JOINT IN THE FLAT POSITION

Fusion run with filler rod on SS Sheet 1.6 mm in flat position by TIG welding

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

- **weld fusion run with filler wire on stainless steel sheet 1.6 mm in flat position.**



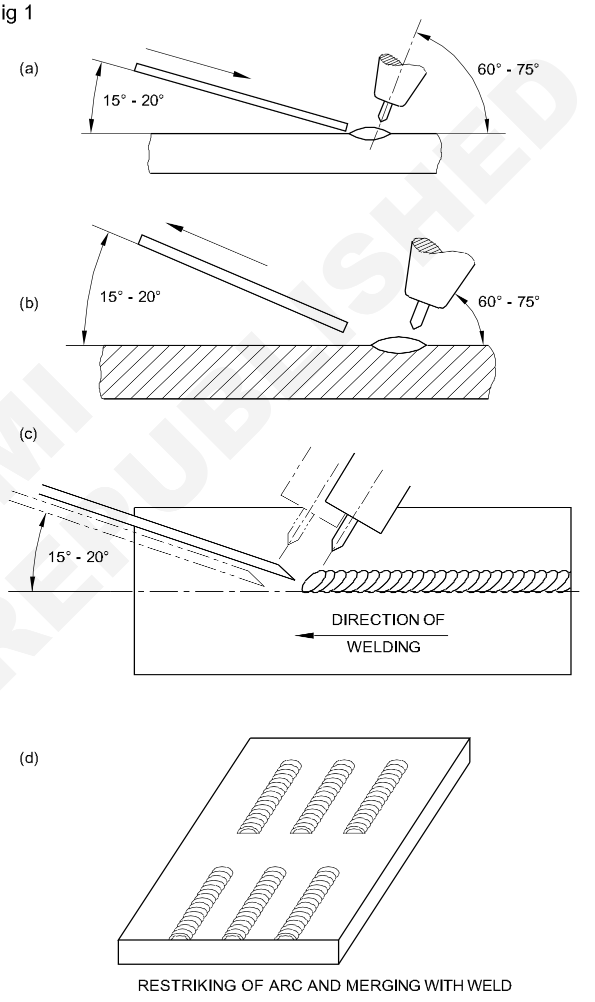
1	100 x 3.15 - 150	- -	X 04 Cr 19 Ni 9	- -	- -	78
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**FUSION RUN WITH FILLER WIRE ON STAINLESS STEEL SHEET 3.15mm - POSITION FLAT**	TOLERANCE ±1	TIME 5h
		CODE NO. SM20N1978E1	

Job sequence

- Making stringer bead in flat position with filler wire
- Take a piece of a plate of size 150 x 100 x 3mm and mark a few straight lines. Hold the torch in the right hand and above the right hand end of the plate, start the arc and establish a puddle holding the torch perpendicular to the plate.
- Maintain a proper arc length until a proper size and shape of the puddle is achieved. Rotate the torch in the clockwise direction slanting the torch to 60^0 - 75^0 to the vertical.
- Now bring the filler rod to the puddle. Keep the filler rod at an angle of 15 to 20^0 from the base plane of the plate. Add the filler rod to the front edge of the molten puddle. (Fig 1a)
- Allow the filler rod to melt off in the molten puddle. Do not melt the filler rod in the head of the arc.
- Add the filler rod-a drop at a time to the leading edge of the puddle. Move the filler rod back and move the torch forward to advance the puddle. Always keep the end of the filler metal within the protective gas shielding.
- Progressing at an even travel speed of the torch and regularly adding the filler rod to produce a uniform bead, move the torch and wire along the straight line always maintaining the size of the molten pool. Do not support and rest your hands and your body on the table or the job.
- Withdraw the filler rod, but within the gas shielding keeping it at an angle of 15 to 20^0 of the plate surface. (Fig 1b)
- Move the torch a little ahead in the left hand direction which will not allow to melt the newly added filler rod. It will melt into the existing puddle. Now move the torch to the leading edge of the molten puddle. (Fig 1c)
- Manipulate the torch in small semicircular contours, finally while stopping the welding at the left edge of the plate.
- Practise this bead on plate welding on the lines marked on the plate using the torch movements at different speeds. Faster movements will produce smaller beads and slower movement will produce larger beads.
- This procedure can be repeated holding the torch in the left hand and feeding the filler by the right hand.
- Restarting and merging with the existing welds can be made by starting the arc at the end of the existing weld just 2-3mm away from the existing weld. When the torch is near to the existing weld, stop feeding the filler rod short of 2mm from the existing weld. Merge the molten metal with the existing weld by the head of the arc. Restarting and merging with right and left hand can be practised. (Fig 1d)

Fig 1



RESTRIKING OF ARC AND MERGING WITH WELD

MAKING A STRINGER BEAD WITH FILLER ROD

Skill sequence

Select a tungsten electrode of a proper ϕ and give a proper angle to its tip 60^0 normally.

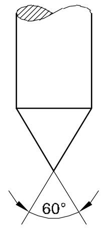
Manipulate the torch and filler rod 60^0 - 75^0 and 15^0 and 20^0 respectively.

Electrodes are normally ground to a vertex angle of 60^0 Fig 1.

For DC EN polarity welding recommended.

Refer the table for selecting and setting various parameters required for welding stainless steel using TIG welding process.

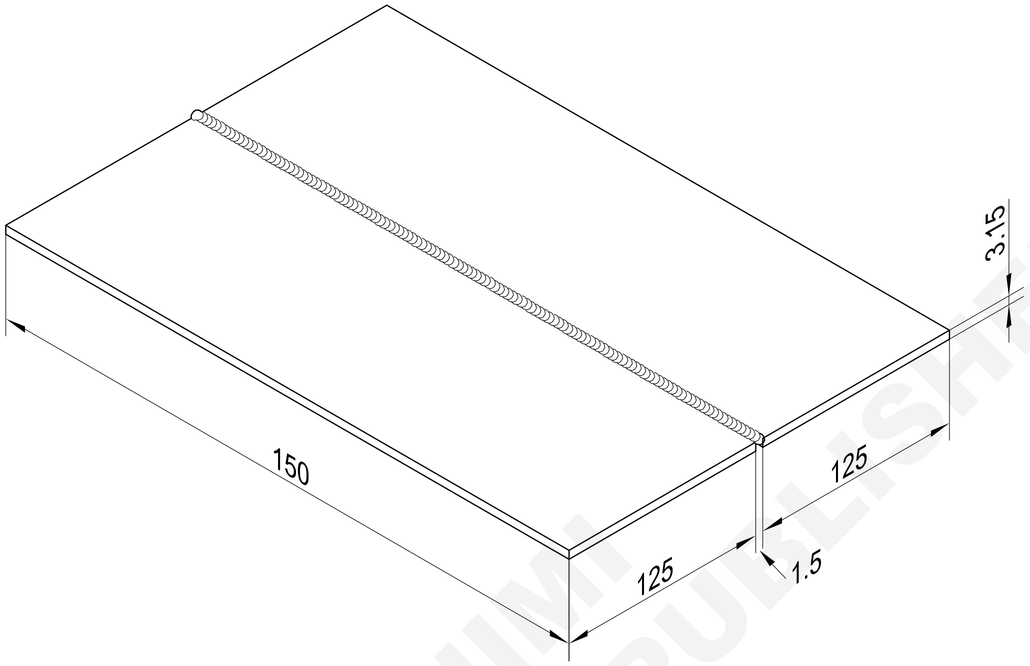
Fig 1

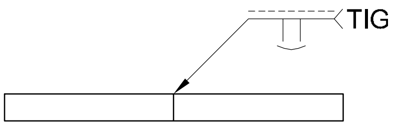


RECOMMENDED ELECTRODE TIP

Butt weld joint on SS.sheet 3.15mm flat position

Objective : At the end of this exercise you shall be able to
- **weld fusion run with filler wire on stainless steel sheet 3mm (t) in flat position.**





Job sequence

- Clean the base metal surface with the wire brush.
- Clean the base metal surface with alcohol.
- Adjust the current to about 80 to 90A.
- Fix the base metal with the jig.
- Tack weld at 10mm inside from both ends of the joint.
- Stop the back shielding gas.
- Remove the base metal from the jig.
- Check if the joint has good alignment.
- Generate an arc at the tack welding position.
- Return to the start end.
- Set the filler wire about 10^0 to 15^0 against the base metal surface.
- Make a molten pool.
- Apply the filler wire when both sides of the pool sink a little.
- Insert the filler wire into the pool leading end.
- Apply the filler wire of optimum length while monitoring the bead forming state.
- Weld along the joint line.

2	125 x 3.15 - 150	- -	X 04 Cr 19 Ni 9	- -	- -	78
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**BUTT WELD SQUARE BUTT JOINT ON STAINLESS STEEL SHEET 3.15mm - POSITION FLAT**	TOLERANCE ±1	TIME 10h
		CODE NO. SM20N1978E2	

Skill sequence

While adding the filler wire to the leading edge of the puddle, be careful not to get the wire too close to the tungsten electrode tip or it will melt onto and contaminate the tungsten. A contaminated electrode will require dressing before further use.

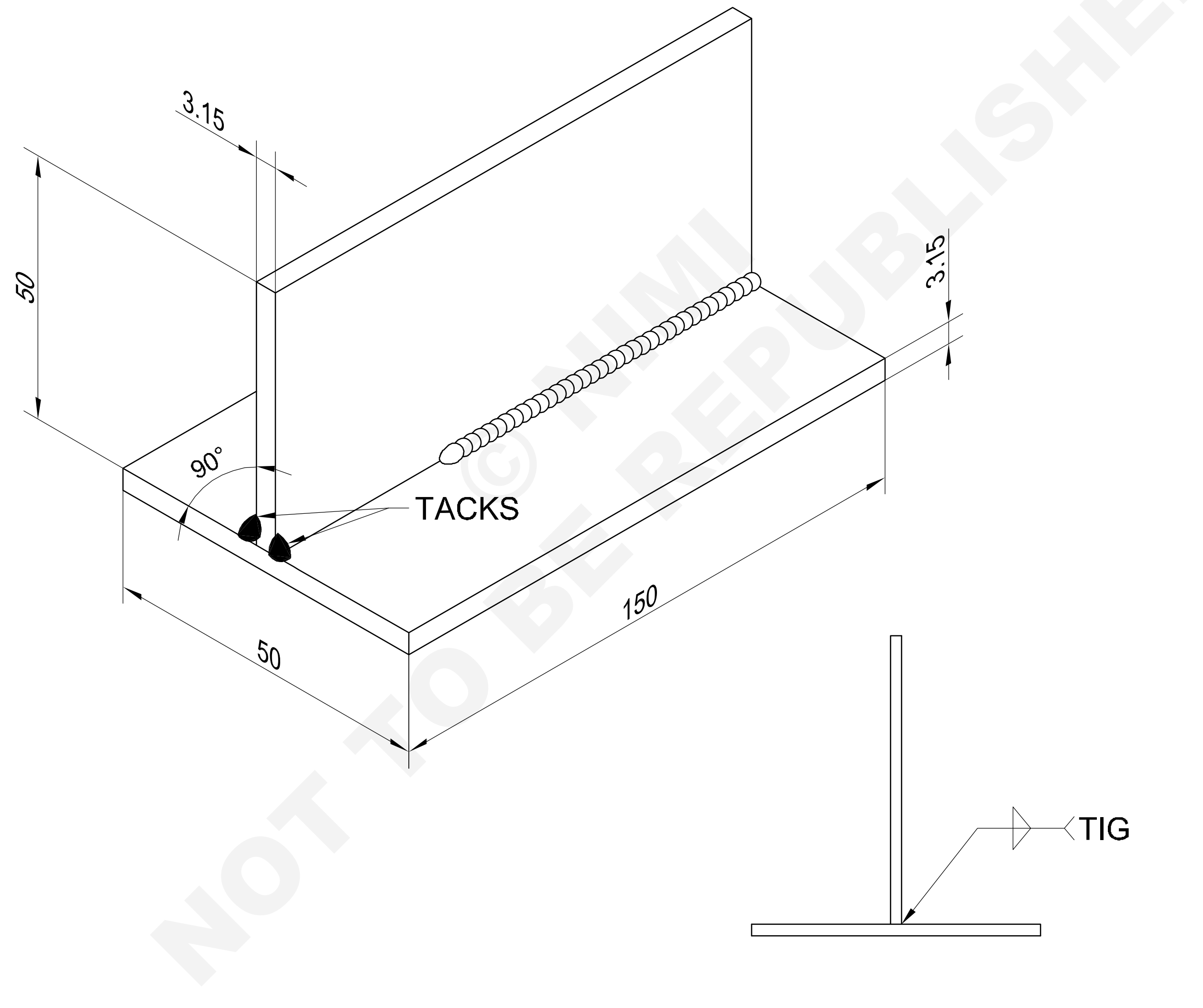
Manipulation of the torch and filler wire.

Improper fastening of the base metal to the jig causes poor alignment as in the Fig 1 and causes excessive offset at the joint area owing to high thermal expansion characteristics of stainless steel.

Fillet TEE joint on SS sheet 3.15 mm in flat position by TIG welding

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

- **weld fusion run with filler wire on stainless steel sheet 3.15 mm in flat position.**



2	50 x 3.15 - 150	- -	X 04 Cr 19 Ni 9	- -	- -	78
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	FILLET WELD TEE JOINT ON STAINLESS STEEL SHEET 3.15mm - POSITION FLAT				TOLERANCE ±1	TIME 5h
					CODE NO. SM20N1978E3	

Job sequence

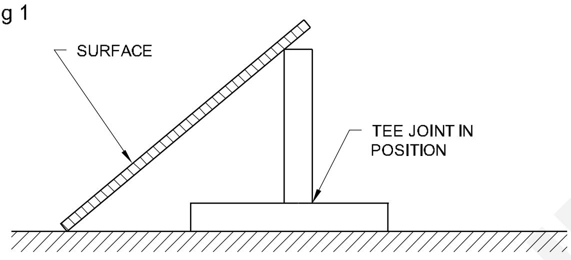
- Prepare the sheets as per drawing and clean the edges.
- Clean the surfaces using the stainless steel wire brush.
- Set the sheets in the form of a 'Tee' joint on the welding table.

Wear safety equipments.

- Set the TIG welding plant with argon gas.
- Select the 2-3mmϕ electrode and 3mmϕ filler wire and electrode tip be grinded for DC.
- Set the current 120 amps to 100 amps.
- Setting and tacking the job pieces

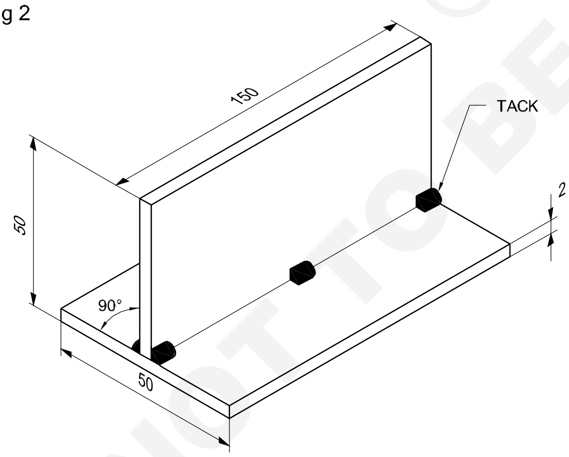
  Place the pieces on the welding table as Tee joint. Hold the pieces in position using support. (Fig.1) Ensure the vertical piece is perpendicular to the horizontal place without gap. Check with a try square.

Fig 1



Tack-weld the joint at both ends and also in the centre. (Fig.2)

Fig 2



ASSEMBLING A TEE JOINT

- Hold the torch perpendicular to the joint and pointing at an angle of about 30^0 toward the direction of travel. Fig.3.
- Strike an arc and establish a puddle. Make sure the side walls melt down to the root of the 'T' joint. Because the side walls are nearer to the electrode than the root of joint, the arc will go to the sidewalls and cause them to melt before the root of the joint does. (Fig 4)

Fig 3

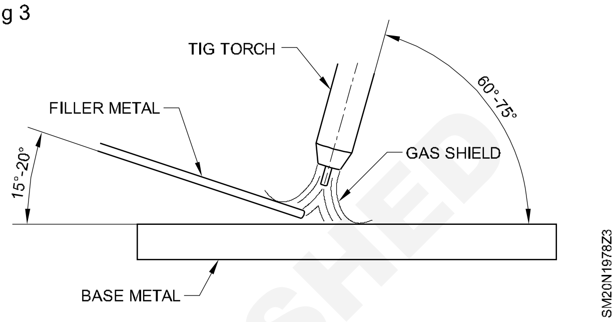
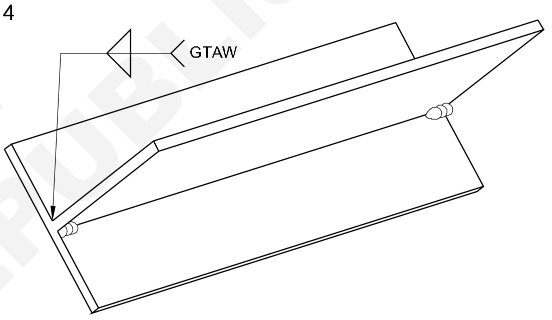


Fig 4

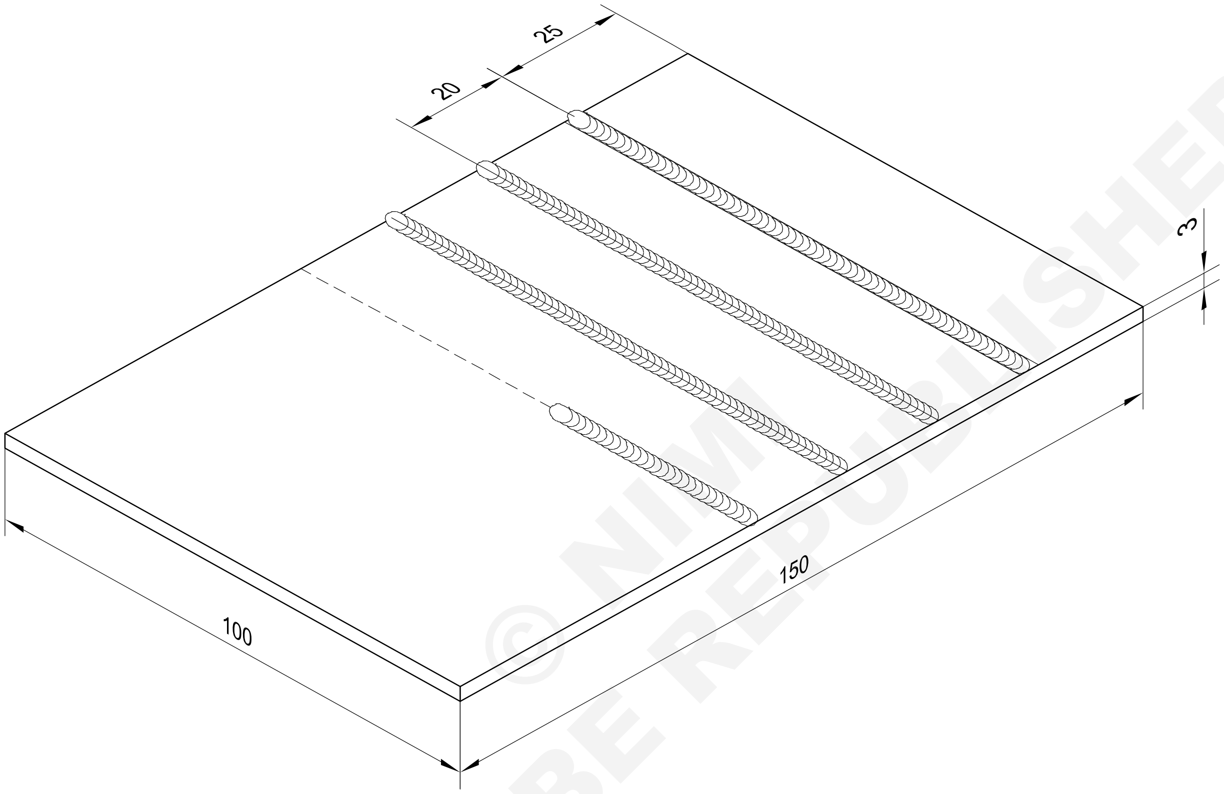


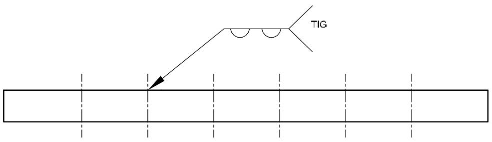
TACKING PROCEDURE AND WELD POSITION FOR A FLAT TEE JOINT

- Add the filler wire in a dabbing motion, advancing the torch when you withdraw the filler metal.
- Remember, when with drawing the wire, keep the wire in the protective gas shield.
- Complete the bead, cool the assembly.
- Reposition the 'T' base and weld the otherside as you did first, using the same procedure.

Fusion runs with filler wire on aluminium sheet-flat position

Objective : At the end of this exercise you shall be able to
- **weld fusion run with filler wire on stainless steel sheet 3mm (t) in flat position.**





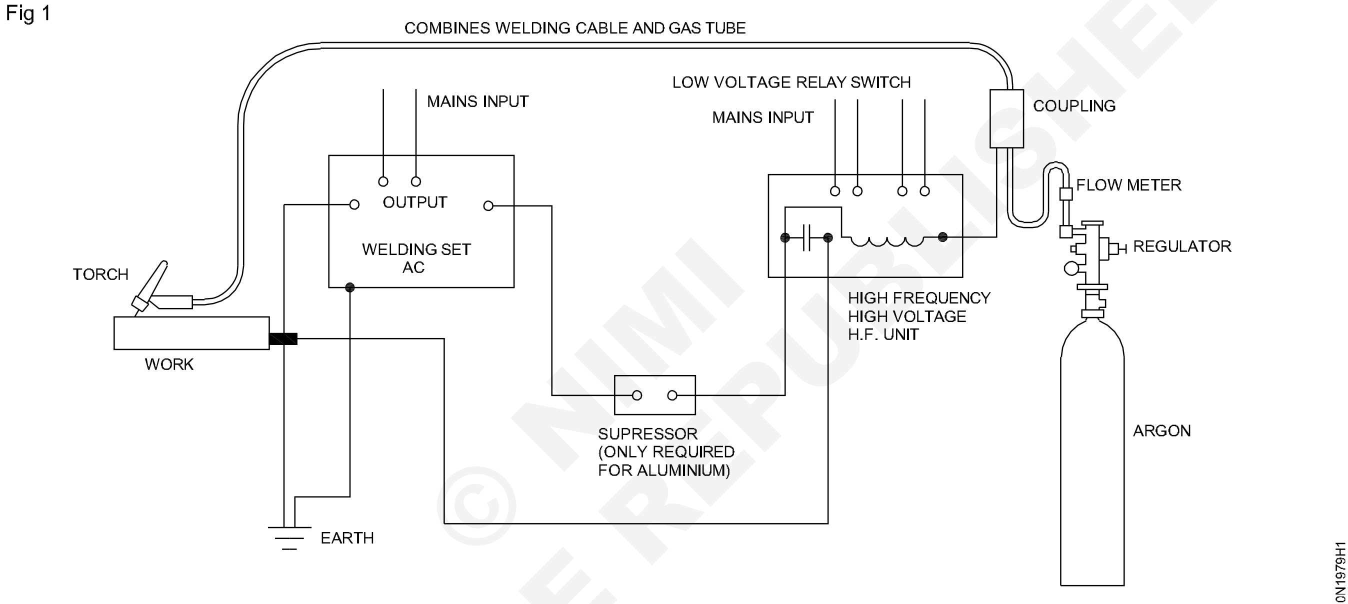
1	100x3 - 150	- -	AL.199990 - IS 737	- -	- -	79
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	FUSION RUNS WITH FILLER WIRE ON ALUMINIUM SHEET 3mm - POSITION FLAT	TOLERANCE ±1	TIME 5h
		CODE NO. SM20N1979E1	

Job sequence

- Prepare the aluminimum sheet as per dimensions.
- Clean the surface with the stainless steel wire brush.
- Also do the chemical cleaning with acetone/alcohol to remove the grease and surface oxide.
- Draw parallel lines and punch mark them as per dimensions.
- Set the job in flat position.
- Select the power supply as follows:
  - – In case of Helium as shielding gas use DCEN.
  - – In case Argon as shielding gas use AC power source. Majority of welding is done using argon gas.
- Set up the TIG welding plant as per the Fig.1.
- Select the type and size of tungsten electrode, current, polarity in case of DC gas flow rate and set them on the machine.
- Select aluminium filler wire. 3mmϕ with 5% silicon.
- Switch on the machine and strike the arc.
- Deposit fusion run with filler wire using the same technique used for Ex.No.2.2.10.
- Clean and inspect the weld job.

Fig 1



CONNECTIONS FOR INERT GAS WELDING USING AIR-COOLED TORCH

Skill sequence

Ensure to use correct size of the sheet for welding.

Select aluminimum (95% AL and 5% Si) filler wire 3.15mmϕ.

Set the current and other parameters given as per Table given below.

Open the gas cylinder valve slowly.

Follow leftward technique.

The filler rod and torch are held at an angle as given in the earlier TIG welding exercises.

Finish welding and ensure to fill the crater.

Wire brush the weld using SS wire brush and check for defects if any.

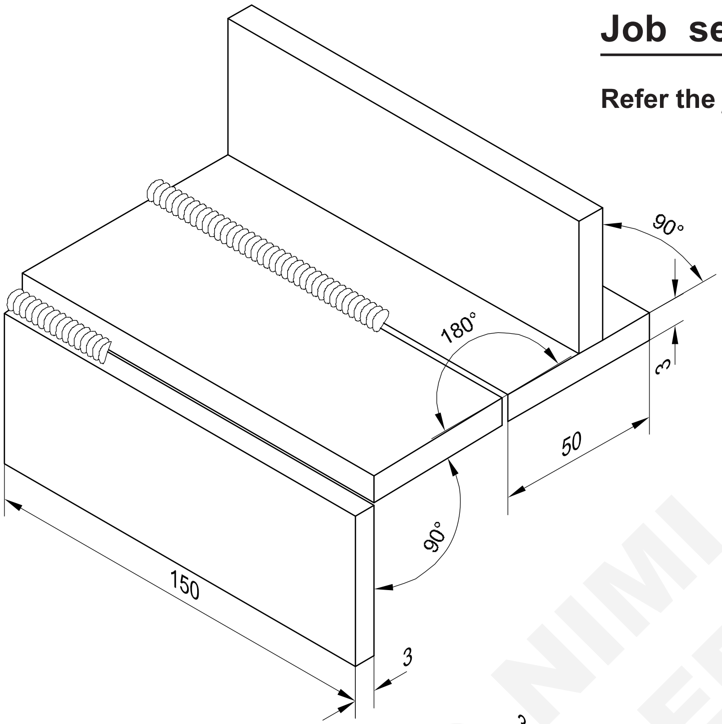
— — — — — — — —

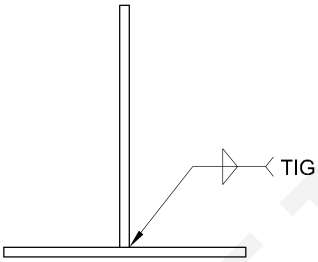
Making butt, Tee and carner joint

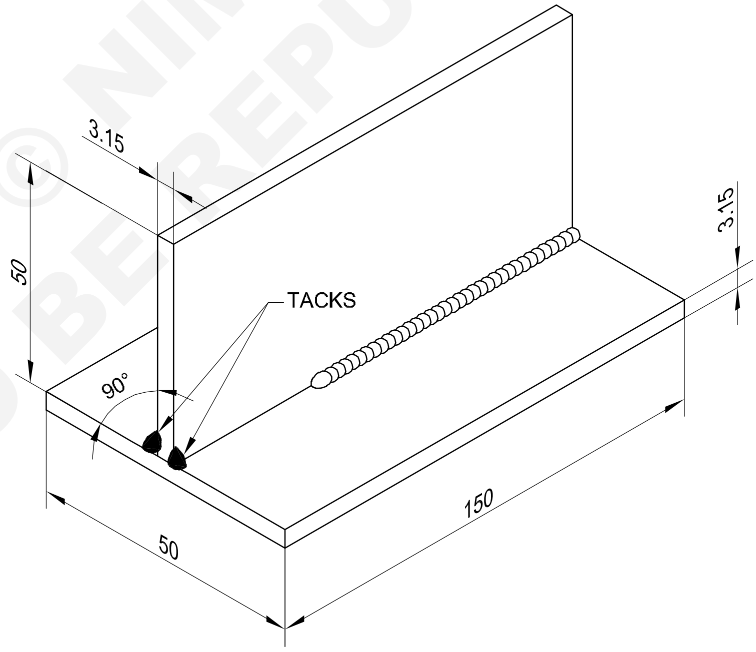
Objective : At the end of this exercise you shall be able to
- **making butt, Tee and carner joint.**

Job sequence

Refer the job sequence Exercise 1.9.77







2	50 x 3.15 - 150	- -	X 04 Cr 19 Ni 9	- -	- -	
1	- -	- -	Fe 310 - W	- -	- -	80
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE
NTS

MAKING BUTT, TEE AND CARNER JOINT

TOLERANCE ±1

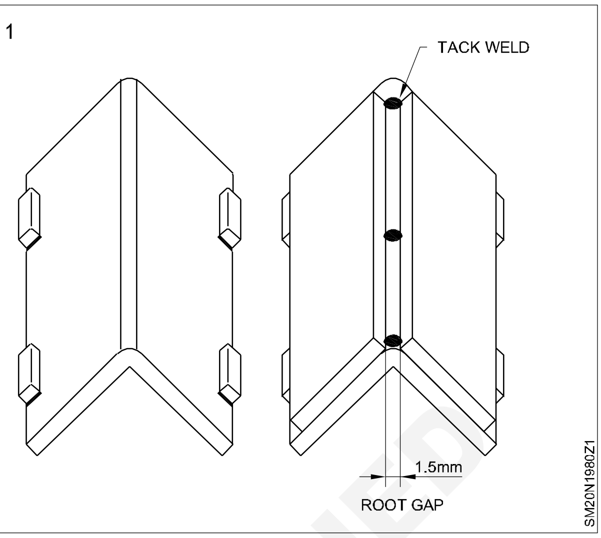
TIME
5Hrs

CODE NO. SM20N1980E1

Job sequence

- Use pure aluminium filler wire ϕ3.15mm.
- Use 3mmϕ (Zirconium) tungsten electrode.
- AC power source with DC suppressor and high frequency units.
- Shielding gas argon.
- Prepare aluminium sheet as per dimensions.
- Clean the edges of the sheets.
- Use stainless steel wire brush for surface cleaning.
- Tack the set pieces at correct intervals and in correct alignment for an outside corner joint.
- Weld the joint in flat position.
- Make uniform size bead with correct penetration at the root in the outside corner joint.
- Clean the weld area thoroughly.

Fig 1



- Inspect the completed outside corner weld for weldment quality.

Skill sequence

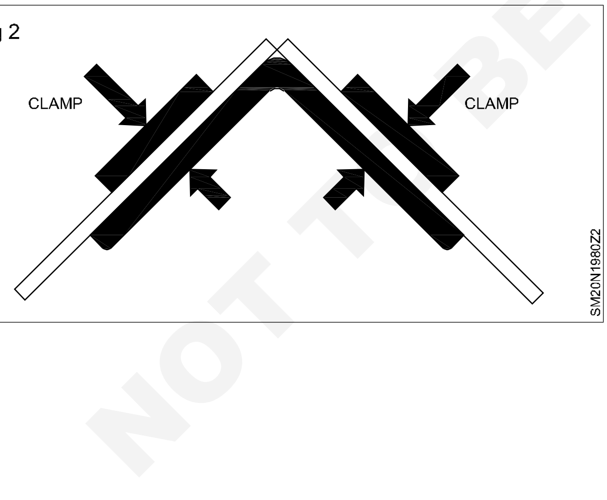
Ensure the setting of an outside corner joint as per drawing.

Adjust current 120 - 150 Amp in AC.(Refer Table 1 of Ex.No.2.2.13).

Use a backing bar made from a piece of steel angle with its apex bevelled or radi used to accommodate the penetration bead.

Hold the sheet onto the backing bar with steel strap. Fig.2

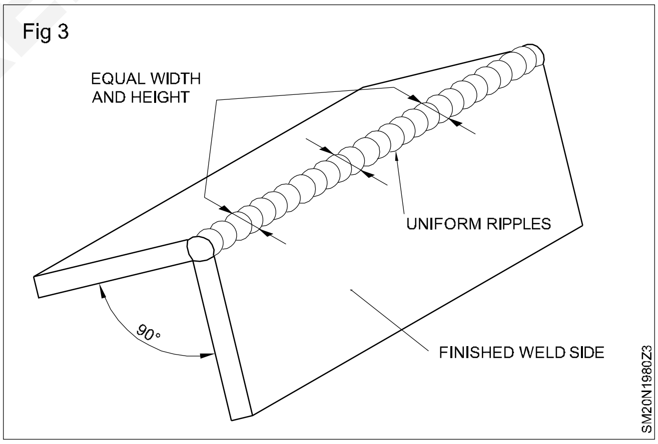
Fig 2



– correct alignment and uniformity of bead with correct penetration after cleaning the welded joint thoroughly.

– uniform ripples with equal width and height of bead (Fig.3).

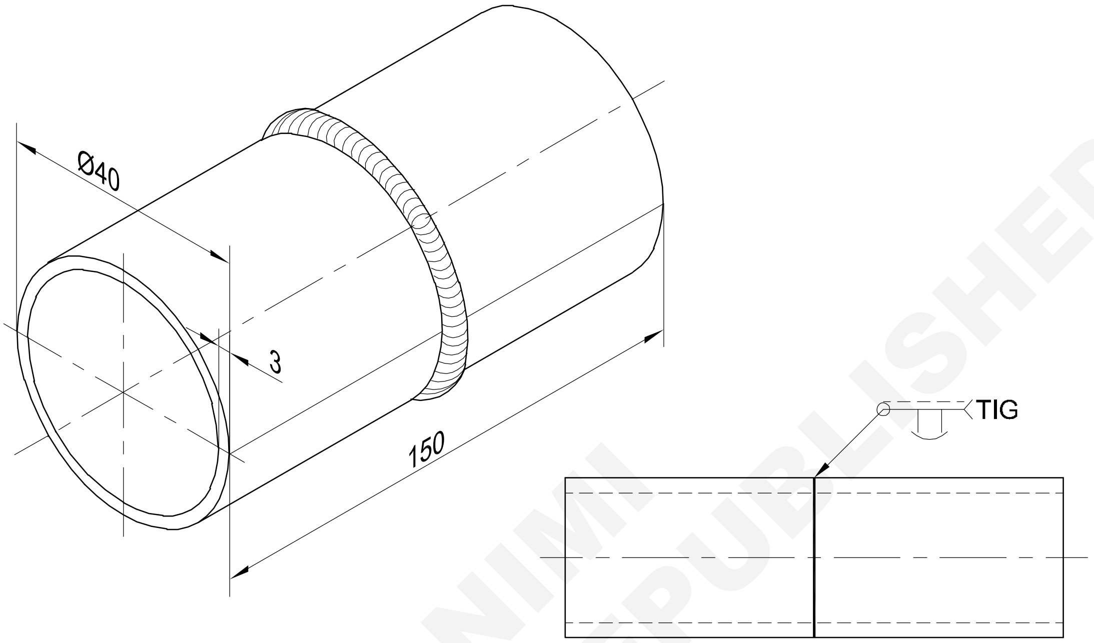
Fig 3



MS/SS pipe butt and 'Y' joint by Tig welding

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

- **weld a square butt joint on stainless steel tube 40mmϕ [0D] 3mm [wall thickness] in flat position (rolling).**



Job sequence

- Prepare the metal tubes S.S.304 with 40mmφ and 3mm wall thickness and 75mm long. 2 Nos.
- Prepare the tube ends and clean the ends with grinding/machining followed by degreasing and pickling.
- Check the squareness of the pipe edge by using a try square.
- Select filler wire SS-308 L2.5mmϕ x 1000mm long.
- Select suitable electrode size from the table IS 2811-1964.

2	Ø40 x 3 - 75	- -	Stainless Steel	- -	- -	81
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**BUTT WELD SQUARE BUTT JOINT ON STAINLESS STEEL TUBE 40mm OD 3mm WT - POSITION FLAT**	TOLERANCE ±1	TIME 15h
		CODE NO. SM20N1981E1	

TABLE 1

Tungsten inert-gas welding flat butt welds without backing bar-Direct current (Electrode negative)

Thickness (1) mm	No. of passes (2)	Edge preparation (3)	Gas cup size (4) mm	Diameter of electrode (5) mm	Current (6) A	Arc travel speed (7) cm/min	Filler rod size (8) mm	Argon flow LPM (9) 1/h
1.0	1	Flange	10.0	1.0	30	25.0	1.6	5-6
1.6	1	a	10.0	1.6	40-60	22.5	1.6	5-6
2.0	1	a	10.0	2.5	60-70	20.0	2.5	6-8
3.15	1	a	12.5	2.5	65-85	15.0	2.5	6-8
5.0	1	b	12.5	3.15	100-125	12.5	3.15	8-10
6.3	2	b or c	12.5	3.15	130-160	15.0	4.0	8-10

Note a = square edge close butt,
b = 80^0 included angle single V preparation (close butt), and
c = 90^0 included angle double V preparation (close butt).

- Electrode tip should be ground to 60^0 angle for uniform - penetrating arc.
- Adjust suitable gas flow, the flow rate in the flow meter 6-8 LPM.
- Before tacking align the pipes on 'V' block on Vee profile with 2mm root gap [Fig.2] and tack them as shown in Fig 3. Check the gap using a 2mm rod.

Fig 1

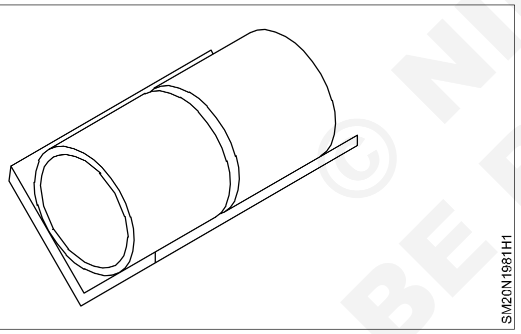
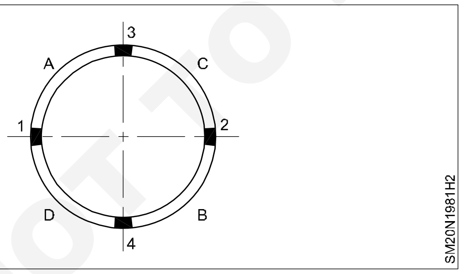
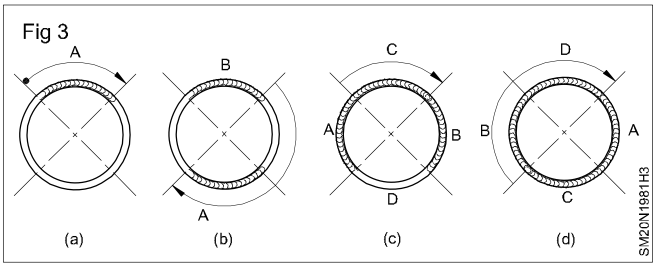


Fig 2



- Start the welding plant and tack the job as shown in the Fig 3 with equal intervals.
- Turn the pipe to place section 'A' in a convenient position. (Fig 4a)
- Weld section A (in clockwise direction).
- Next position section 'B' opposite to section 'A' and weld it. (Fig 4b)
- Turn the pipe and weld section 'C'. The run must melt completely into the other welds. (Fig.4c)
- Turn the pipe and weld the last section (Section D). The run must melt into the other welds. (Fig.4d)
- Complete the weld and clean the job inspect the weld for surface defects.

Fig 3



Skill sequence

Pipe development for "Y" joint by Tig welding

Objectives: At the end of this lesson you shall be able to
- **develop and able to layout the pattern for "Y" joint pipes intersecting at 120°**
- **develop and layout the pattern for "Y" joint pipes branching at 90°.**

Prior to welding select correct filler rod composition; this will depend on

a Tendency to cracking

b Properties required

Maximum weld run size to be maintained otherwise large weld runs may lead to crack.

Sequence of welding required to minimise distortion; it is more difficult to avoid distortion in austenitic steels by comparison with mild steel.

Manipulate the torch and filler metal angle $70 - 80^0$ and 10 to 20^0 respectively to the line of weld in IG or rolling position of pipe welding.

Development of "Y" joint pipes intersecting at 120°: Draw the development of intersecting cylinders of dia. 30 mm at 120°. (Fig 1)

All the cylindrical pipes are of same diameter and intersecting each at equal angles. Hence in this case the development of all the pipes are same and so the development of one pipe will represent other pipes.

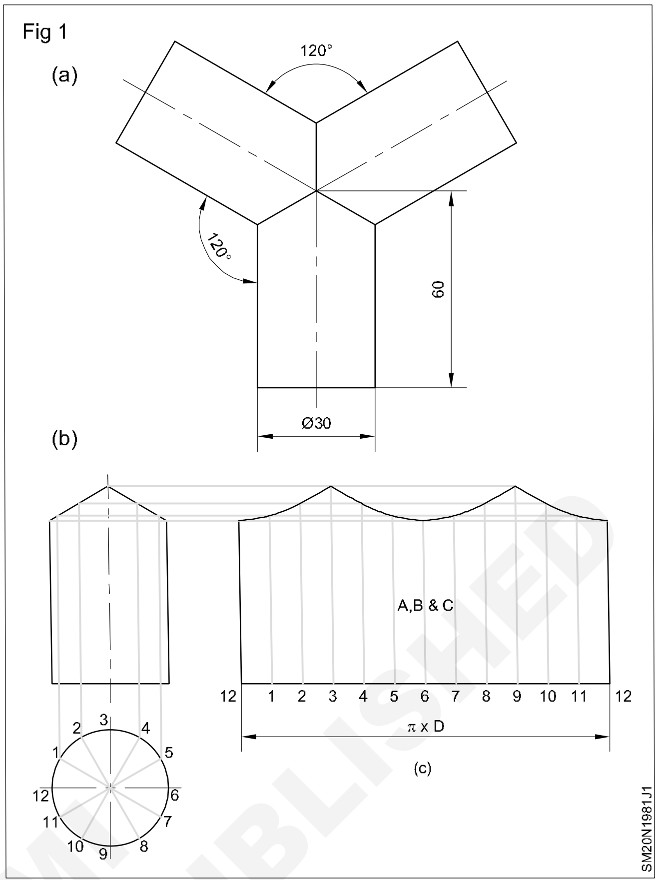
- Draw the plan and elevation of the pipe 'A' and mark the division on the plan. (Fig 1b)
- Draw the vertical projectors from the plan to front view to meet the line of intersection.
- Draw horizontal projectors from these points on to the development.
- Mark the intersecting points and join with a smooth curve to complete the required development.

Development of 'Y' joint branching at 90°: Three cylindrical pipes of X, Y, Z form a 'Y' piece. (Fig 2) Draw the lateral surface development of each pipe.

In the three pipes XYZ, Y & Z are similar in size and shape, hence their developments are also similar.

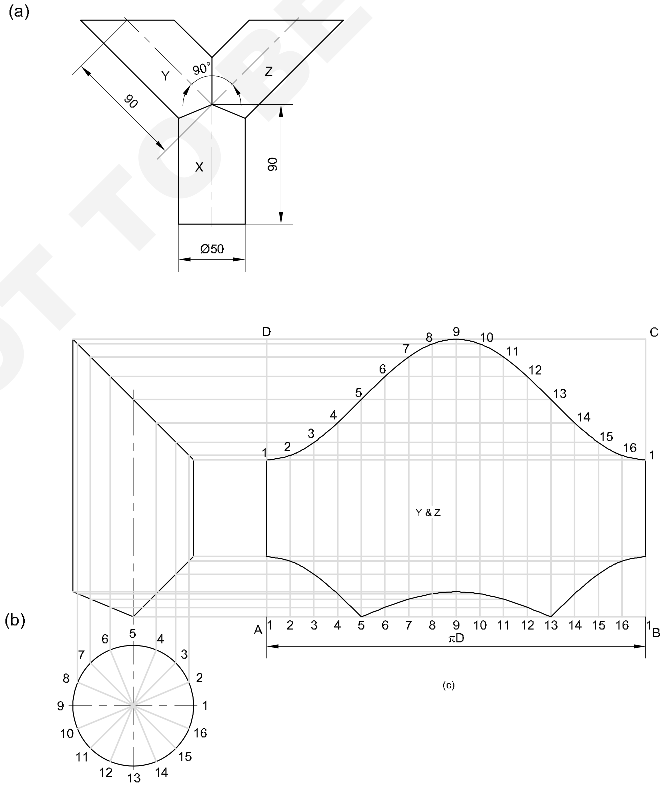
- Draw the development of pipe 'X' as in the previous exercise.
- Draw the elevation and plan of pipe 'Y' as shown.

Fig 1



- Divide the plan circle into 16 equal parts.
- Project the points to the elevation.
- Draw the rectangle ABCD in which AB is equal to D.
- Draw the development of pipe Y as shown in Fig 2.

Fig 2



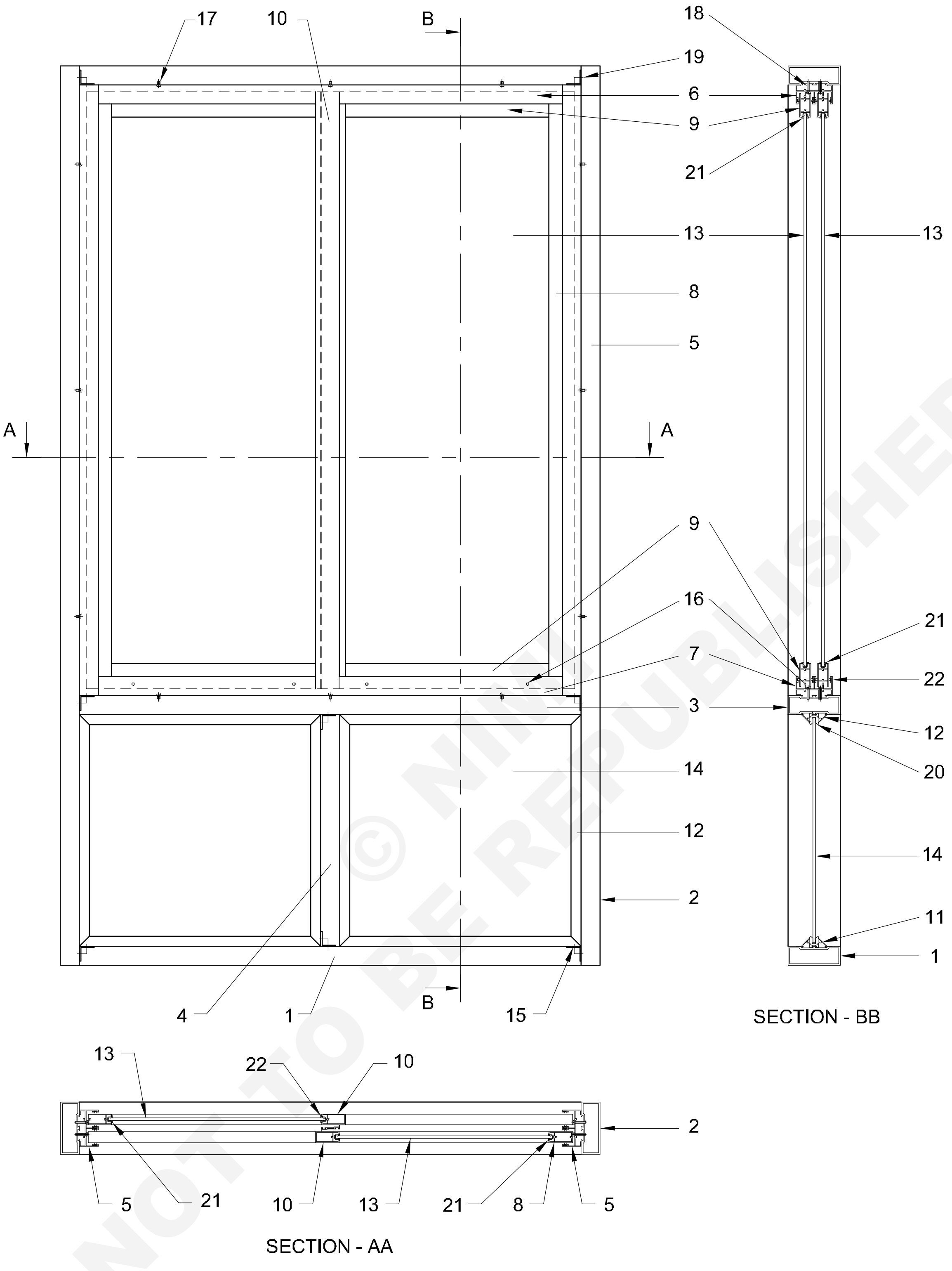
Make aluminium sliding widow

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

- **identify the different sections of aluminium partition to make sliding window frame**
- **make a window frame by assembling single and double partitions using aluminium angle as per given drawing**
- **fix the two track bottom frame and two track top and side frames on partition frame using screws**
- **make a sliding window by assembling top and bottom shutters, interlock shutter and side shutter using screws as per given drawing**
- **mount glazing clips on single and double partitions by pressing them by hand**
- **fix glass in partition frame alongwith suitable rubber packing by hand**
- **fix glass in sliding window alongwith suitable rubber packings by hand**
- **fix bearing on bottom shutter from bottom in correct position using screws**
- **mount sliding windows in window frames in correct position.**

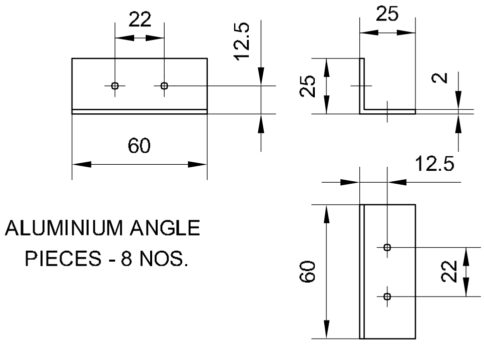
Job sequence

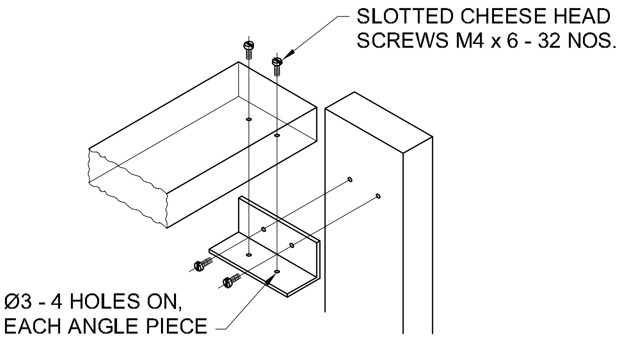
- Cut the aluminium material of single partitions, double partitions, angle pieces, two track bottom frame, two track top and side frames, bottom and top shutters, interlock shutter and side shutter to the required sizes using hacksaw by hand.
- Make the outer partition frame, as per Fig 1, using angle pieces and slotted cheese head screws of M4 x 6 length.
- Fix two track bottom frames on central double partition, two track side frames on single partitions at both sides and two track top frame on the top single partition using slotted cheese head screws of M4 x 16 length.
- Fix this frame at window opening in the wall using rawl plug and slotted counter sunk screws of M6 x 50 length.
- Now make two sliding windows by fixing top and bottom shutters, side shutters and interlock shutters with slotted cheese head screws of M4 x 40 length, as shown in Fig 3. Remember that interlock shutters are fixed in opposite direction to each other, to facilitate interlocking of windows.
- Mount bearings on bottom shutter from bottom using slotted cheese head screws of M4 x 8 length. Fix two bearings on each sliding window at approximately 150 mm distance from the ends.
- Insert rubber packings in slots of two track bottom side and top frames and interlock shutters.
- Take rubber packing for shutters, apply the rubber adhesive in the middle slot of it and insert it in all four side edges of the glasses of both windows.
- Now loosen the screws at corners of sliding windows and open the side and interlock shutters and top and bottom shutters out to accommodate glass with rubber packing on its edges.
- Mount the glasses with rubber packing in the slots of top, bottom, side and interlock shutters of sliding window and tighten the screws of all corners uniformly, till the glasses get fixed tight in position.
- Remove the two track top frame.
- Now mount these aluminium glass windows on bottom tracks matching bearings slots with tracks on bottom frames, place the two track top section in position and fix it on single partition on top using slotted cheese head screws.
- Now fix glazing clips on both grooves of the bottom partition and only one groove of the remaining three sides of partitions when glasses are to be fitted.
- Take 5 mm thick plain glasses of required sizes (already cut) and fix rubber packing on all sides of them.
- Hold the glasses alongwith rubber packing in position and press it in the middle of two glazing clips.
- Ensure that the glass is secured properly in bottom partition in place and then fix glazing clips on other grooves of the remaining three sides.



–	–	–	–	12	–	82
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	ALUMINIUM SLIDING WINDOW	DEVIATIONS ±0.06	TIME 25h
		CODE NO. SM20N11082E1	





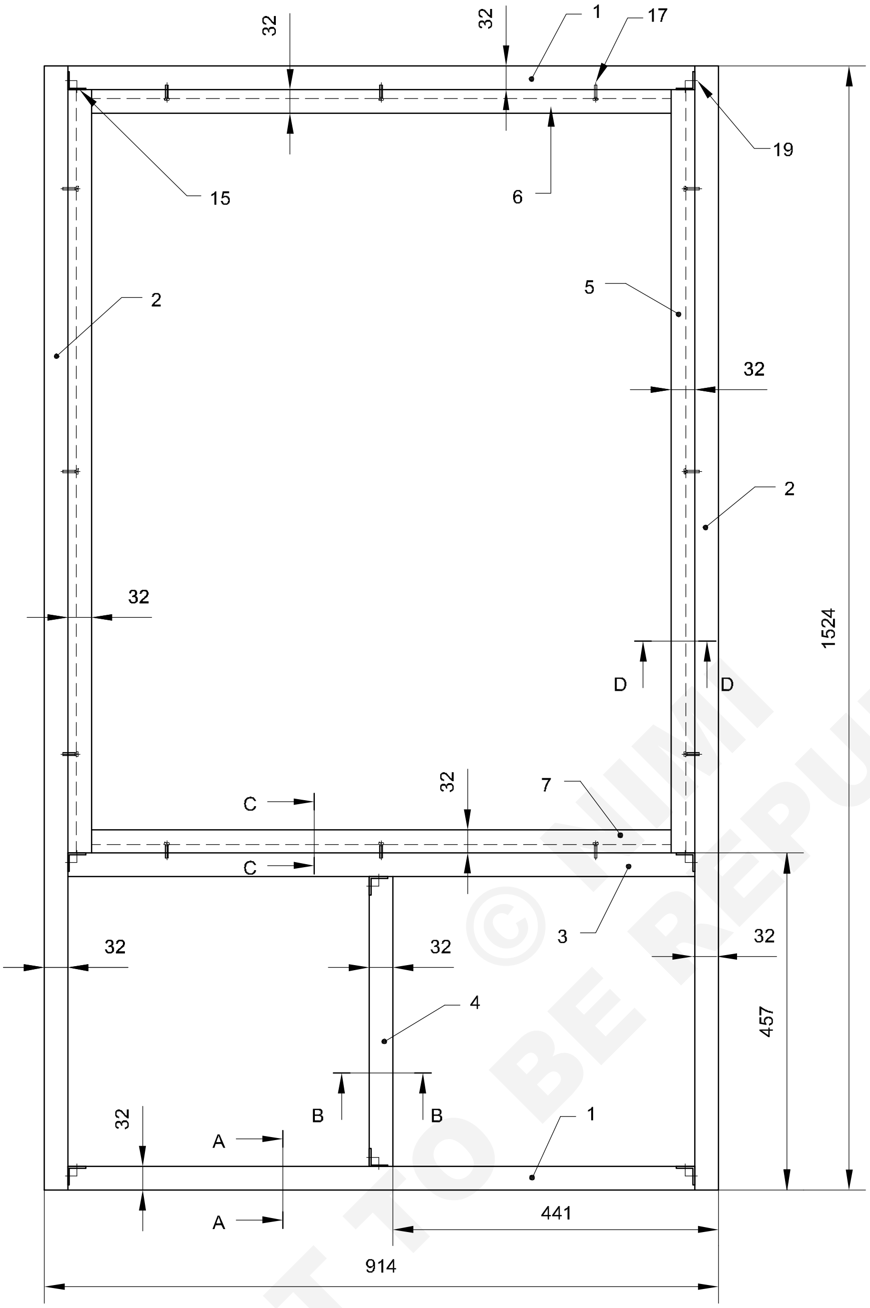
1	16.5 METER	RUBBER PACKING FOR TWO TRACK FRAMES AND INTERLOCK SHUTTER	RUBBER	–	22	–
1	5.2 METER	RUBBER PACKING FOR 40 x 10 WINDOWS SHUTTER FOR 5mm GLASS	RUBBER	–	21	–
1	3.2 METER	RUBBER PACKING FOR ALUMINIUM PARTITION FOR 5mm GLASS	RUBBER	–	20	–
48	M4 x 6	SLOTTED CHEESE HEAD SCREW	ALUMINIUM	–	19	–
16	M4 x 40	SLOTTED CHEESE HEAD SCREW	ALUMINIUM	–	18	–
12	M4 x 16	SLOTTED CHEESE HEAD SCREW	ALUMINIUM	–	17	–
4	–	SLIDING WINDOW BEARING	ALUMINIUM	–	16	–
8	ISA 25 x 25 - 80	EQUAL ANGLE 2mm THICK	ALUMINIUM	–	15	–
2	399 x 383	PLAIN GLASS 5mm THICK	ALUMINIUM	–	14	–
2	937 x 363	PLAIN GLASS 5mm THICK	ALUMINIUM	–	13	–
4	19.05 x 17.25 - 400	GLAZING CLIPS JINDAL SECTION NO. 4407	ALUMINIUM	–	12	–
4	19.05 x 17.27 - 415	GLAZING CLIPS JINDAL SECTION NO. 4407	ALUMINIUM	–	11	–
2	40 x 18 - 1010	INTERLOCK SHUTTER	ALUMINIUM	–	10	–
4	40 x 18 - 380	TOP AND BOTTOM SHUTTER	ALUMINIUM	–	09	–
2	40 x 18 - 1010	SIDE SHUTTER	ALUMINIUM	–	08	–
1	62 x 31 - 795	TWO TRACK BOTTOM FRAME	ALUMINIUM	–	07	–
1	62 x 31 - 795	TWO TRACK TOP AND SIDE FRAME	ALUMINIUM	–	06	–
2	62 x 31 - 980	TWO TRACK TOP AND SIDE FRAME	ALUMINIUM	–	05	–
1	290 LONG	SINGLE PARTITION 32mm WIDTH JINDAL SECTION NO. 4659	ALUMINIUM	–	04	–
1	860 LONG	SINGLE PARTITION 32mm WIDTH JINDAL SECTION NO. 4659	ALUMINIUM	–	03	–
2	1535 LONG	SINGLE PARTITION 32mm WIDTH JINDAL SECTION NO. 4659	ALUMINIUM	–	02	–
2	860 LONG	SINGLE PARTITION 32mm WIDTH JINDAL SECTION NO. 4659	ALUMINIUM	–	01	82
NO.OFF	STOCK SIZE	PARTS NAME	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

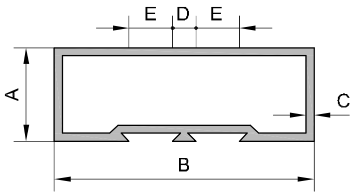
SCALE 1:1

PROJECT: ALUMINIUM SLIDING WINDOWS

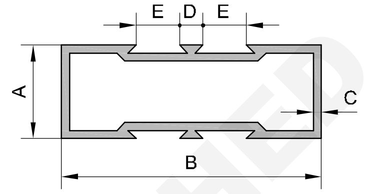
DEVIATIONS : ± 0.06

CODE NO. SM20N11082E2

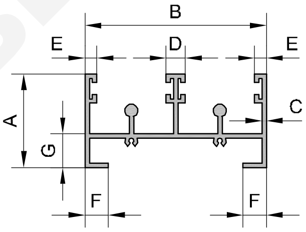




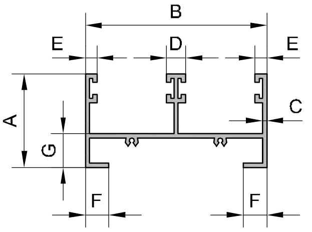
SINGLE PARTITION
(SECTION - AA)
A = 32, B = 89, C = 2.75,
D = 8, E = 14.86



DOUBLE PARTITION
(SECTION - BB)
A = 32, B = 89, C = 2.75,
D = 8, E = 14.86,



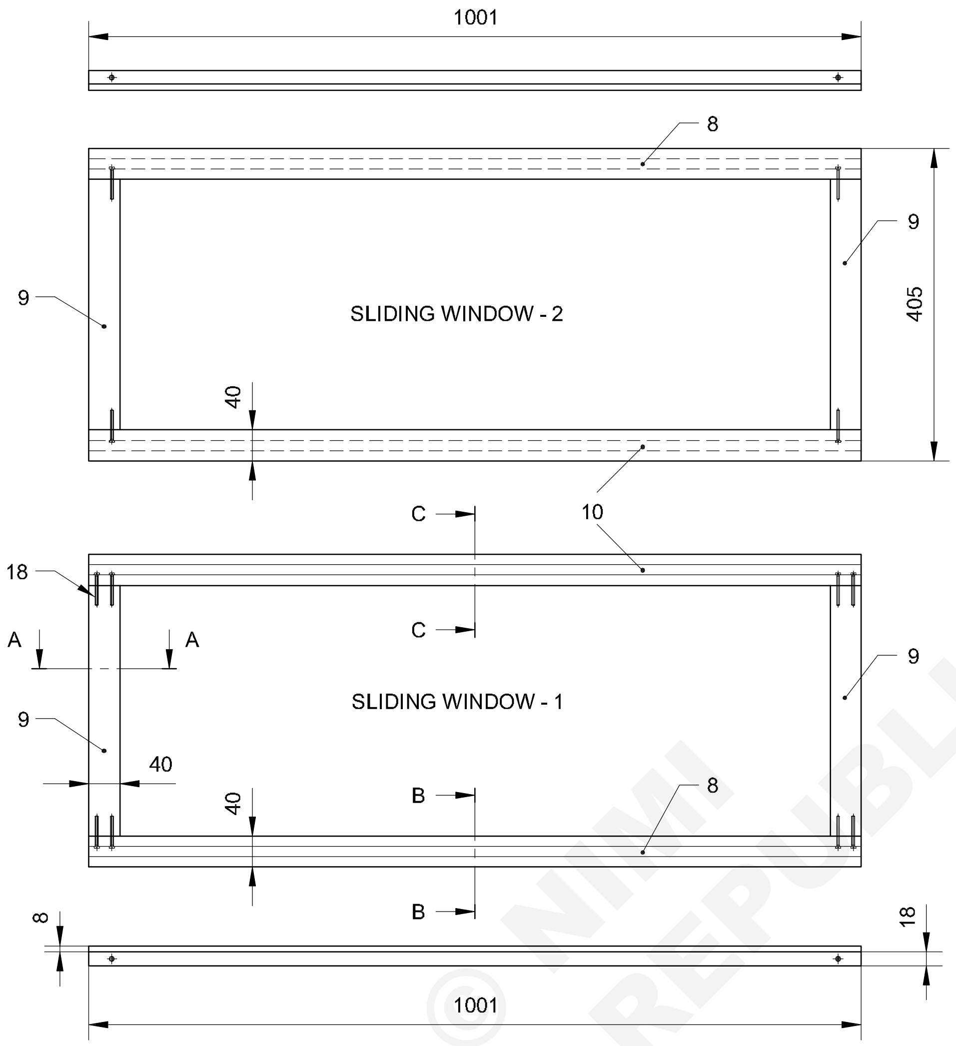
TWO TRACK BOTTOM FRAME
(SECTION - CC)
A = 32, B = 62, C = 1.5, D = 8,
E = 4, F = 8, G = 10,

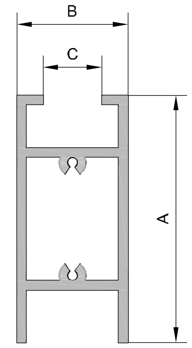


TWO TRACK TOP & SIDE FRAME
(SECTION - DD)
A = 32, B = 62, C = 1.5, D = 8,
E = 4, F = 8, G = 10,

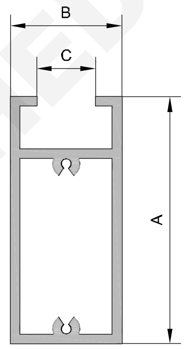
–	–	–	–	–	–	82
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	ALUMINIUM SLIDING WINDOW	DEVIATIONS ±0.06	TIME 25h
		CODE NO. SM20N11082E3	

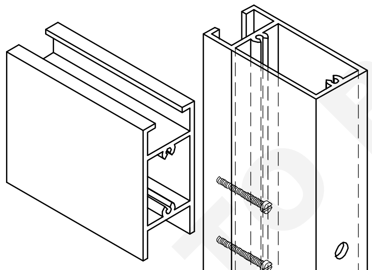




TOP AND BOTTOM SHUTTER
SECTION - AA
A = 40, B = 18, C = 9.5,
PART NO. 9

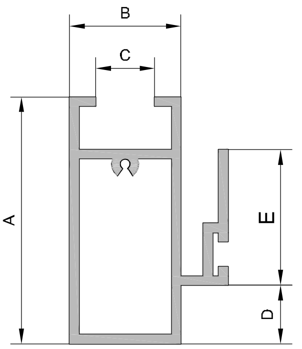


SIDE SHUTTER
SECTION - BB
A = 40, B = 18, C = 9.5,
PART NO. 8



VIEW 'X'
PART NO. 18

CHEESE HEAD SCREW M4x40



INTERLOCK SHUTTER
SECTION - CC
A = 40, B = 18, C = 9.5,D = 9.5,E = 19,
PART NO. 10

–	–	–	–	–	–	82
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1

ALUMINIUM SLIDING WINDOW

DEVIATIONS ±0.06

TIME 25h

CODE NO. SM20N11082E4

Skill sequence

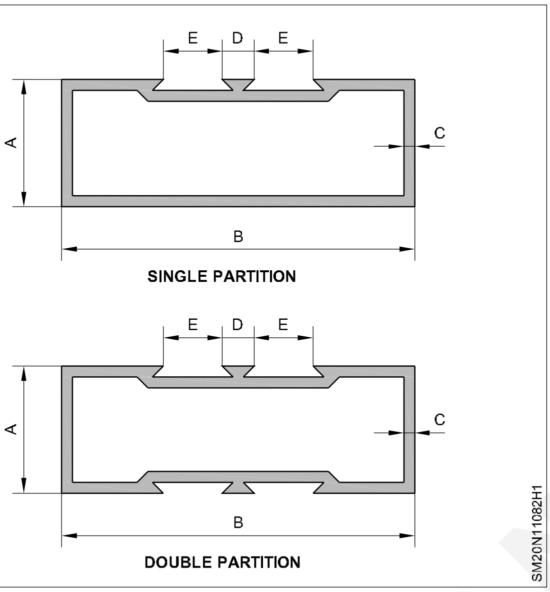
Making of glass partition frame (using aluminium partition sections)

Objectives: This shall help you to

- **identify different aluminium partition sections used in partition frames**
- **make frames, joining single and double partitions using aluminium angle pieces and screws**
- **assemble glazing clips in single and double partition.**
- **fix glasses in partition using glazing clips and rubber packing.**
- **fix particle boards in partition using glazing clip.**

Identify the aluminium partition sections required to make the glass partition. (Fig 1)

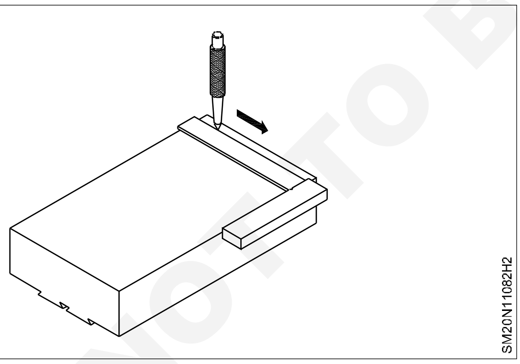
Fig 1



Mark the required length on the longer side of the partition section.

Mark the line perpendicular to the length of the section using try square. (Fig 2)

Fig 2



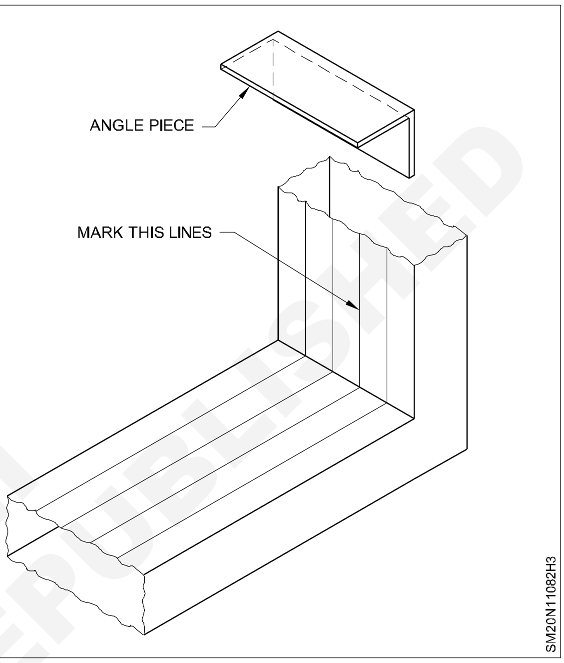
Cut on the marked line using hacksaw by hand.

If the sections cut are not perpendicular to their length, the joint will not be square and as a result, the frame will not be square.

Now cut the aluminium equal angle piece slightly shorter in length than the width of the section.

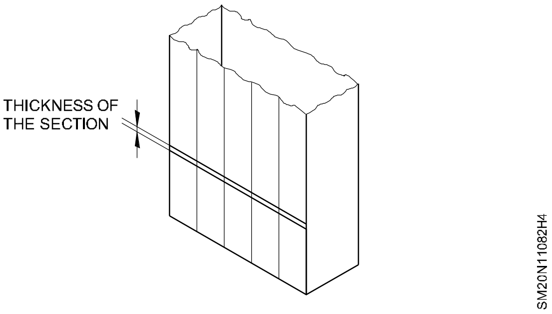
Hold the sections to be joined at right angles to each and mark the line as shown in Fig 3.

Fig 3



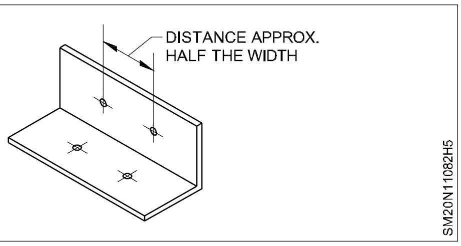
Mark a parallel line below the line marked as above, at the distance of thickness of the section. (Fig 4)

Fig 4



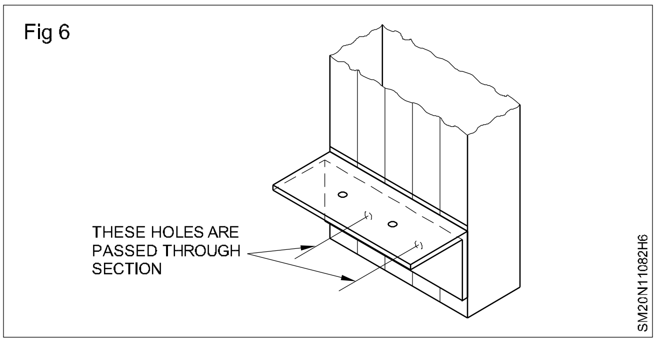
Mark the centre points and drill ϕ 3 mm 4 holes on the centre lines of the sides as shown in Fig 5.

Fig 5



Hold the angle piece, matching the corner edge with the lower marked line and pass ϕ 3 drill on to the section. (Fig 6)

Fig 6



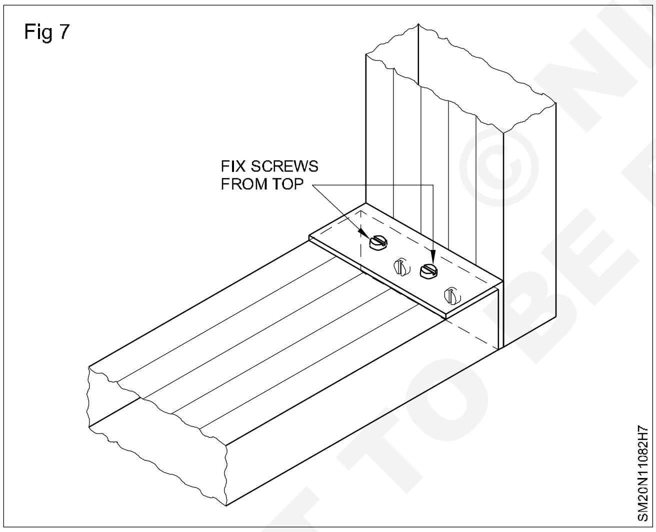
Enlarge the diameter of these two holes to f 4 mm and fix the angle piece on the section using slotted cheese head screws of M4 x 6 long.

Since the thickness of the section is less and material is aluminium, tapping is not required. Threads of the screws, while rotating, cut the aluminium material and screws fix tightly.

Similarly, place the section to be joined above the angle piece in the opposite direction and pass ϕ 3 holes onto it, from the other side. Enlarge the diameter of the holes on section to 4 mm. Do not enlarge the diameter of these two holes on the angle piece.

Now hold the section to be joined above angle piece as shown in Fig 7 and fix on it with slotted cheese head screws of M4 x 6 long.

Fig 7



Similarly make the joints of the aluminium sections (single and double partitions) and make the frame as per the given drawing.

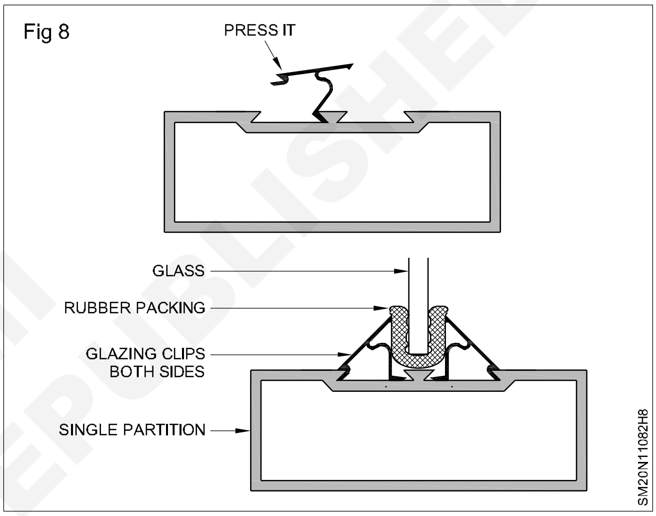
Thus angle pieces will not be visible and only heads of the screws will appear from outside.

Now assemble glazing clips on both the grooves of the bottom partition first and only one glazing clips on one side groove of the remaining three sides.

Apply rubber adhesive in the middle slot of the rubber packing and insert it in the edges of the required size glass as supplied.

Hold the glass alongwith the rubber packing vertically above the gap between two glazing clips and press it down against the glazing clips till it rests on the colour of the rubber packing. (Fig 8)

Fig 8



Now fix the glazing clips on the other groove of the top section so that the glass remains in vertical position.

Finally fix the glazing clips on other groove of sections on sides similarly.

In case the particle board (Novapass) is to be fixed between glazing clips, rubber packing is not required. You can fix the particle board on single or double partition with glazing clips as described above.

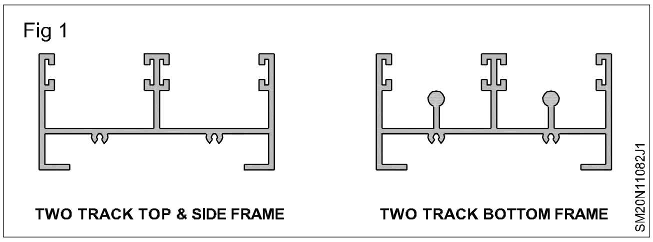
Making of aluminium sliding window outer frame (using aluminium window sections)

Objectives: This shall help you to
- **identify the aluminium window sections for making aluminium sliding window outer frame (Fig 1)**
- **join two track bottom, top and side frames on partition sections using slotted cheese head screws**
- **joint two track bottom and top frames to two track side frames using slotted cheese head screws**
- **select and fix suitable rubber packings on two track bottom, top and side frames.**

Identify two track bottom frames, two track top and side frames to make an aluminium sliding window outer frame. (Fig 1)

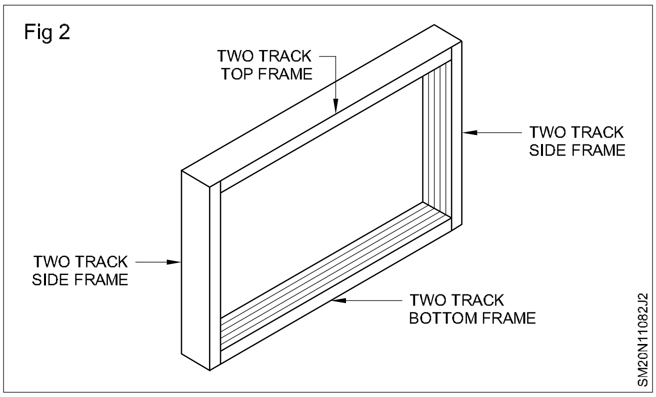
Cut the frames to the required length, square to their length using trysquare and hacksaw by hand.

Fig 1



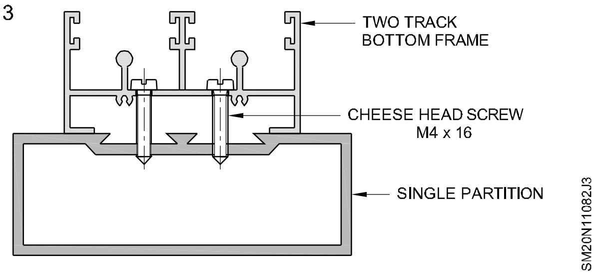
While cutting the frames, remember that the top and bottom frames are fixed between two vertical side frames. (Fig 2)

Fig 2



First hold the two track side frames vertically at sides against partition and drill ϕ 3 mm holes through inside of the track, passing through single/double partition section, using power operated portable drilling machine. Then enlarge the holes on the bottom track to 4 mm and fix rigidly with slotted cheese head screws. Fix screws at a distance of approximately 300 mm. (Fig 3)

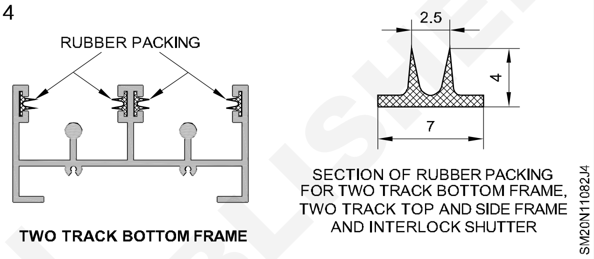
Fig 3



After fixing two track side frames on both sides, take exact distances between the two at top and bottom, accordingly cut the lengths of the top and bottom frames. Hold the bottom and top frames in position and fix it on the partition sections similarly.

Now apply rubber adhesive to rubber packing and insert the packing in slots of track sections as shown in Fig 4.

Fig 4



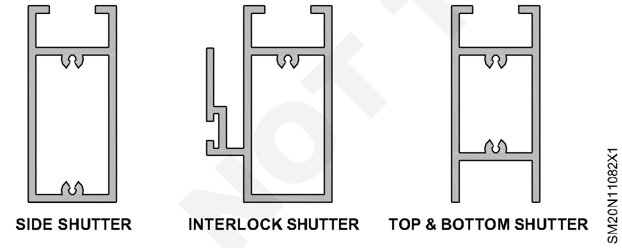
Making of aluminium sliding window (using aluminium window section)

Objectives: This shall help you to

- **identify an aluminium window sections to make sliding windows (Fig 1)**
- **fix top and bottom shutters to the side and interlock shutters with cheese head screws**
- **fix the bearing on bottom track from bottom using cheese head screws**
- **fix the glass in the frame along with rubber packing**
- **fix rubber packing in interlock shutter**
- **mount the sliding windows on tracks in an aluminium sliding outer window frame.**

Identify an aluminium window section required to make an aluminium sliding windows. (Fig 1)

Fig 1



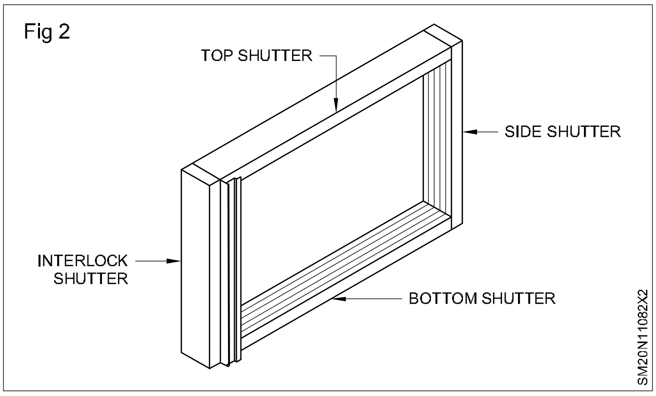
Mark and cut the sections to the required length square to their length using trysquare and hacksaw by hand.

While cutting the sections, remember that the top and bottom shutters are fixed between the side and interlock shutter. (Fig 2)

Fix bottom and top shutters to the side and interlock shutter as shown in Fig 3.

For drilling the holes, first make the template for marking the position of holes as shown in Fig 4.

Fig 2

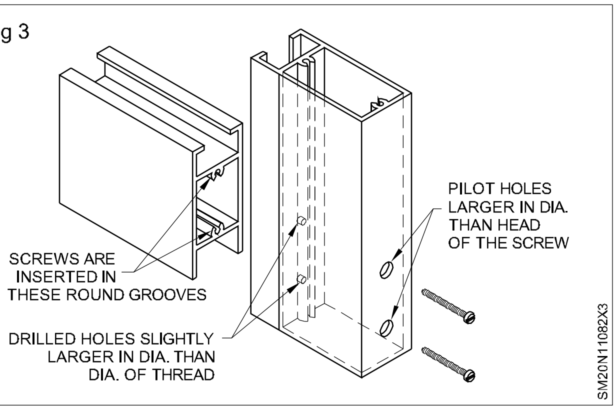


Mark the position of holes, by placing the template on the plain side of the side shutter.

Drill through holes of dia equal to the diameter of the round groove using portable power operated hand drilling machine.

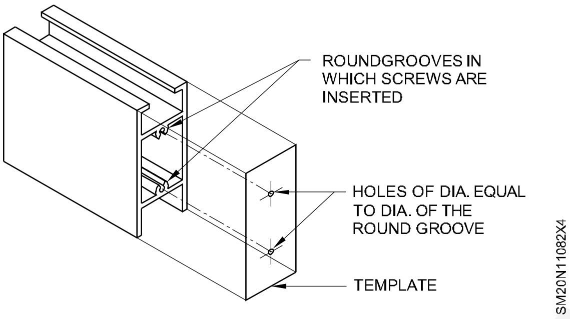
Now enlarge the diameter of the outside section to the diameter larger than the diameter of the head of the screw. (See Fig 3)

Fig 3



Now hold the bottom and the side shutter perpendicular and insert the screws having root diameter of thread equal to the diameter of round groove. (Fig 4)

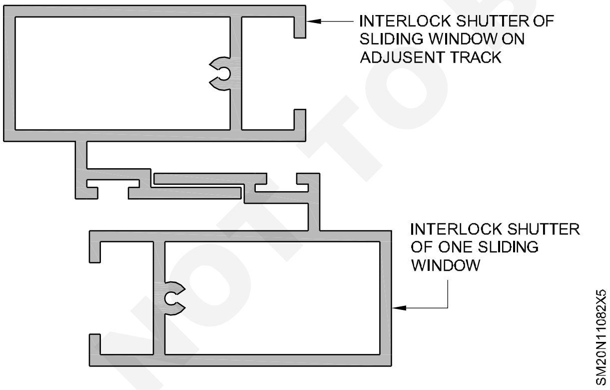
Fig 4



Tighten the screws, as the material is aluminium, while rotating threads will be formed inside the round groove and screws get tightened.

Similarly for interlock shutter is top and bottom shutter at corners to make sliding window. Remember interlock shutters are fixed in opposite direction to facilitate interlocking of windows. (Fig 5)

Fig 5

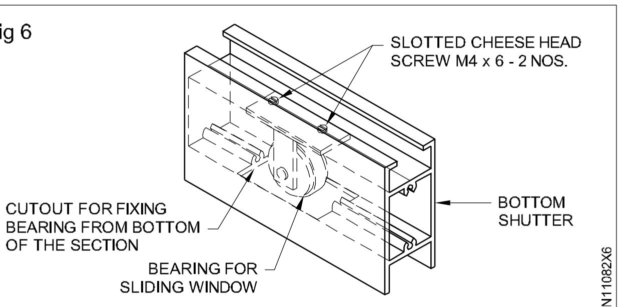


For fixing the bearing on bottom shutter from bottom, cut the lower rib section in rectangular shape to accommodate bearing in it (Fig 6) using chisel.

Insert the bearing inside the bottom frame as shown in Fig 6 and fix it on the horizontal round groove, by passing mounting holes on bearing bracket through it. Drill diameter should be equal to the diameter to the round groove.

Fix the bearing using slotted cheese head screw. Ensure that the bearing roller groove is at the centre line of the bottom shutter.

Fig 6



FIXING BEARING FROM BOTTOM OF BOTTOM SHUTTER

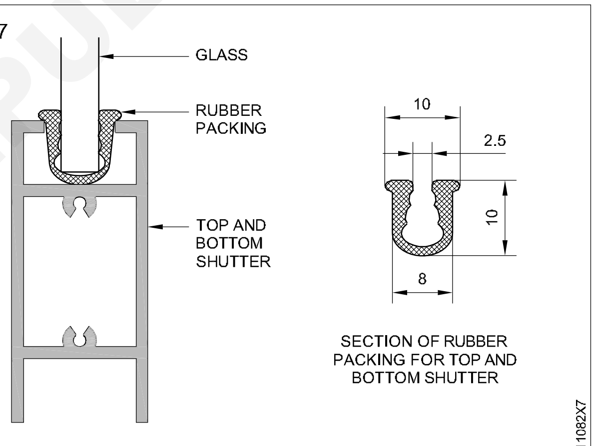
Fix two bearing on each window at about 150 mm length from its ends.

Take the glass of the required size (as supplied).

Apply rubber adhesive in the middle slot of the rubber packing and insert the rubber packing in the edges of all the sides of glass.

Now loosen the screws holding the shutter frame, open it wide to accommodate glass in it. Hold the glass alongwith rubber packing in position and tighten the screws at comers, uniformly. (Fig 7)

Fig 7

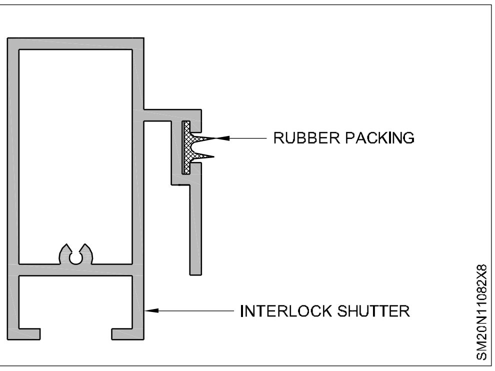


FIXING GLASS IN TOP AND BOTTOM SHUTTER
ALONG WITH RUBBER PACKING.

Ensure that the glass is mounted properly in shutters.

Insert the rubber packing in slot of interlock shutter. (Fig 8)

Fig 8



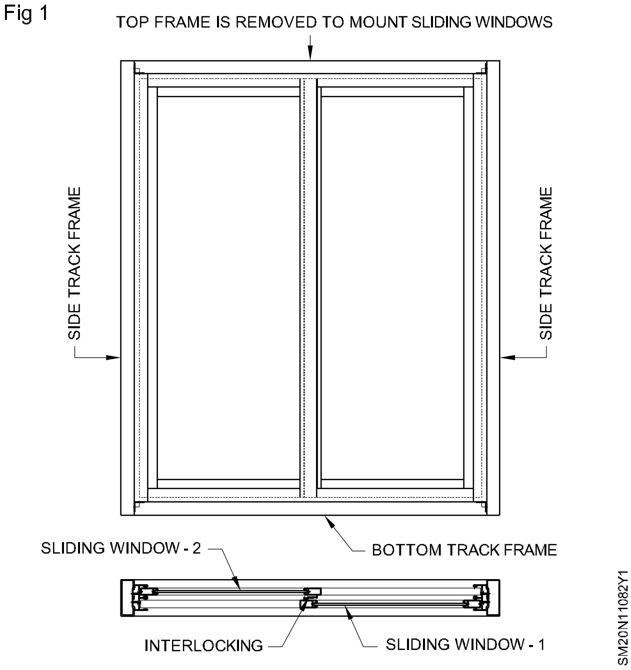
Mounting of aluminium sliding window in window frame

Objective: This shall help you to

- **mount an aluminium sliding window in window frame to run smooth on tracks.**

First remove top track frame from the outer window frame. (Fig 1)

Fig 1



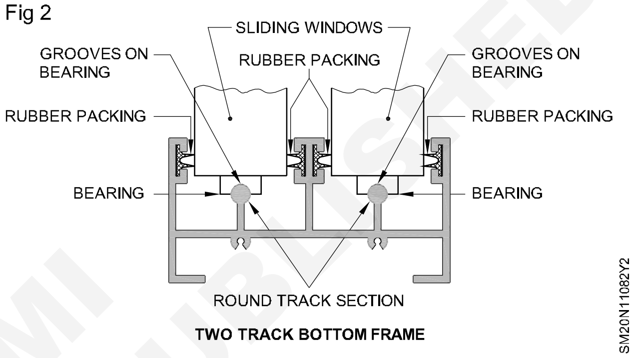
Mount one sliding window on each track vertically such that interlock shutter interlocks the windows. See that groove of bearing roller is engaged with the track section and it is properly sliding on track section. (Fig 1 & 2)

Now holding both the sliding windows firmly by hand, tilt it slightly and engage top track frame from top properly and then again hold the windows vertical. Before fixing top track frame to top partition, once again check the movement of the sliding windows.

After ensuring sliding movement of the window on bearing, fix the top track frame to top partition frame.

After top track frame is fixed once again check the movement of the sliding window and interlocking of the window.

Fig 2



Capital Goods & Manufacturing Exercise 1.10.83
Sheet Metal Worker- Specification of Aluminium

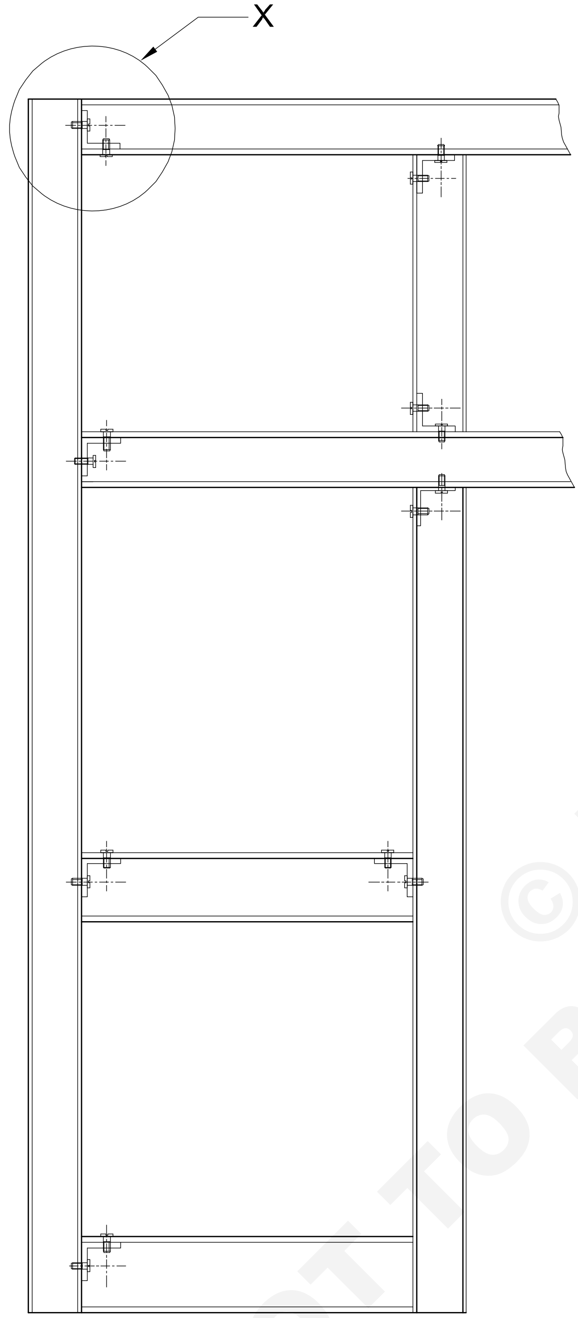
Make a mini model cabin - by using Alu. channel. beading etc.

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

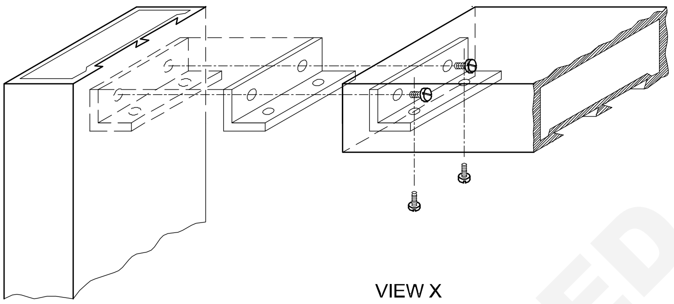
- **identify different sections to make partition and door assembly etc.**
- **fix single groove, double groove, door sections, pre laminated particle boad, glass fitting, etc.**
- **mount glazing clips on single groove and double groove partitions**
- **fix partition board and glass using suitable rubber packing**
- **make door frame fixed with handle, board, glass and winges.**

4	M8	HEX NUT	STD		32	
2	M8	STUD	STD		31	
1	44.5 x 101.6 x 440	HORZ DG	ALU. SEC		30	
4	44.5 x 101.6 x 440	HORZ DG MID	ALU. SEC		29	
2	44.5 x 101.6 x 1810	HORZ SG TOP	ALU. SEC		28	
3	44.5 x 101.6 x 320	VERT. DG	ALU. SEC		27	
3	44.5 x 101.6 x 1600	VERT. DG	ALU. SEC		26	
1	44.5 x 101.6 x 2010	VERT. SG (PART-B)	ALU. SEC		25	
	AS REQUIRED	SELF TAPPING SCREW	STD		24	
	AS REQUIRED	EQUAL ANGLE 25x25x2	ALU		23	
	AS REQUIRED	GLASS 5MM	STD		22	
	AS REQUIRED	PARTICLE BOARD 12MM	STD		21	
	AS REQUIRED	PACKING RUBBER	STD		20	
	AS REQUIRED	GLAZING CLIPS	STD		19	
18	AS REQUIRED	SCREW (FOR DOOR HINGE)	S.S.STD		18	
4	AS REQUIRED	HEX. NUT M8	S.S.STD		17	
2	AS REQUIRED	STUD M8	STD		16	
3	AS REQUIRED	HINGE	S.S.STD		15	
1	100 x 30	HANDLE SEC.	ALU. SEC		14	
1	44.5 x 101.6 x 750	HORZ. DG DOOR SEC.	ALU. SEC		13	
2	44.5 x 101.6 x 750	HORZ. SG DOOR SEC.	ALU. SEC		12	
2	44.5 x 101.6 x 1620	VERT. DG DOOR SEC.	ALU. SEC		11	
1	44.5 x 101.6 x 760	HORZ. SG PART. SEC	ALU. SEC		10	
2	44.5 x 101.6 x 390	HORZ. DG PART. SEC	ALU. SEC		9	
1	44.5 x 101.6 x 450	HORZ. DG PART. SEC	ALU. SEC		8	
1	44.5 x 101.6 x 400	HORZ. SG PART. SEC	ALU. SEC		7	
1	44.5 x 101.6 x 1810	HORZ. SG PART. SEC	ALU. SEC		6	
4	44.5 x 101.6 x 410	VERT. SG PART SEC.	ALU. SEC		5	
1	101.6 x 101.6 x 2010	VERT. CORNER DG SEC	ALU. SEC		4	
1	44.5 x 101.6 x 1630	VERT. DG PART. SEC	ALU. SEC		3	
2	44.5 x 101.6 x 2010	VERT. SG SEC(DOOR SIDE)	ALU. SEC		2	
1	44.5 x 101.6 x 2010	VERT. SG PART. SEC	ALU. SEC		1	1.10.83
NO.OFF	STOCK SIZE	PARTS NAME	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

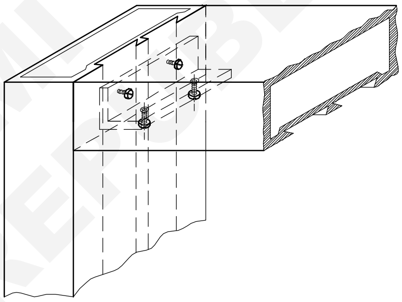
SCALE : NTS	MAKE A MINI MODEL CABIN BY USING ALUMINUM CHANNEL, BEADING ETC	DEVIATIONS ±1
		CODE NO. SM20N11083E1



SECTION A-A OF PARTITION SIDE -A
ILLUSTRATION OF JOINTS



VIEW X
(BEFORE JOINING)



VIEW X
(AFTER JOINING)

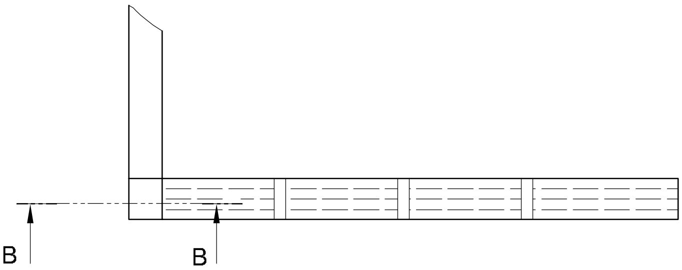
		–		2	–	83
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS

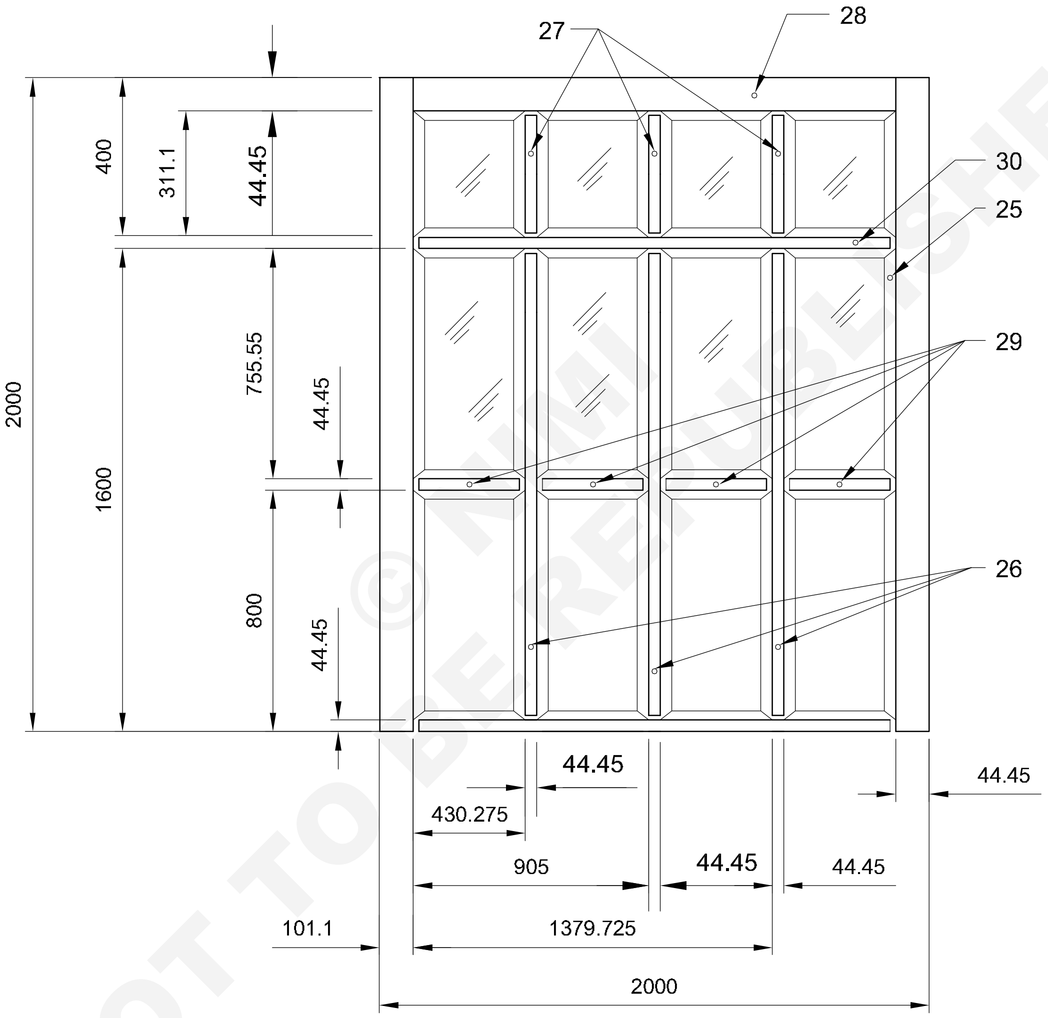
MAKE A MINI MODEL CABIN BY USING ALUMINIUM CHANNEL,BEADING ETC

DEVIATIONS ±1

CODE NO. SM20N11083E2



PARTITION SIDE - B



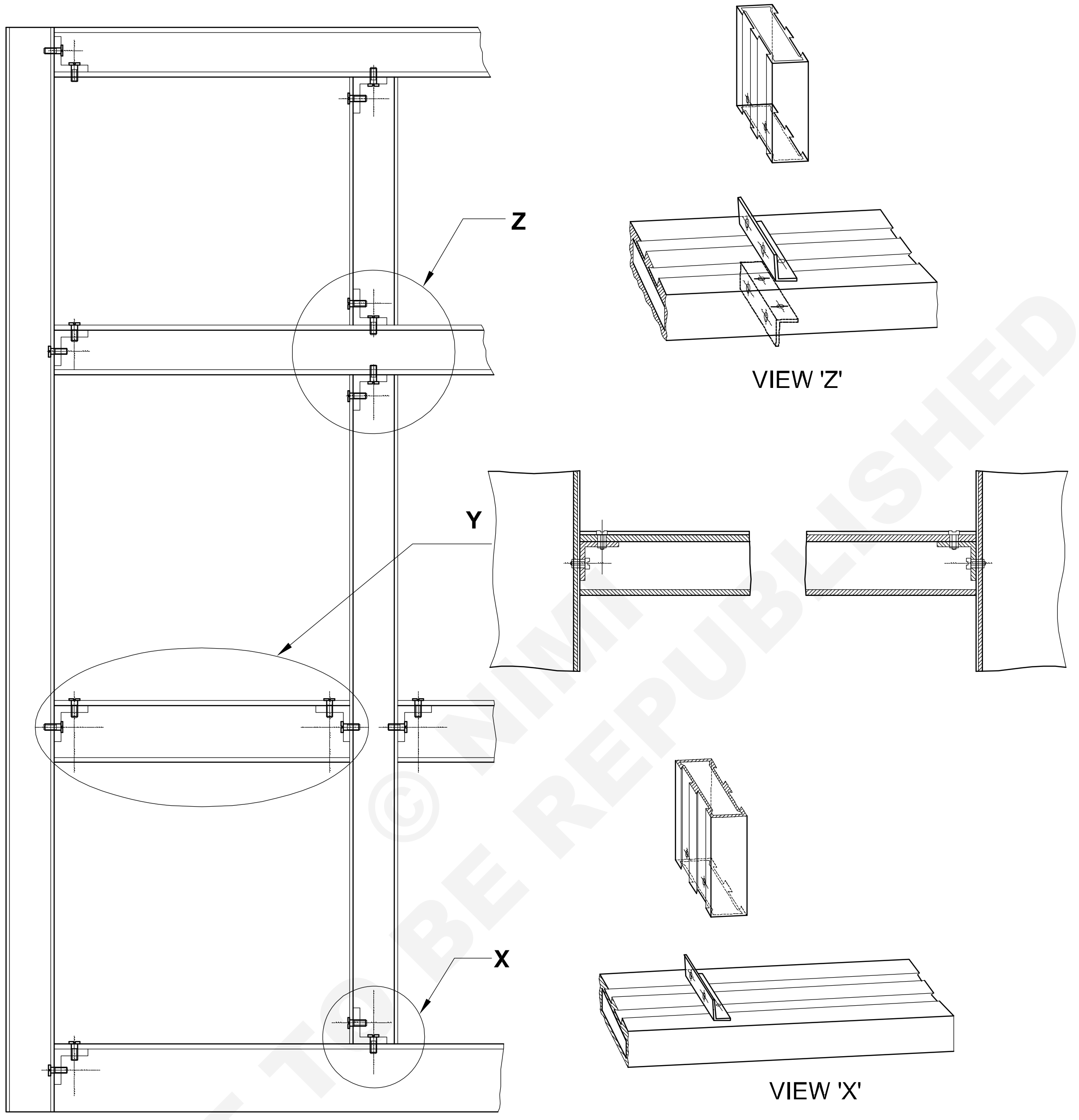
		–		2	–	83
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : NTS

MAKE A MINI MODEL CABIN BY USING ALUMINIUM CHANNEL BEADING ETC

DEVIATIONS ±1

CODE NO. SM20N11083E3



	ISSH 170 x 105 x 0.61	–		2	–	83
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

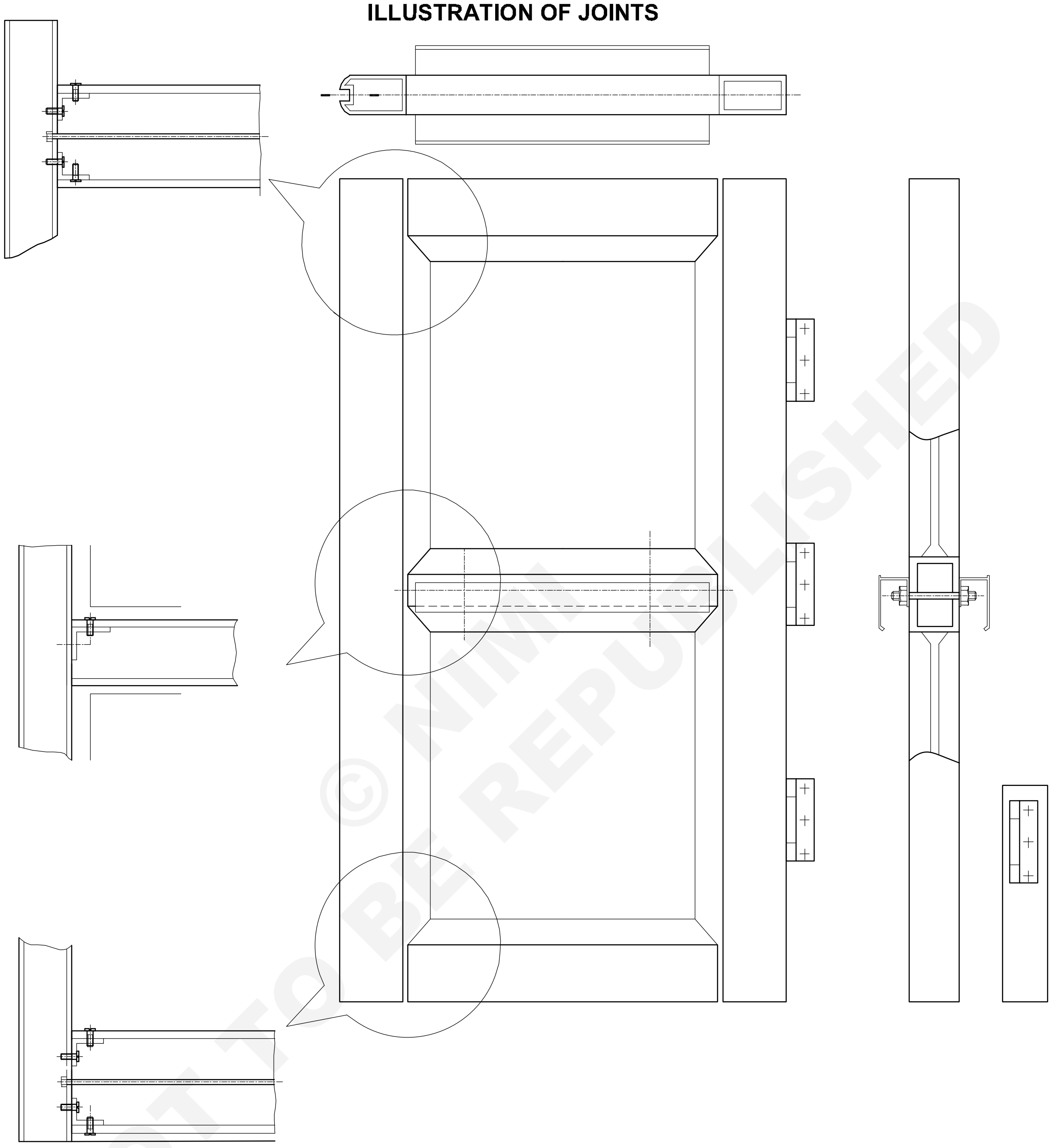
SCALE NTS

MAKE A MINI MODEL CABIN BY USING ALUMINIUM CHANNEL,BEADING ETC

DEVIATIONS ±1

CODE NO. SM20N11083E4

DOOR ASSEMBLY
ILLUSTRATION OF JOINTS



	ISSH 170 x 105 x 0.61	–		2	–	83
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : NTS

MAKE A MINI MODEL CABIN BY USING ALUMINIUM CHANNEL BEADING ETC

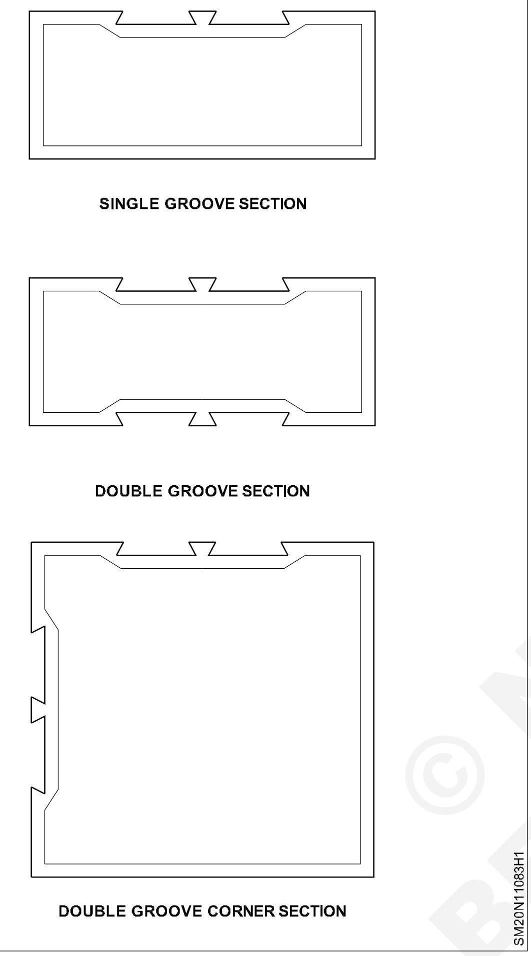
DEVIATIONS ±1

CODE NO. SM20N11083E5

Job sequence

- Check material with respect to bill of material provided in the drawing.
- Select single and double groove and corner sections to make cabin partition work. (Fig 1)

Fig 1

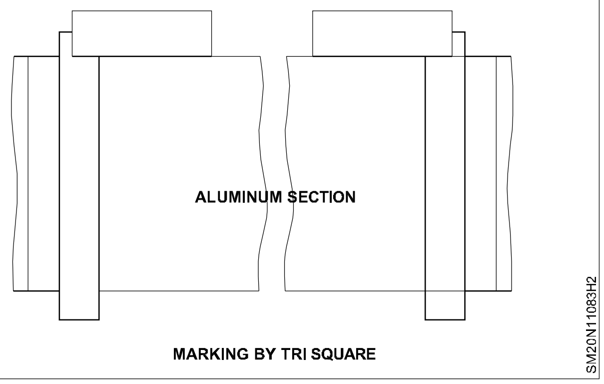


- Cut to length as per drawing dimension maintaining perpendicularity, using try square, mark lines to cut and deburr.
- Marked lines to cut correctly, if not it will effect the squareness of the frame with respect to joining sections.

> **If the sections are not cut perpendicular to their length, the joint will not be square and as a result, the frame will not be square.**

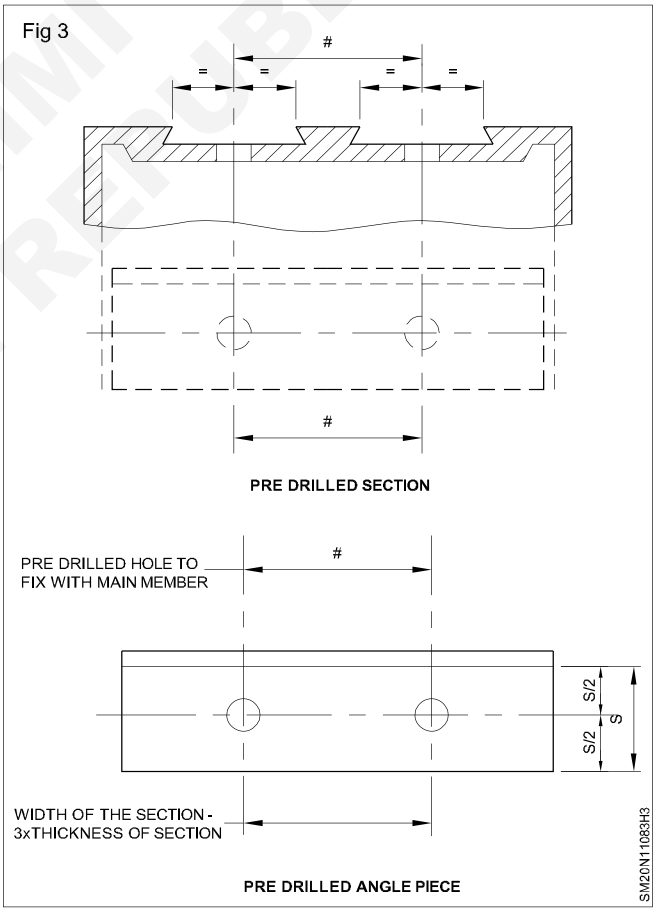
- Cut angle pieces to a length of section inner dimension-thickness of section. (overall width - 4 x thickness).
- Make 2 holes φ3 in one side of the angle pieces. (Fig 2)
- Fix angle piece sections as per drawing.
- Insert sections and fix screws using self tapping screws.
- Similarly follow the sequence at all joints shown in the drawing. Such that the equal angle plate should not be visible. The screws are fixed in the middle of the groove, which will invisible after fixing glazing clips.

Fig 2



- Fix angle pieces. Insert joining member, such that the undrilled partition of angle piece should be inside the sections and drive self tapping screw through pre drilled joining member.
- Assemble all partitions section as per drawing of side A and B.
- The whole frame structure to be fixed to the walls and floor by lag screws for sturdiness.

Fig 3



- Select door sections to make door frame. Similar assembly procedure to be followed for the door assembly.
- Fix glazing clips in the grooves of single and double partition grooves both sides.

- As per partition dimension cut and prepare particle board and glasses. Fix particle board and glasses with suitable rubber packing in between clips. Finally screw down door hinges and screw down to the partition structure.

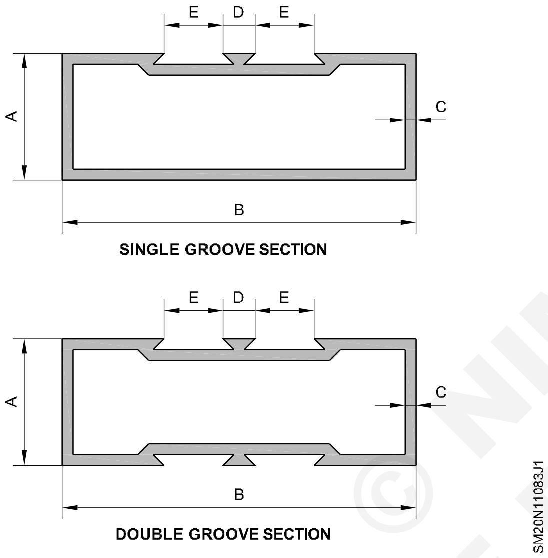
Skill sequence

Making partition frame (using aluminium partition sections)

Objectives : At the end of this exercise you shall be able to
- **identify different types aluminium partition sections used in partition frame**
- **make frames by using aluminium angle piece and screws(invisible method)**
- **fix glasses in partition frame using glazing clips and rubber packing**
- **fix particle board in partition frame by using glazing clip.**

- Identify aluminium partition sections to make partition frame. (Fig 1)

Fig 1



- Mark to required length and mark with try square, cut exactly perpendicular, if not the squareness of the frame will effect.
- Cut the aluminium angle less than the width of the section.
- Mark centre line at B/2 and S/2 in section and angle piece.
- Mark hole centre from centre line to D/2+E/2 distance either side and mark from the edge of angle piece of R/ 2 distance. (Fig 2)
- Drill primary hole of ϕ3 mm holes on angle piece for guiding self tapping screw to fix on frame sections.
- Mark the angle position on frame section as per drawing.
- Fix angle piece on frame by self tapping screw. (Fig 3)
- Insert joining member as shown in Figure. (Fig 4)
- The angle piece will be inside the joining member and fixed by self tapping screws as shown.
- Similarly assemble all section members to complete frame structure.

Fig 2

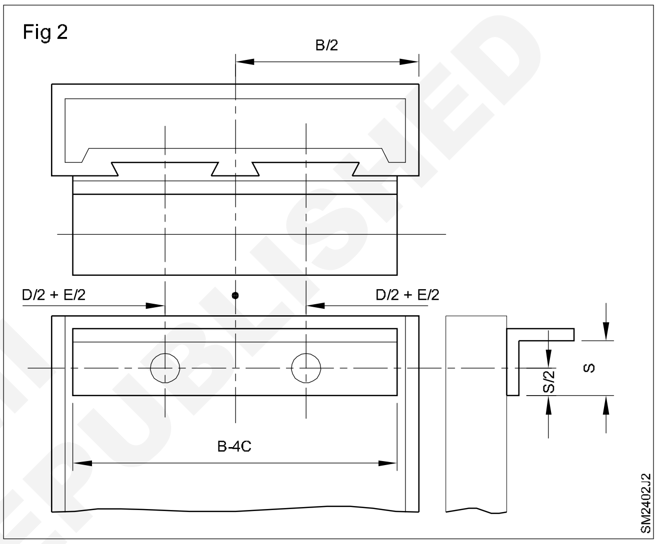


Fig 3

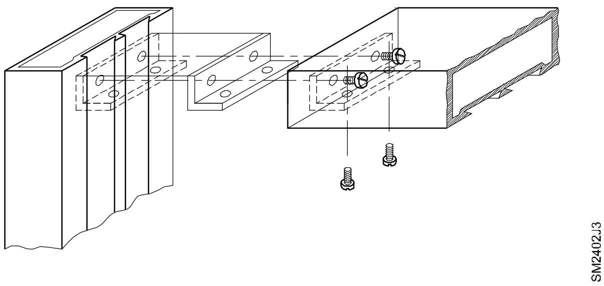
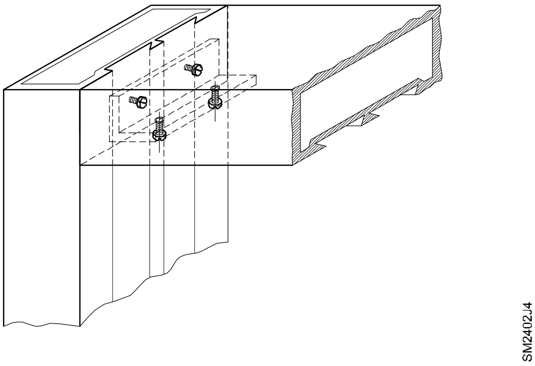


Fig 4



- Similarly assemble the door frame.
- Fix the partition frame part-A and part-B on to wall and floor by grouting.

Make a electrical panel box

Objectives : At the end of this exercise you shall be able to
- **make the ventilation slits at the backside of the electrical panel box by lancing on fly press**
- **make an electrical panel box by toggling the edges on fly press and folding**
- **make a door for electrical panel box by punching the holes, piercing the square cutouts on the power press and folding the edges on bar folder**
- **make an electrical panel by assembling door by hinges and making locking arrangement by fixing nut**
- **paint an electrical panel with suitable colour by spray painting to make good appearance.**

Job sequence

Part No.1 Electrical Panel Door

- Cut the material to size on tradle operated squaring shears.
- Cut the slots on one edge as shown in job drawing using straight snips.
- Drill ϕ 2 holes at corners to insert locking screws on bench drilling machine.
- Punch the ϕ 8-9 holes, ϕ 25.4 - 3 holes and ϕ 30 - 3 holes for mounting electrical accessories on the power press.
- Pierce 90 x 90-2 square slots for mounting electrical meters on the power press.
- Fold the edges on the bar folder.

Part No.2 Electrical Panel Box

Cut the material to size on tradle operated squaring shears.

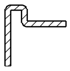
Mark the slits for ventilation and folding, joggling and flanging lines.

Make ventilation slits by lancing on fly press using lancing tool. (Fig 1) Cut the slots on one side for fixing hinges by straight snips. Mark and drill ϕ 8-2 holes at corners as per job drawing to accommodate locking screws on bench drilling machine.

Fig 1

Joggle the 16 mm edge to 3 mm depth on fly press. (Fig 2) Flange the edges and fold the sides on bar folder. Tag weld at 4 spots Hex. nut M6, at the centre of ϕ 8 holes from inside of the joggled edge by arc welding. Finish the box by filing, abrasive paper etc.

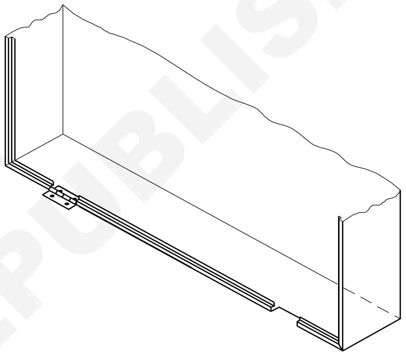
Fig 2



Assembly of Electrical Panel

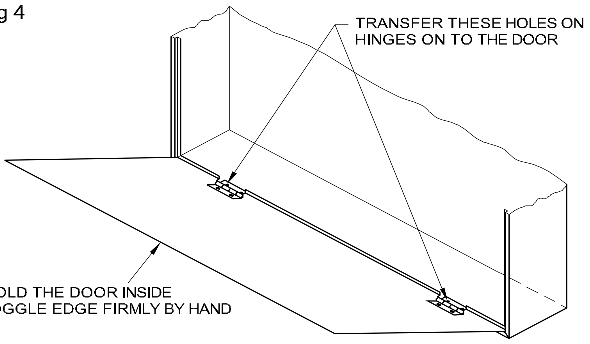
Place one part of the 38 mm (1 1/2") hinge in the centre of 40 mm slot of one side flange. Adjust the central round section in 5 mm slot on the side and pass ϕ 4 drill through the holes on hinges to sheet metal using portable drilling machine and rivet f 4 x 8 mm long snap head M.S rivets using rivet snap and dolly. Similarly fix one part of another hinge in the other slot. (Fig 3)

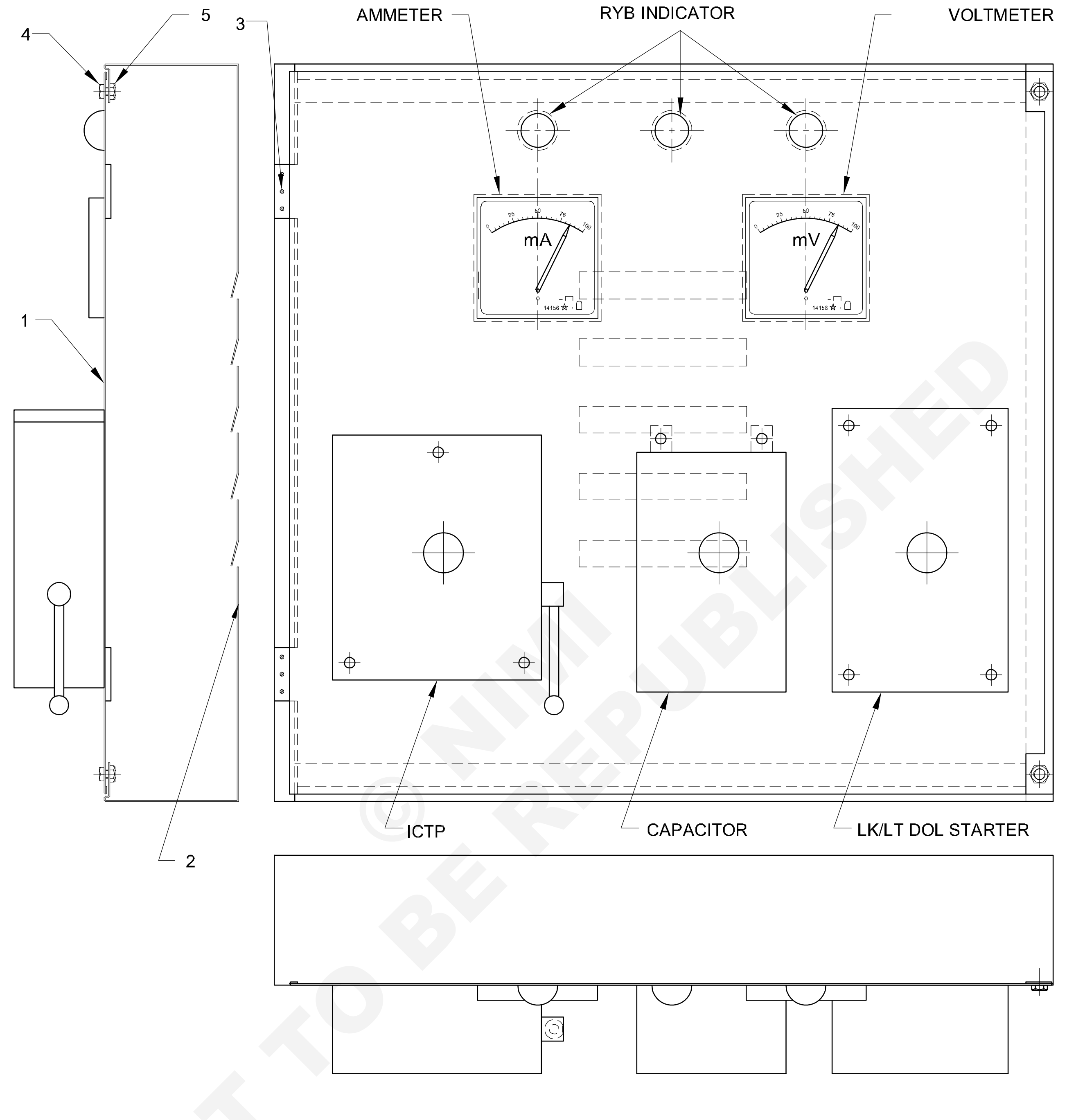
Fig 3



Now place the door panel inside joggled edges of the flange, hold it firmly by one hand and open it from the opposite of hinged side. Take the other part of the hinge on the inside face of the door and transfer the holes on hinge on to the inside face of the door. Take out the door and drill ϕ 4 holes on it. Finally rivet ϕ 4 x 8 snap head M.S rivets using rivet snap and dolly. Similarly fix other part of another hinge on door. (Fig 4) Close the door and insert ϕ Hex bolt M6 x 8 long in locking nut. If it is not fit properly, enlarge the diameters of holes on door by round file. Finish the electrical panel and so assemble with door with smooth flat file and smooth abrasive paper. Prepare the inside and outside surfaces of the electrical panel by applying putty and primary coats. Paint the electrical panel with suitable colour to make good appearance.

Fig 4





16	Ø4 x 8	–	M.S. RIVET FLAT HEAD	23	–	84
2	M6	–	M.S. HEX. NUT STD	23	5	84
2	M6 - 8	–	M.S. HEX. BOLT STD	23	4	84
2	32 mm	–	M.S. HINGE STD	23	3	84
1	ISSH 625 x 1 - 590	–	M.S. SHEET	23	2	84
1	ISSH 610 x 1 - 560	–	M.S. SHEET	23	1	84
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS

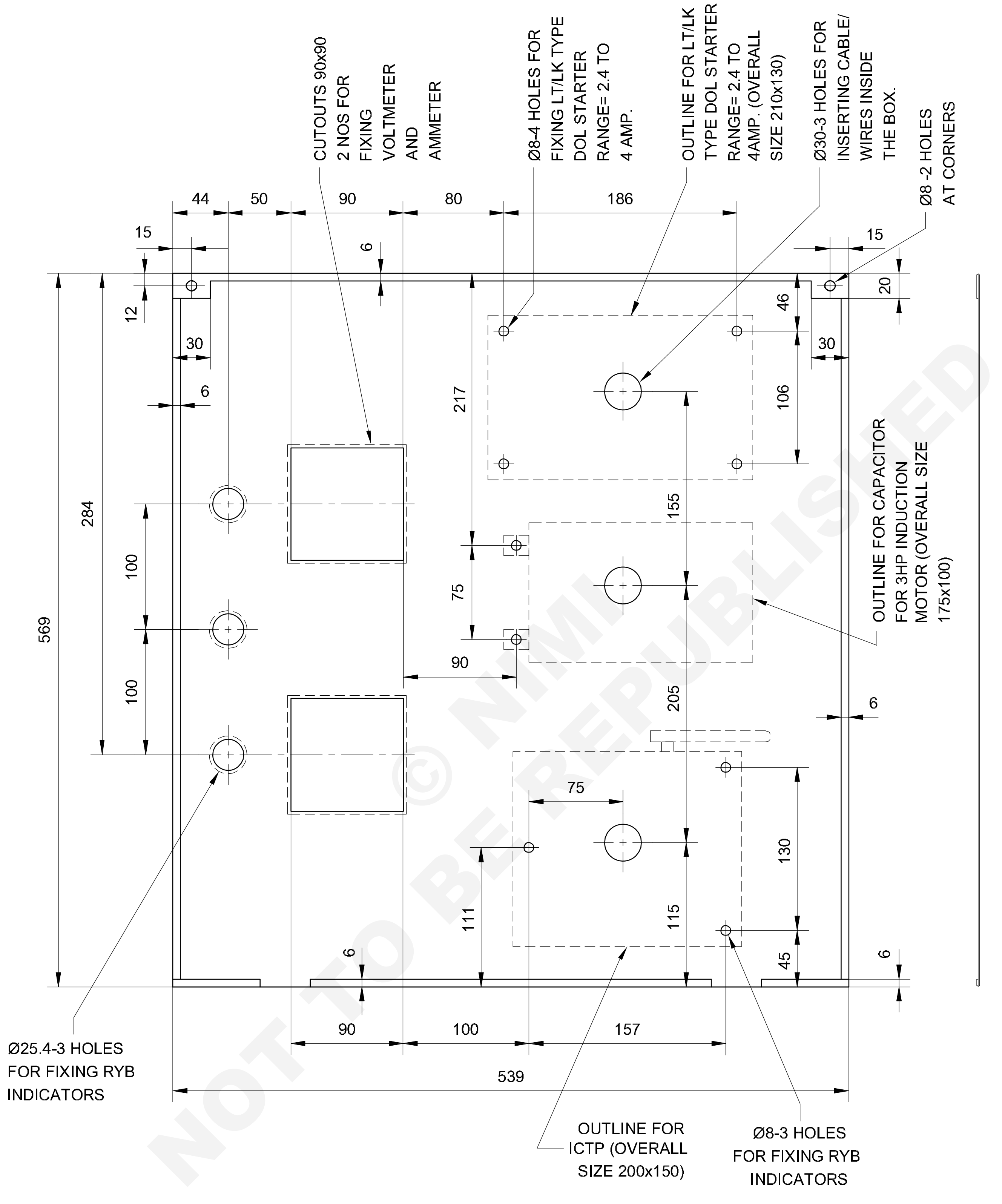
PROJECT: ELECTRICAL PANEL

PART: **1. PANEL DOOR 2. PANEL BOX**

DEVIATIONS ±2

TIME 20h

CODE NO. SM20N11084E1



1	ISSH 610 x 1 - 560	–	M.S. SHEET	23	1	1.10.84
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS

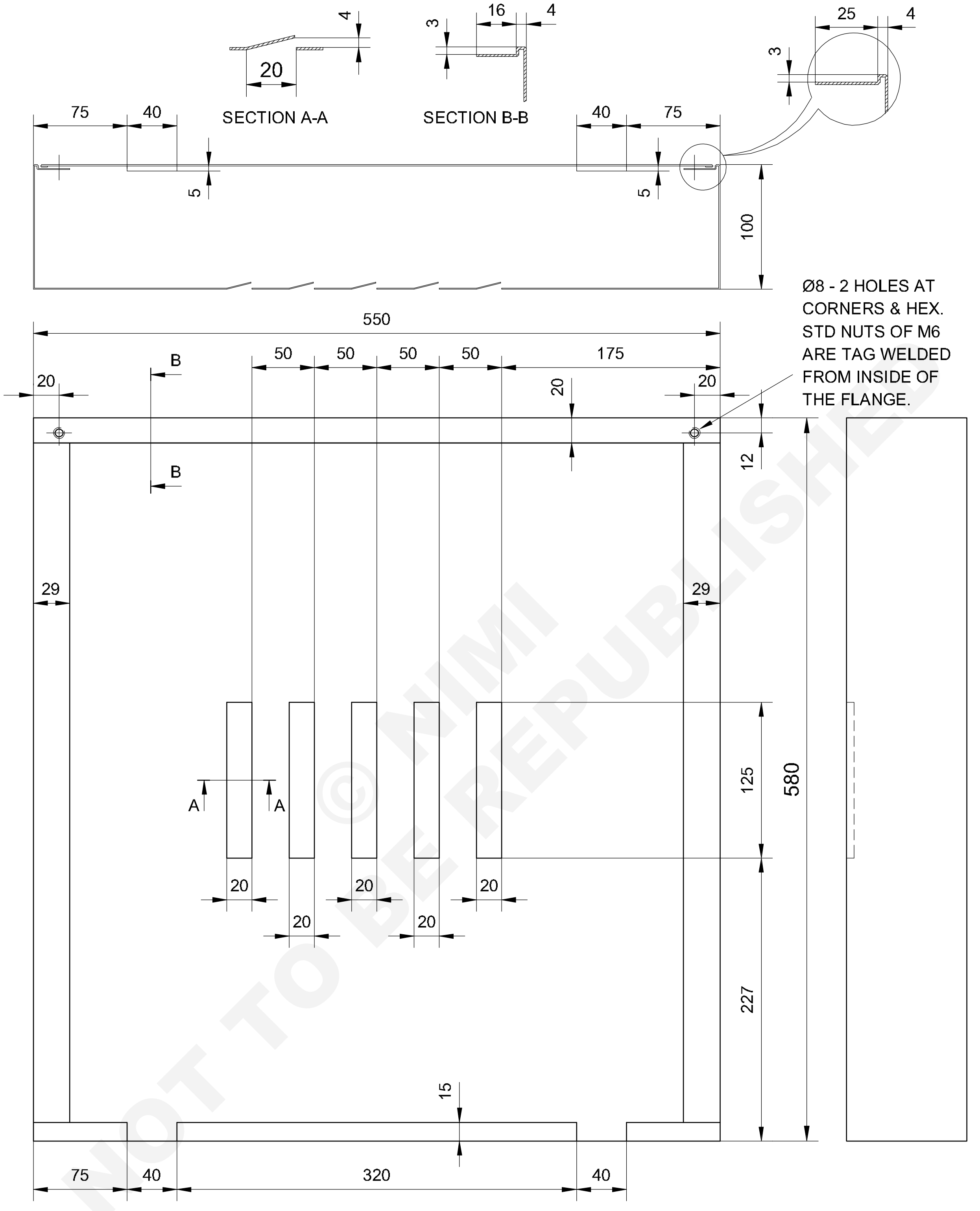
PROJECT: ELECTRICAL PANEL

PART: **PANEL DOOR**

DEVIATIONS ±2

TIME 10h

CODE NO. SM20N11084E2



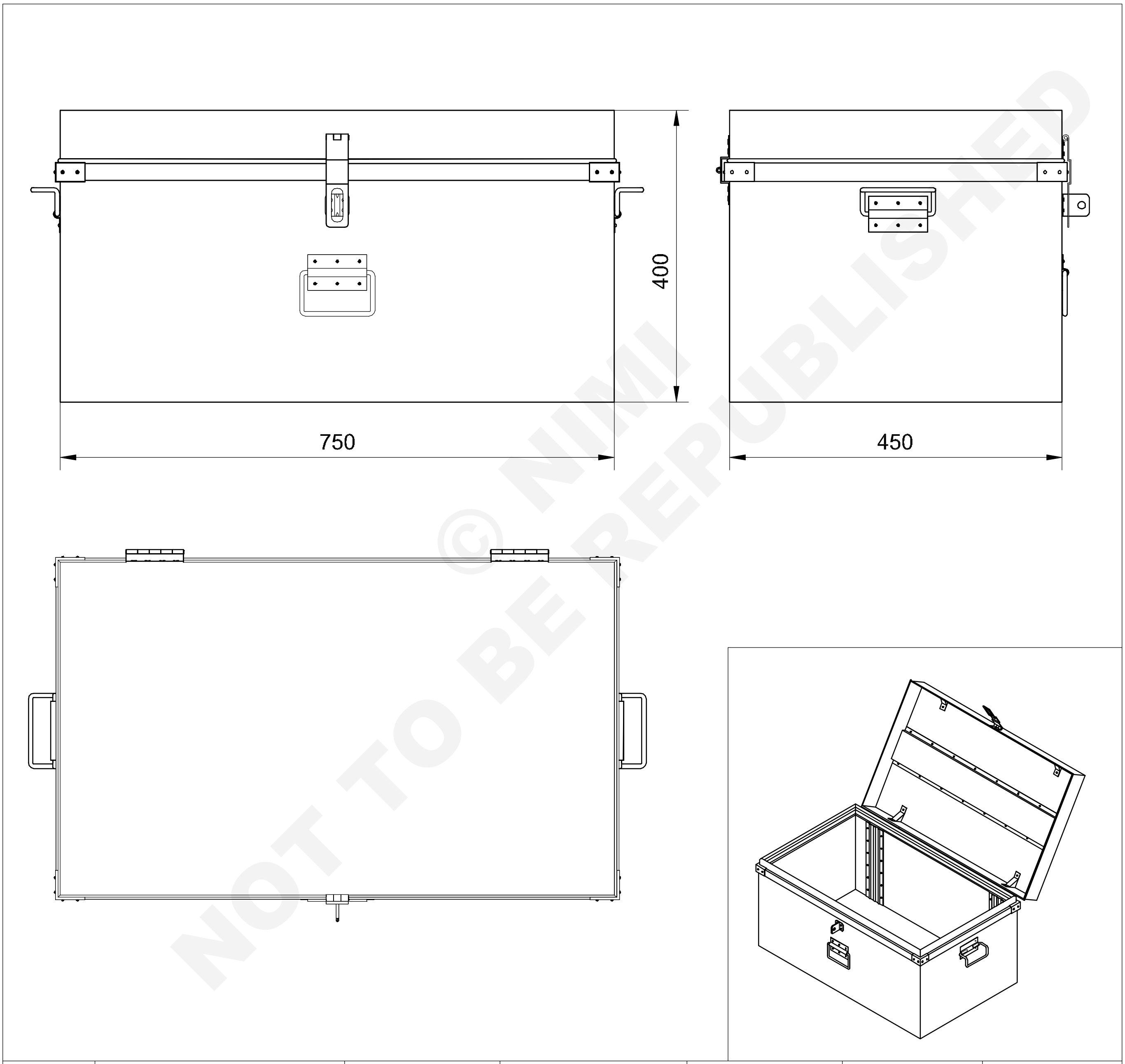
1	ISSH 625 x 1 - 590	–	M.S. SHEET	23	2	1.10.84
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PROJECT: ELECTRICAL PANEL	DEVIATIONS ±2	TIME 10h
	PART: **PANEL BOX**	CODE NO. SM20N11084E3	

Make a trunk box

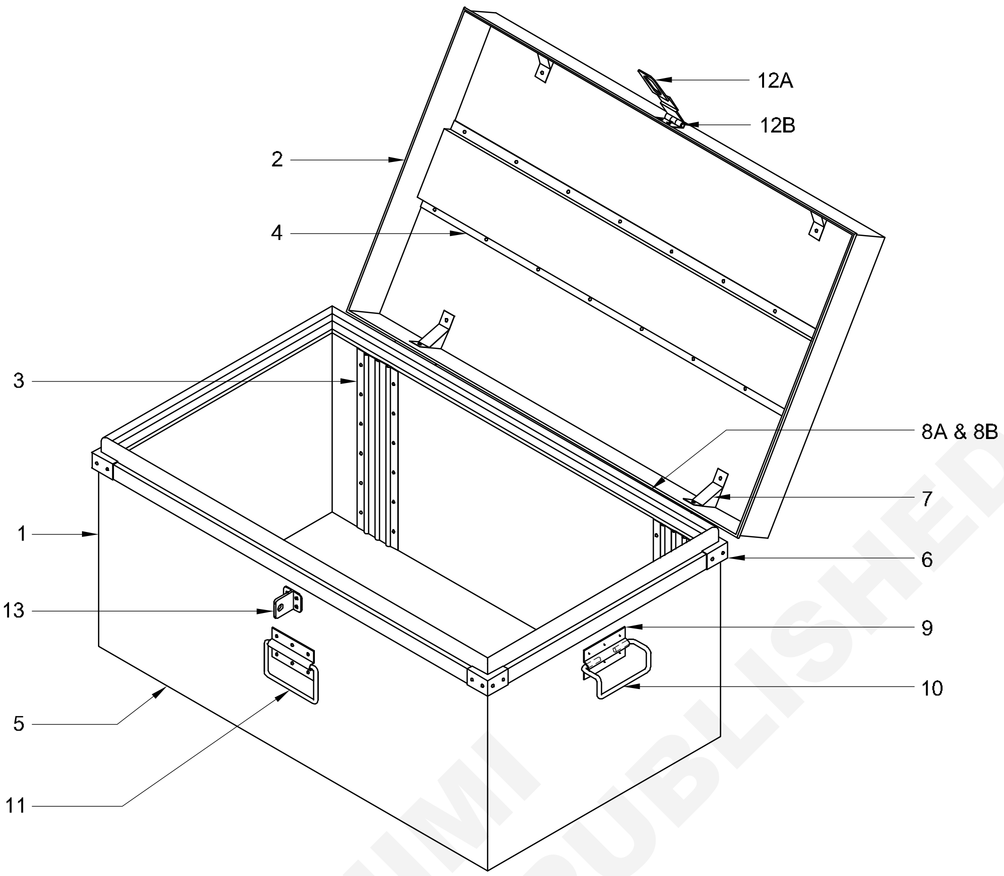
Objectives: At the end of this exercise you shall be able to

- **develop and layout the pattern with required allowances for the body and lid of the trunk box by geometrical construction method**
- **wire the straight edge by universal swaging machine**
- **joggle on edge by folding machine**
- **make a channel by folding machine**
- **make the channel on press brake**
- **stiffen the trunk box by fixing channel, side clamp, triple bead and corner brackets**
- **make hinge and pad lock**
- **join two parts of trunk box with hinges and pad lock.**



1	ISSH 1820 x 0.61 - 780	–	G.I. SHEET	18	1	84
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PROJECT: TRUNK BOX	DEVIATIONS ±1	TIME 25h
	PART: **BODY**	CODE NO. SM20N11084E4	



NO.OFF	STOCK SIZE	PART NAME	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
20	Fe - Ø3 - 8	ASSEMBLY	M.S.- F.H. RIVET	18	1 TO 13	–
98	Fe - Ø3 - 6	ASSEMBLY	M.S.- F.H. RIVET	18	1 TO 13	–
1	ISSH 100 x 1.6 - 35	PAD LOCK BOTTOM	M.S. SHEET	18	13	–
1	Fe - Ø3 - 40	PAD LOCK TOP	M.S. WIRE	18	12B	–
1	ISSH 200 x 1.6 - 35	PAD LOCK TOP	M.S. SHEET	18	12A	–
1	Fe - Ø6 - 270	FRONT HANDLE	M.S. WIRE	18	11	–
2	Fe - Ø6 - 300	SIDE HANDLE	M.S. WIRE	18	10	–
3	ISSH 90 x 1.2 - 65	HANDLE COVER PLATE	M.S. SHEET	18	9	–
2	Fe - Ø4 - 85	HINGE	M.S. WIRE	18	8B	–
2	ISSH 85 x 1.6 - 75	HINGE	M.S. SHEET	18	8A	–
4	ISSH 110 x 0.61 - 95	SIDE CLAMP	G.I. SHEET	18	7	–
4	ISSH 55 x 0.61 - 95	CORNER BRACKET	G.I. SHEET	18	6	–
2	ISSH 480 x 1.2 - 170	HAT SECTION CHANNEL(Base of Body)	G.I. SHEET	18	5	–
1	ISSH 760 x 1.2 - 170	HAT SECTION CHANNEL (Lid)	G.I. SHEET	18	4	–
4	ISSH 310 x 1.2 - 100	TRIPLE BEAD STRETCHER	G.I. SHEET	18	3	–
1	Fe - Ø4.5 - 2400	TRUNK BOX LID	G.I. WIRE	18	2B	–
1	ISSH 880 x 0.61 - 640	TRUNK BOX LID	G.I. SHEET	18	2A	–
1	Fe - Ø4.5 - 2400	TRUNK BOX BODY	G.I. WIRE	18	1B	–
1	ISSH 1820 x 0.61 - 780	TRUNK BOX BODY	G.I. SHEET	18	1A	84

SCALE NTS	PROJECT: TRUNK BOX	DEVIATIONS ±2	TIME 25h
		CODE NO. SM20N11084E5	

Job sequence

Make a trunk box

Trunk box body (Assembly of Part 1A and 1B)

- Cut the material of required size on power operated guilletin shear.
- Develop and layout the pattern as per job drawing for trunk box body part '1A' (Fig 1) and Part '1B' (Fig 2) by geometrical construction method with all allowances for wiring, joggling, folding and box corner joint by geometrical construction method on sheet using suitable marking, measuring and layout tools. Check the patterns for its correctness with reference to job drawing.

Fig 1

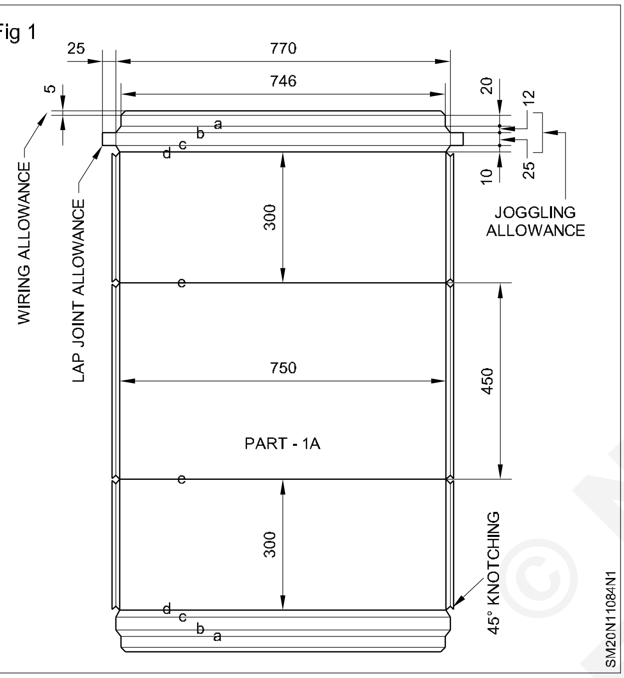
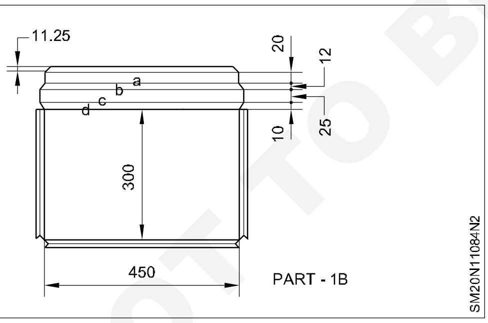
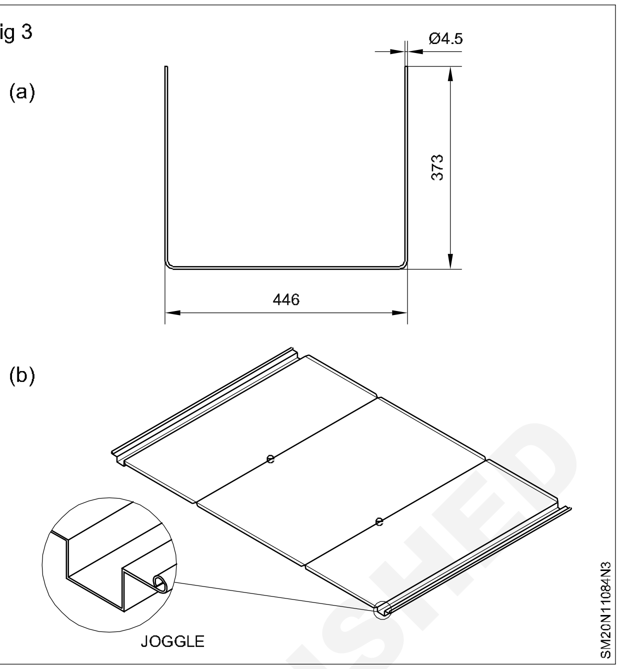


Fig 2



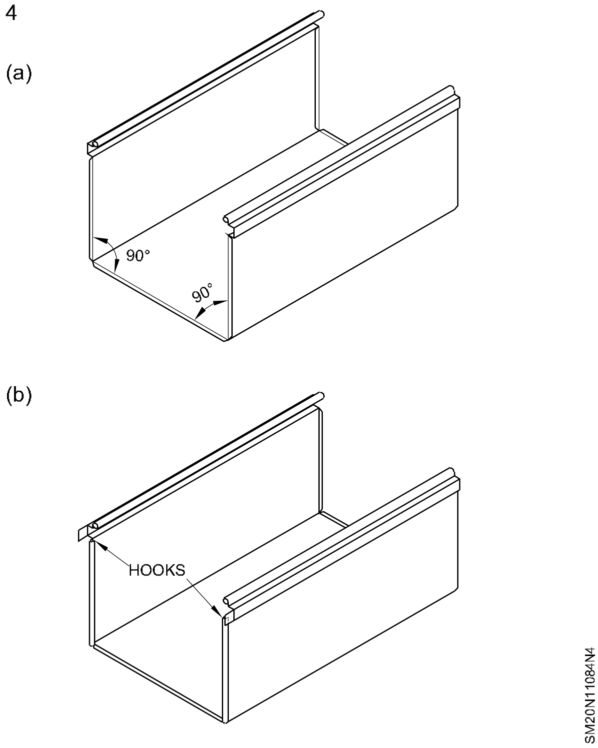
- Cut the patterns with notches using straight snips and deburr the edges using smooth file.
- Wire the edges using universal swaging machine by changing the wiring rollers, form the same wired edge as false wired edge by removing the wire on the straight edge of Part 1A.
- Form two wires of 4.5 mm f to U shape as shown in Fig 3.
- Place the 446 mm size of 'U' shaped wire on the straight edge of Part 1B (1 No.) and wire the edges using universal swaging machine. Similarly wire other piece of 1B.

Fig 3



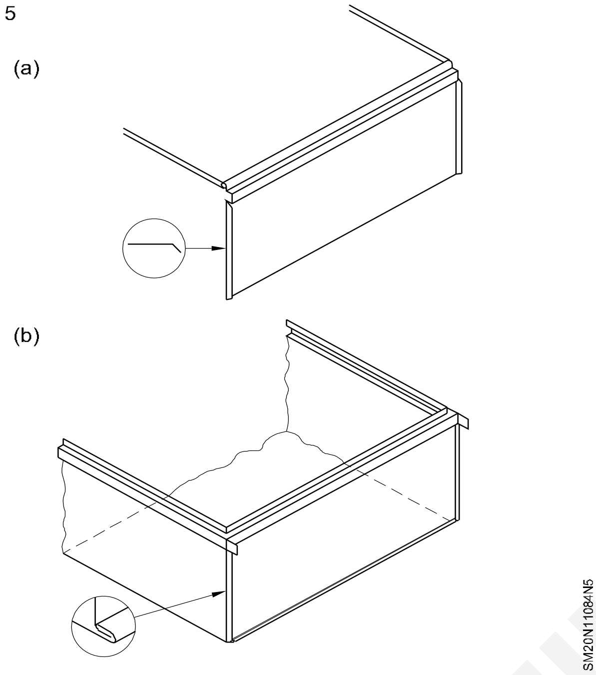
- Hold the part 1A, on line a,b,c and on folding machine and form joggle as shown in Fig 3b. Similarly form joggle on Part 1b (2 Nos.).
- Hold the part 1 A on line "e" on folding machine and fold at an angle of 90° as shown in Fig 4a.
- While holding the job on folding machine to form joggle, make sure that the wired edge must come inside the body.
- Make 4 mm hooks on joining allowance of the edges of both ends of Part 1A by using setting hammer, mallet and stakes for box corner joint. (Fig 4b)

Fig 4



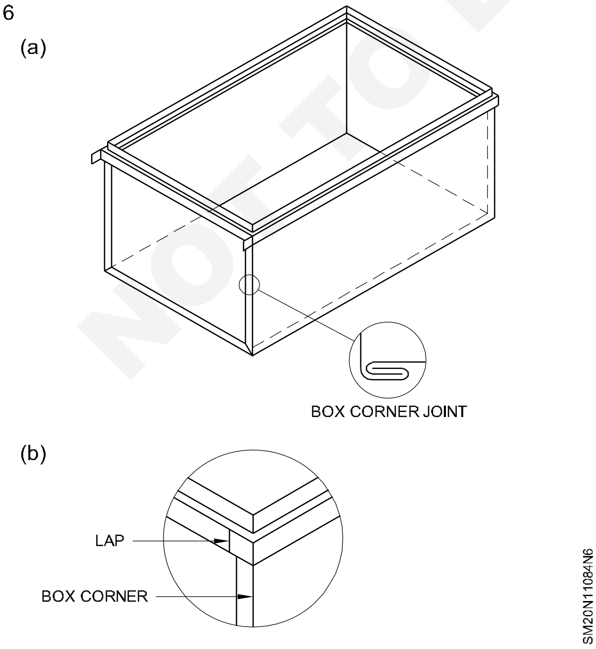
- Turn 4 mm on joining allowance of the edges of three sides of Part 1B (2 Nos.) using setting hammer, mallet and stake for box corner joint. (Fig 5a)
- Insert the existing wire ends of Part 1B (2 Nos.) into the false wired edges of Part 1A and then insert the turned edges into hooks simultaneously and press the joint to make pane down joint. (Fig 5b)

Fig 5



- With the support of steel block, blunt chisel and mallet, form box corner joint (Fig 6a) on both ends of Part 1A.
- Turn the lap joint allowance on corners (Fig 6b) of Part 1A and finish the box corner joint of the body of the trunk box.
- Check the dimensions of the body of the trunk box.

Fig 6



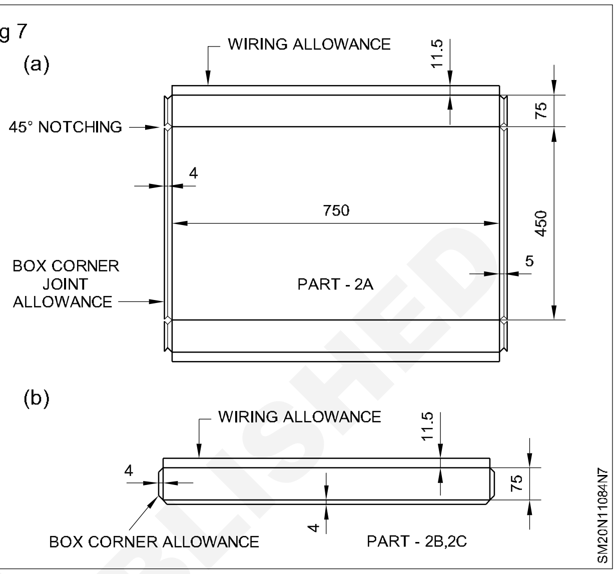
Lid (Assembly of Part 2A and 2B)

Part 2A - 1 No.

Part 2B - 2 Nos.

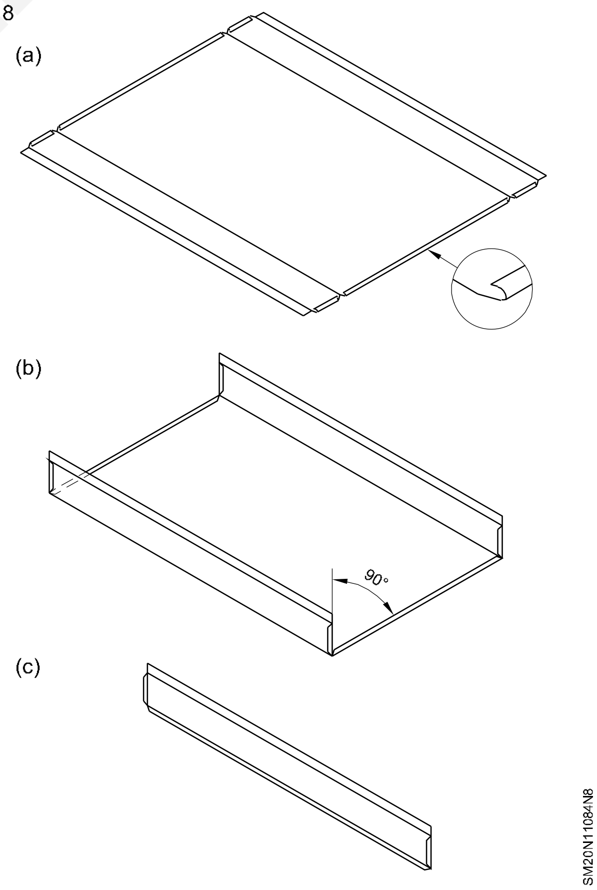
- Cut the material on power operated guilletin shear.
- Develop and layout the pattern for Part 2A and 2B by geometrical construction method. (Fig 7a & 7b)

Fig 7



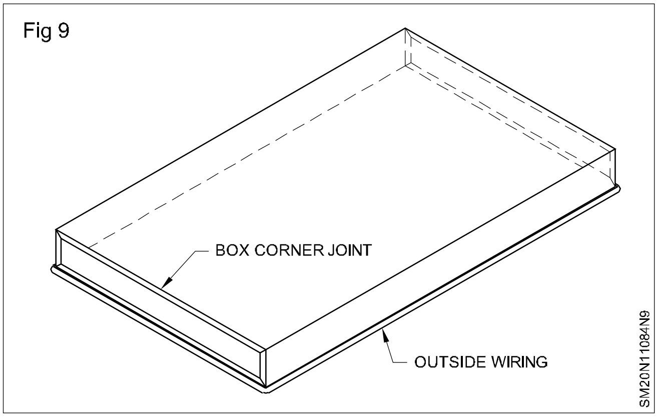
- Hold the job Part 2A on 4 mm. Cut the pattern joining allowance line and make hook on both ends for box corner joint. (Fig 8a)

Fig 8



- Hold the job on line 'e' on folding machine and fold at an angle of 90° as shown in (Fig 8b).
- Turn 4 mm on joining allowances of the three sides of Part 2B (2 Nos.) using hand tools for box corner joint. (Fig 8c)
- Insert the turned edge into hooks of Part 2A and form box corner joint on both ends. (Fig 9)
- Make outside wiring on four sides at the edges of lid. (Fig 9)
- Finish the box corner joint and outside wiring and check the dimensions of the lid of the trunk box.

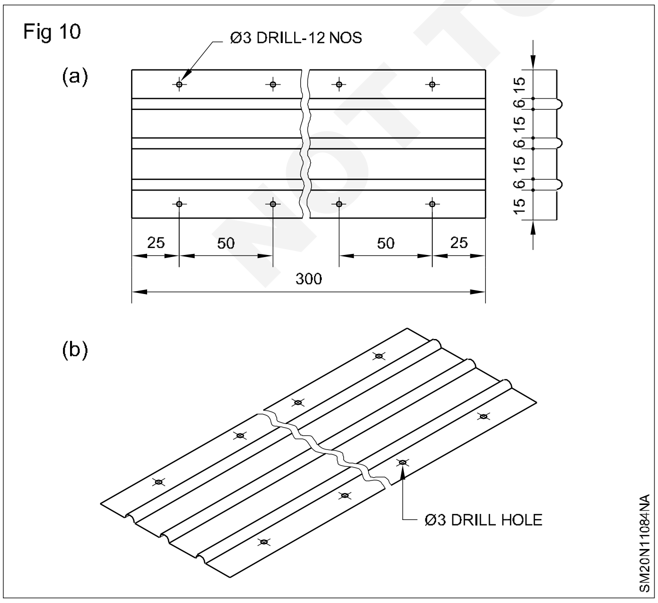
Fig 9



Triple Beaded Stretcher (Part 3) 4 Nos.

- Cut the material to the required size on power operated guilletin shear.
- Calculate the length and width required to make the triple beaded stretcher as per job drawing and draw the centre lines on a sheet to make triple bead and centres to be drilled for riveting.
- Remove unwanted metal by using snips and deburr the edges. (Fig 10a)
- Set the 6 mm width rollers on beading machine. Make triple bead on sheet to the required distance by adjusting and setting the guide plate.

Fig 10



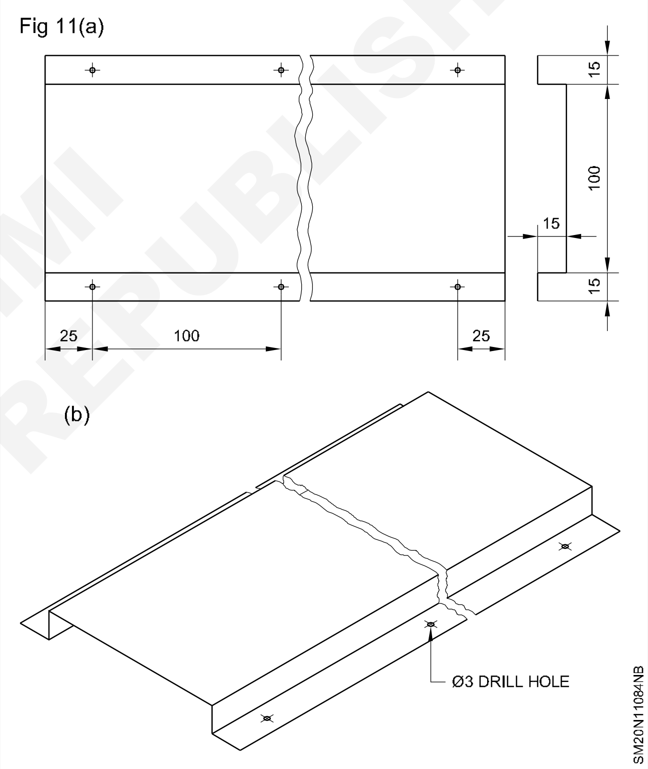
- Drill ϕ 3 mm holes on marked centres using drilling machine and deburr.
- Flatten the flat surfaces of the triple beaded stretcher. (Fig 10b)
- Finish and check the triple beaded stretcher.

Hat Section Channel (Part No.4&5)

Part 4 - 1 No. - Part 5 - 2 Nos.

- Cut the material to the required size on power operated guilletin shear.
- Develop and layout the pattern for hat section channel for lid (Part 4) (Fig 11a & 11b) and base of the body. (Part 5) (Fig 12a & 12b) as per job drawing, including the centres to be drilled for riveting by geometrical method. Check the pattern for its dimensions.(Part 5) (Fig 12a & 12b) as per job drawing, including the centres to be drilled for riveting by geometrical method. Check the pattern for its dimensions.

Fig 11(a)



- Cut the patterns with notches and deburr the edges. Make the channel on the sheet (Part 4) by press brake and fold step by step as shown in Fig 12a & 12b and complete the hat section channel. (Part 4)
- Make centre punch marks on the marked centres and drill ϕ 3 mm 16 holes on drilling machine and remove the burrs. (Fig 12a & 12b)
- Make the channel on Part 5 on press brake and then fold the sides having flange on folding machine as shown in Fig 13a.
- Make centre punch mark and drill ϕ 3 mm 10 holes and deburr.(Fig 13b)

Fig 12

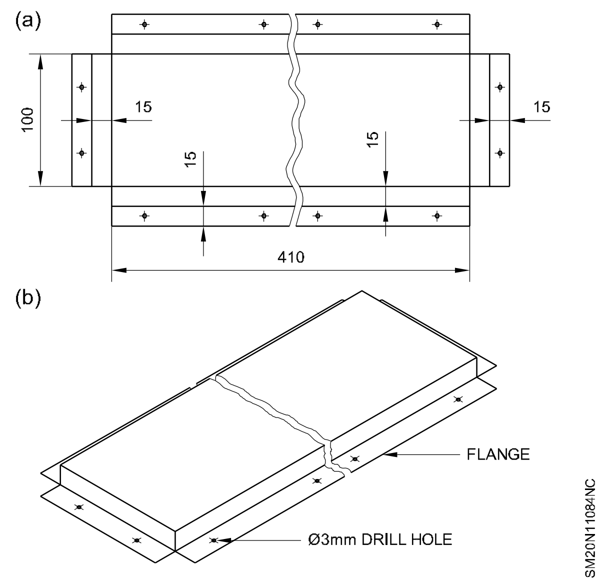
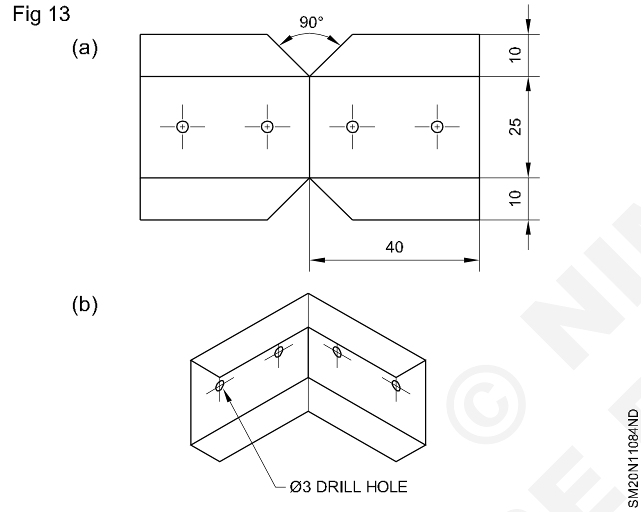


Fig 13



Corner brackets (Part 6) - 4 Nos.

- Layout the pattern for corner bracket by geometrical construction method including the centres to be drilled.
- Cut with notches and deburr the edges as shown in Fig 13a.
- Make ϕ 3 mm 4 holes on the centres. Prepare corner bracket by folding sides as shown in Fig 13b.

Side clamp (Part 7) - 4 Nos.

- Layout the pattern for side clamp with centres to be drilled.
- Cut the pattern with notches and deburr the edges and mark centres to be drilled with centre punch as shown in Fig 14a.
- Drill ϕ 3 mm 2 holes on centre and form side clamp by folding as shown in Fig 14b.

Hinge (Part 8A and 8B) - 2 Nos. each

- Layout the pattern for hinge as per job drawing, adding allowance for tabs to cramped joint and mark centres of holes as shown in Fig 15a.

Fig 14

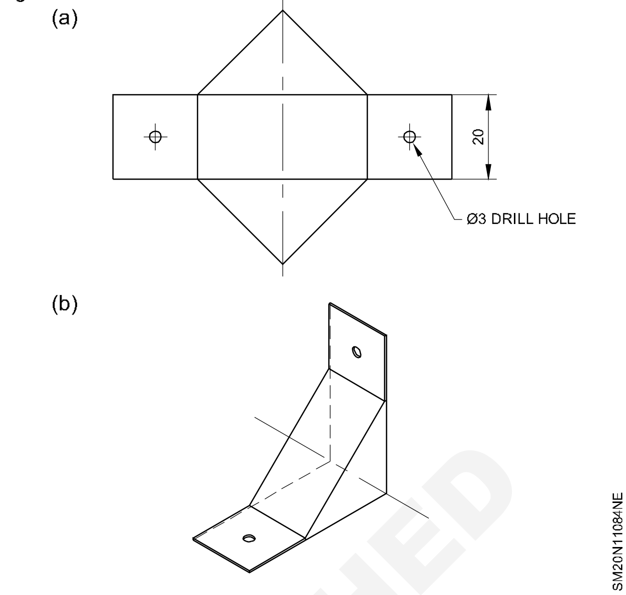
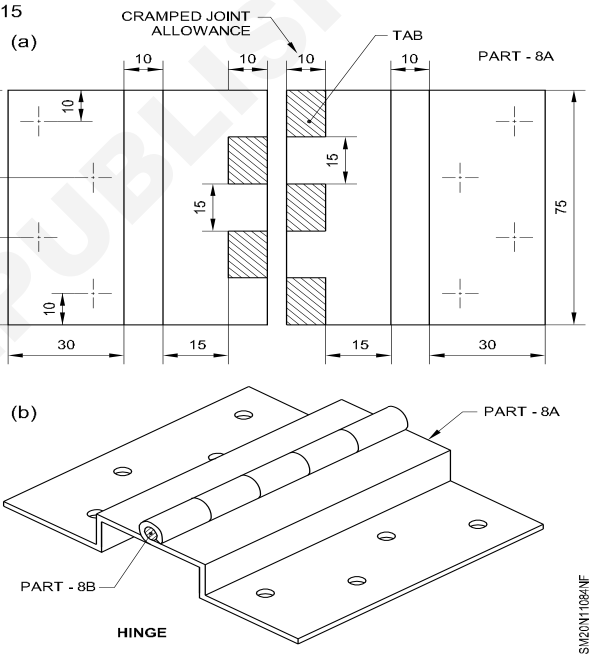


Fig 15



- Cut and slit the two metal pieces and make the tabs for cramped joint and form hinge. Drill ϕ 4 mm holes and form the hinge to our required shape by folding machine as shown in Fig 15b. Check that the hinges is working without struck.

Handle Cover Plate (Part 9)

- Calculate the length and width required to make the handle cover plate as per job drawing and mark centres of holes as shown in Fig 16a.
- Cut the sheet, deburr the edge, form ‘U’ groove in the middle of the sheet and drill ϕ 3 mm hole on the centres as shown in Fig 16b.

Fig 16

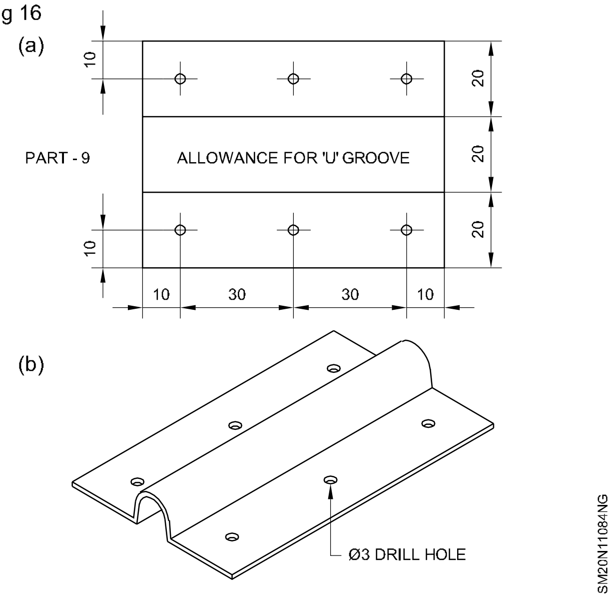
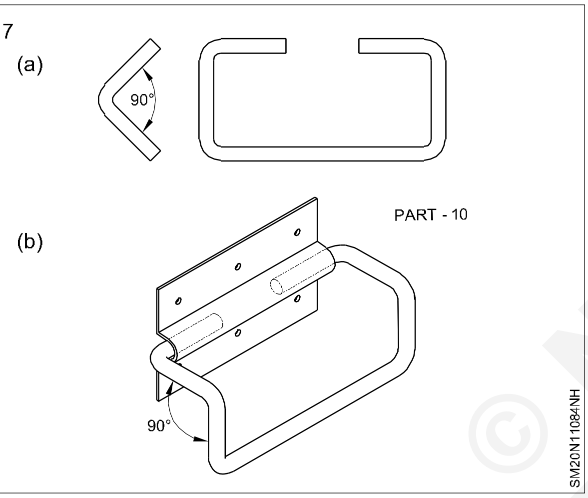


Fig 17



Side handle (Part 10) - 2 Nos.

- To prepare the handle rod for side, form the ϕ 6 mm x 270 mm long round rod in rectangular shape. (Length 90 mm width 60 mm) Then bend at an angle of 90° in the middle of 60 mm width as shown in Fig 17b.

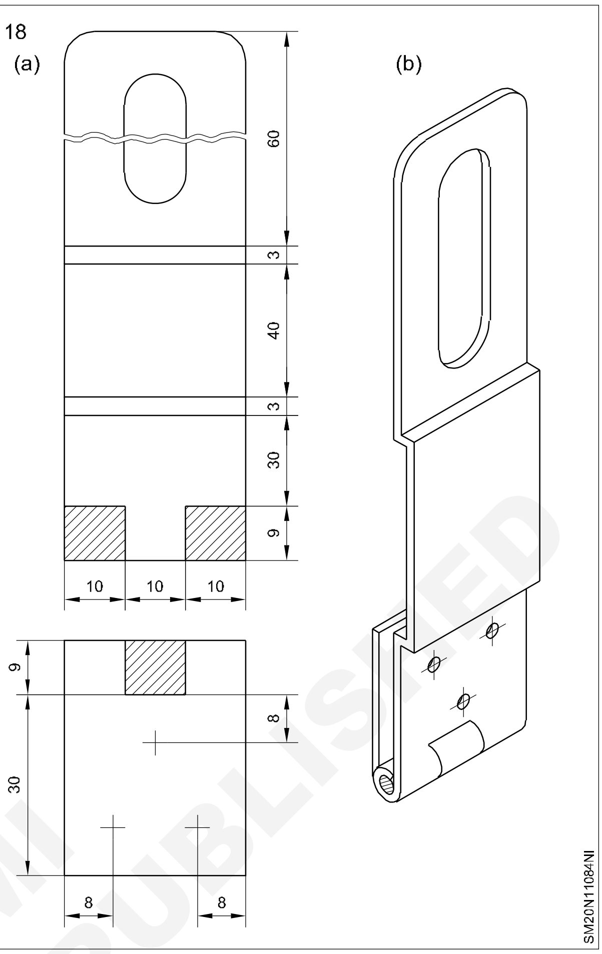
Front handle (Part 11) - 1 No.

- To prepare handle rod for front, form the ϕ 6 mm x 250 mm long round rod as rectangular shape. (Length 90 mm width 50 mm) as shown in Fig 17a.

Pad lock top (Part 12A & 12B) - 1 each

- Calculate the length and width required to make pad lock top as per job drawing by allowing allowance for cramped joint, tabs and mark centres to drill holes as shown in Fig 18a.
- Make pad lock hinge by joining two sheet metal pieces of pad lock top (Part 12A & 12B) by cramped joint and check its movement.

Fig 18



- Make slot on Part 12A and 3 mm f holes on Part 12B. Form the same to the required shape as shown in Fig 18b.

Pad lock bottom (Part 13) - 1 No.

- Cut and deburr the marked piece of the pad lock bottom (Fig 19a) and form it to the required shape by folding as shown in Fig 19b.
- Drill ϕ 10 mm and ϕ 3 mm holes at their respective centres and remove the burr.
- Make 5 mm radius on the corners of the bottom. (Fig 19b)

Assembly

Fix Corner Brackets to Body

- Place the corner brackets on lapped corners of the body of the trunk box and transfer the drilled holes, drill and fix the corner bracket on the corners of body by rivet and finish the body of the truck box as shown in Fig 20.

Fix Triple Beaded Stretchers to Body

- Transfer the drilled holes by placing the triple beaded stretcher at a distance of 50 mm from the inside corners on both sides of body Part 1A drill and fix by riveting as shown in Fig 21.

Fig 19

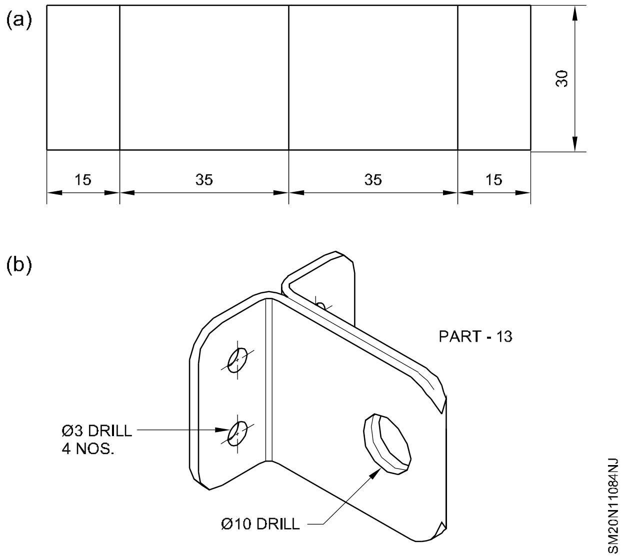


Fig 20

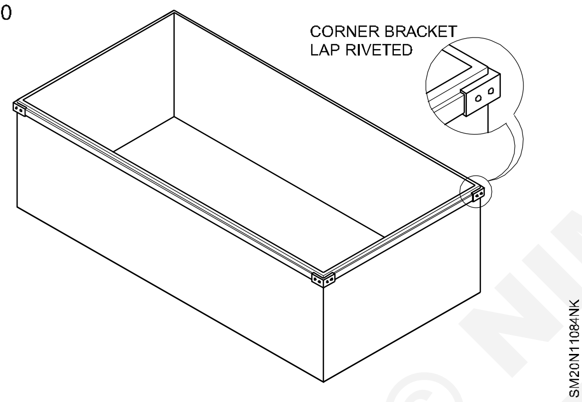
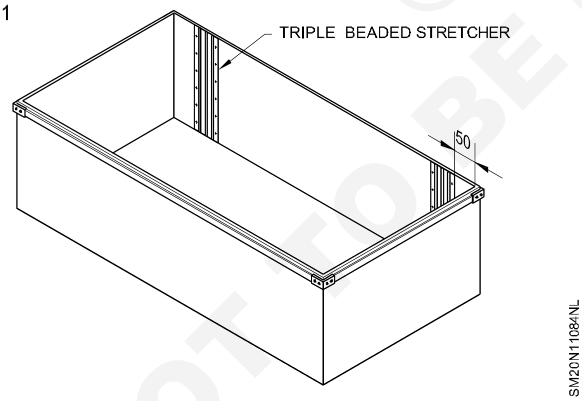


Fig 21



Fix hat section channels (Base of the body) to body

- Transfer the drilled holes by placing the hat section channel on the base of body of the trunk box at a distance of 50 mm from the edge, on both ends, drill and fix by riveting as shown in Fig 22.

Fix side handles to body

- Cover the open ended portion of the side handle by inserting the handle plate upto 'U' groove as shown in cover (Fig 23a)

Fig 22

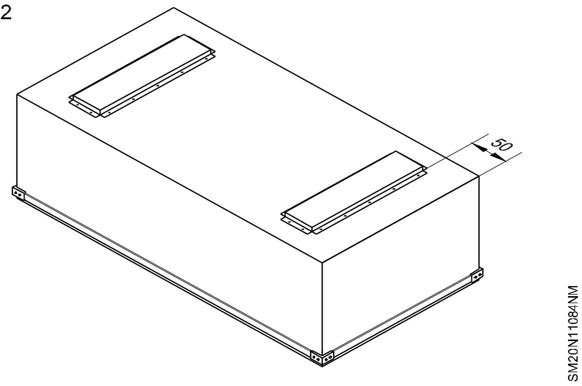
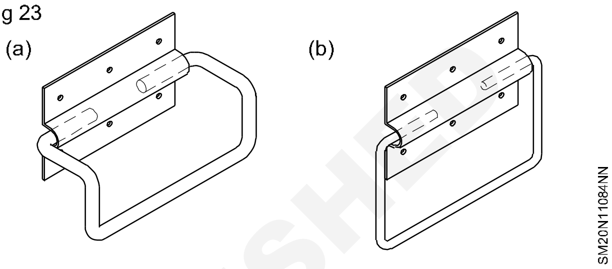
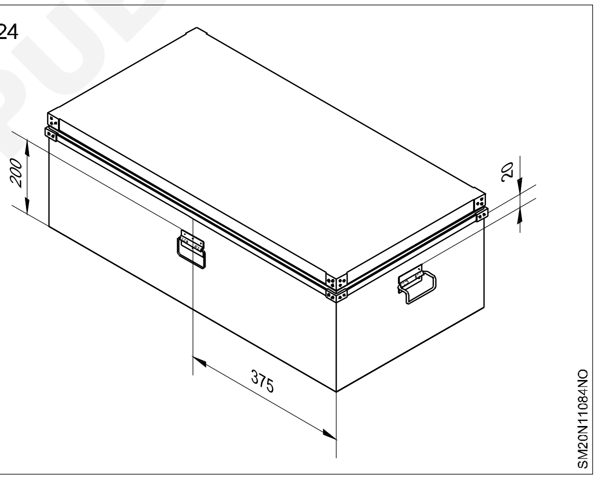


Fig 23



- Fix the handle by placing the handle cover plate 20 mm below to joggle and centre to side of body on part 1B by rivet. (Fig 24) Check its movement.

Fig 24



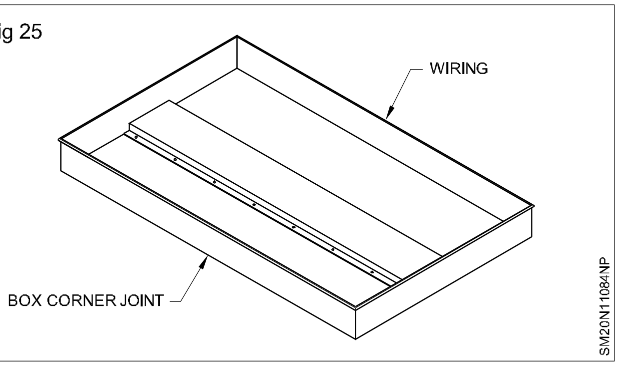
Fix front handle to body

- Cover the open ended portion of the front handle with handle cover plate as done previously (Fig 23b) Fix the handle with cover plate on the centre of front side of trunk brox body part 1A by rivet as shown in Fig 24 and check its movement.

Fix hat section channel (Lid) to lid

- Place the channel inside of the lid centre and transfer the drilled holes.
- Make the drill holes on transferred drill mark. Rivet the hat section channel inside of the lid as shown in Fig 25.

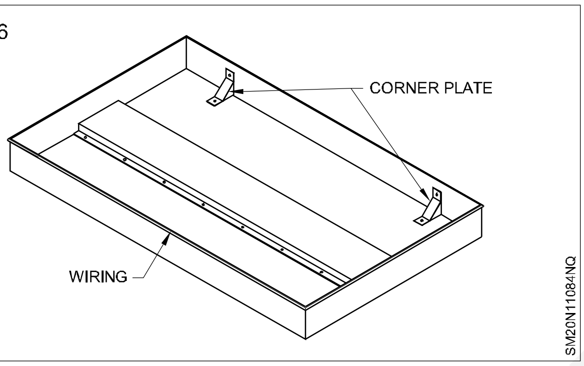
Fig 25



Fix side clamps to lid

- Place the side clamp inside of the trunk box lid Part 2A on both sides at a distance of 100mm from the corner and join with rivet and finish the trunk box lid as shown in Fig 26.

Fig 26



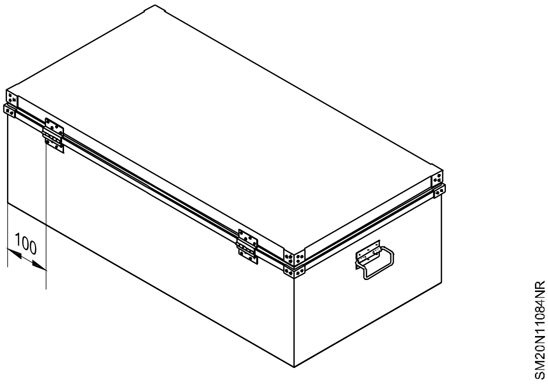
Fix hinges to body and lid

- Place the lid over the body of trunk box and fix the hinge at a distance of 100 mm from both ends of the trunk box by riveting. (Fig 27) Finish and check the lid movement of trunk box.

Fix pad lock top to the lid and pad lock bottom to the body

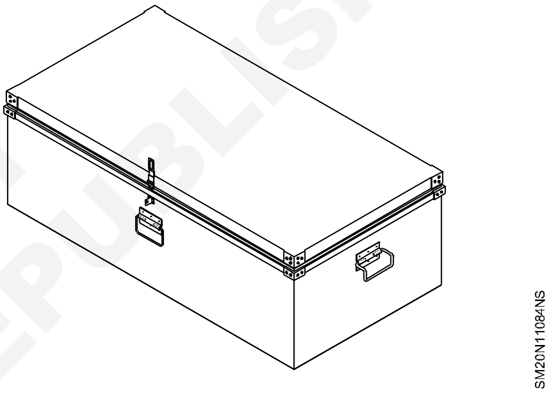
- Place the pad lock top on wired edge and centre to the lid of the front side and join with rivet. (Fig 28) (Ensure that the wiring of pad lock top is on outside while placing it on the lid before riveting)

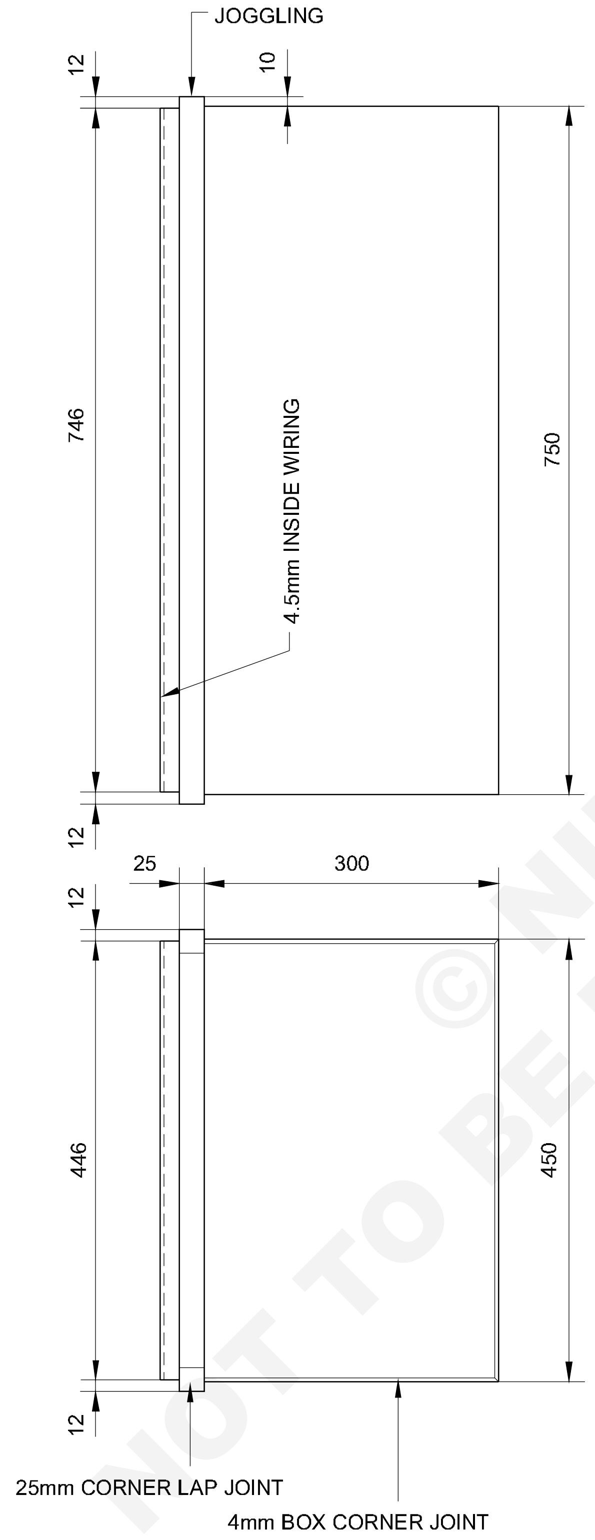
Fig 27

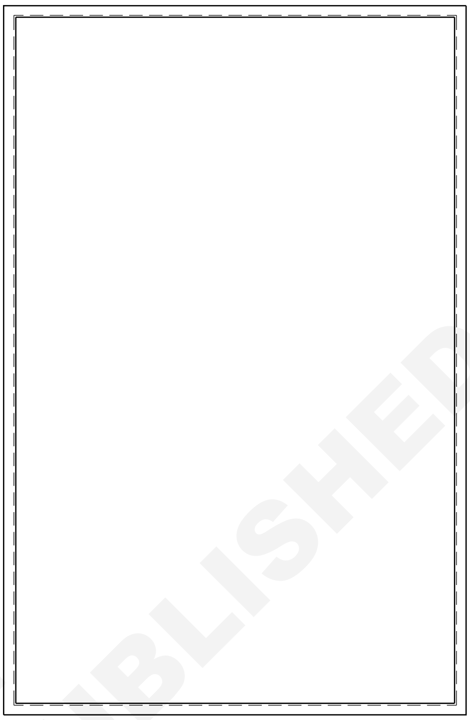


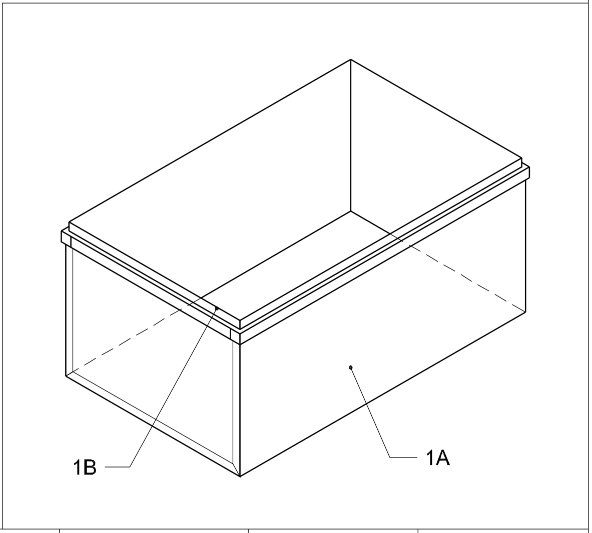
- Insert the pad lock bottom into slot hole and place it on the trunk box body and transfer the holes. Drill and join the pad lock bottom by riveting with trunk box body. (Fig 28)
- Paint the trunk box with decorative colour by spray painting for good appearance.

Fig 28



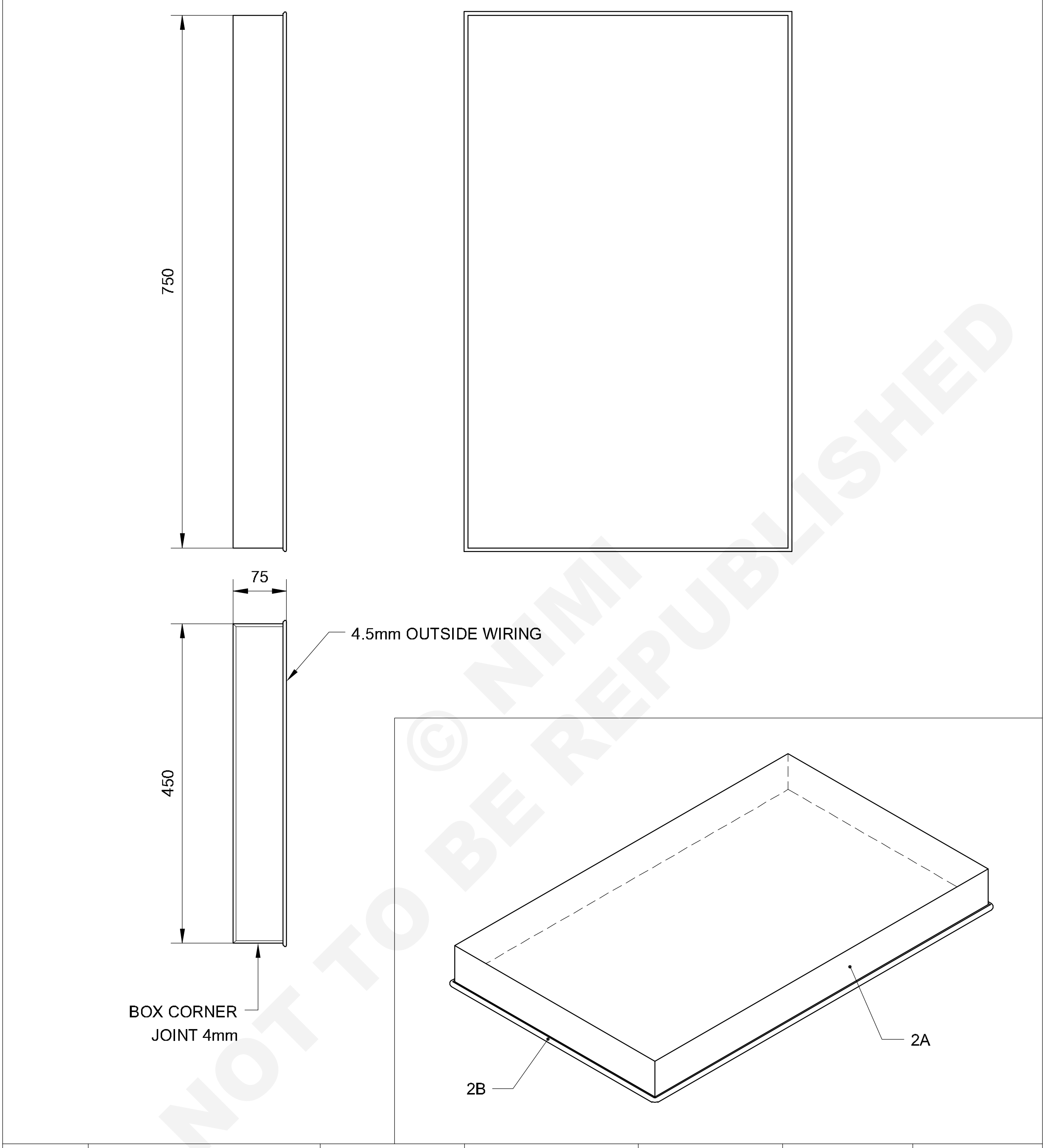






1	Fe - Ø4.5 - 2400	–	G.I. WIRE	18	1B	84
1	ISSH 1820 x 0.61 - 780	–	G.I. SHEET	18	1A	84
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PROJECT: TRUNK BOX	DEVIATIONS ±2	TIME h
	PART: **BODY, 1A & 1B**	CODE NO. SM20N11084E6	



1	Fe - Ø4.5 - 2400	–	G.I. WIRE	18	2B	84
1	ISSH 880 x 0.61 - 640	–	G.I. SHEET	18	2A	84
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS

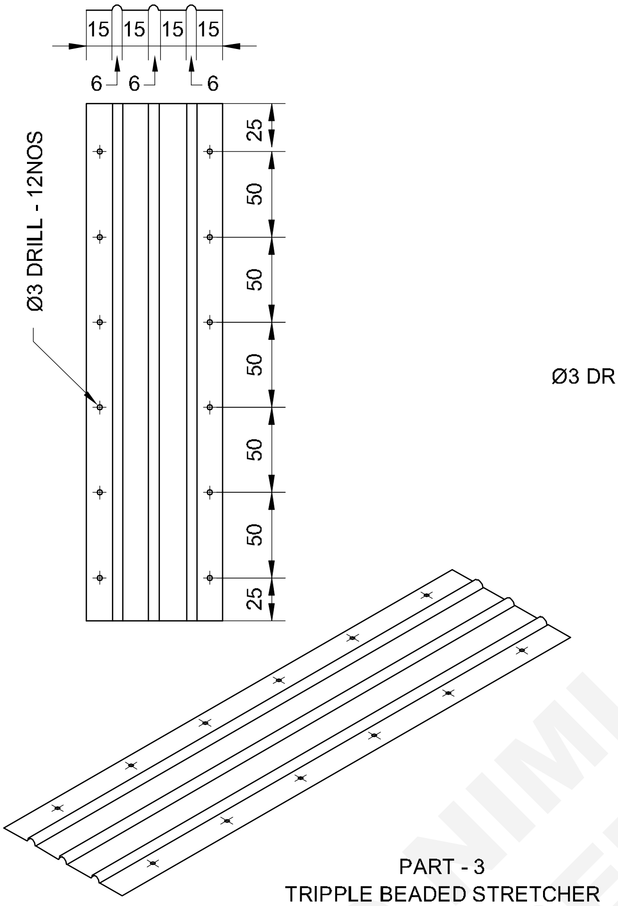
PROJECT: TRUNK BOX

PART: **LID, 2A & 2B**

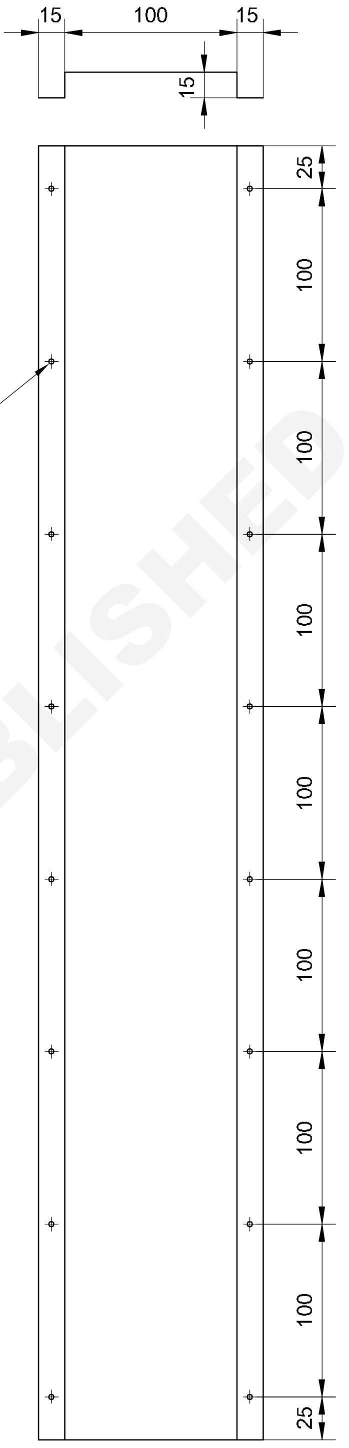
DEVIATIONS ±2

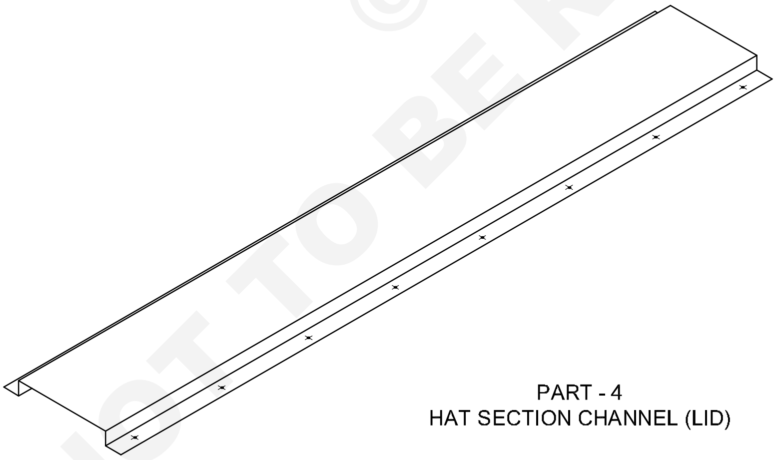
TIME h

CODE NO. SM20N11084E7



PART - 3
TRIPPLE BEADED STRETCHER





PART - 4
HAT SECTION CHANNEL (LID)

1	ISSH 760 - 1.2 - 170	–	G.I. SHEET	18	4	–
4	ISSH 310 - 1.2 - 100	–	G.I. SHEET	18	3	84
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS

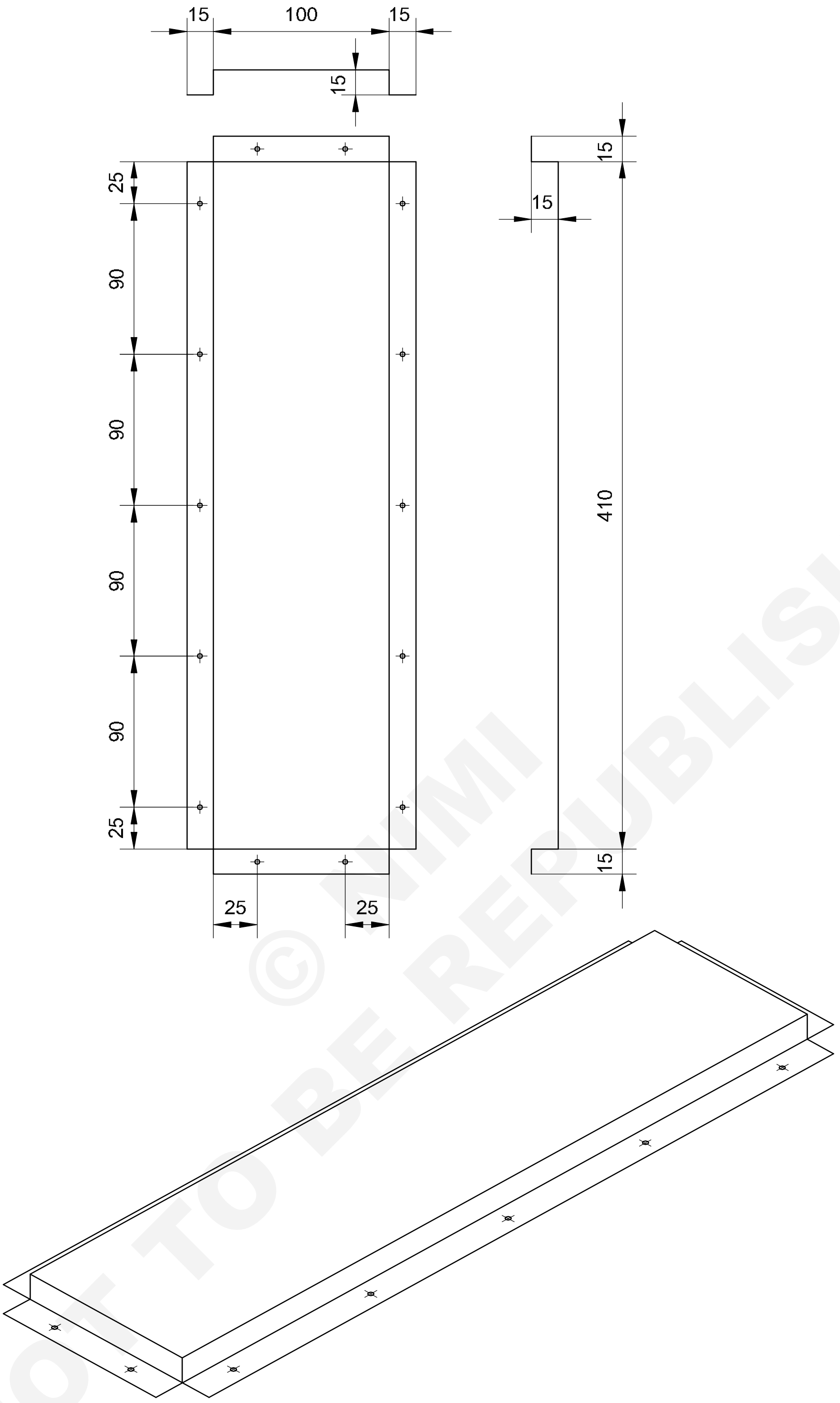
PROJECT: TRUNK BOX

PART: **3. TRIPPLE BEADED STRETCHER**
4. HAT SECTION CHANNEL (LID)

DEVIATIONS ±2

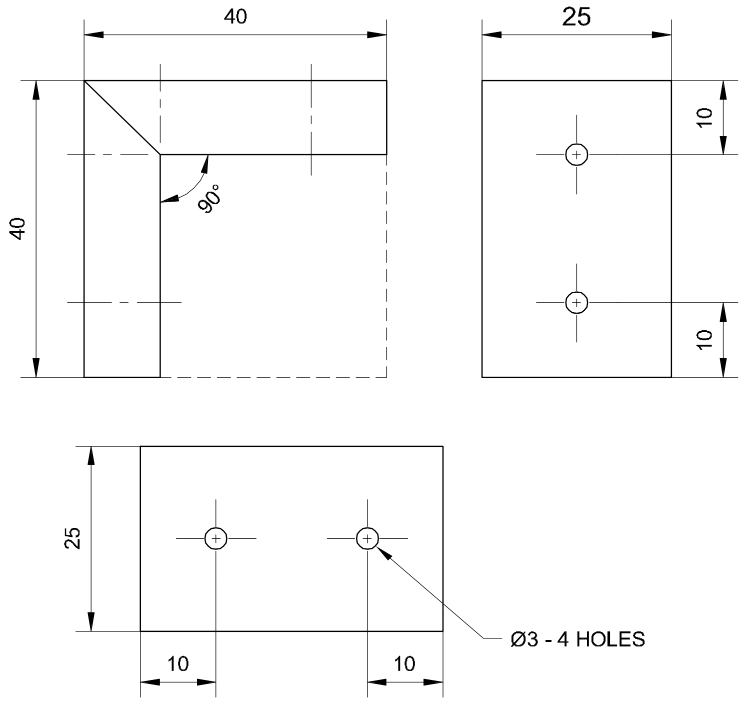
TIME h

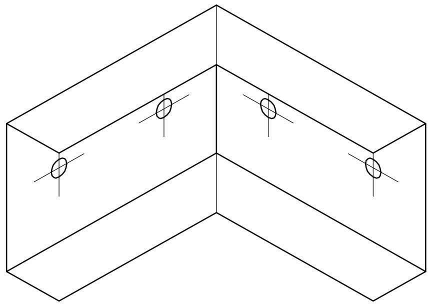
CODE NO. SM20N11084E8



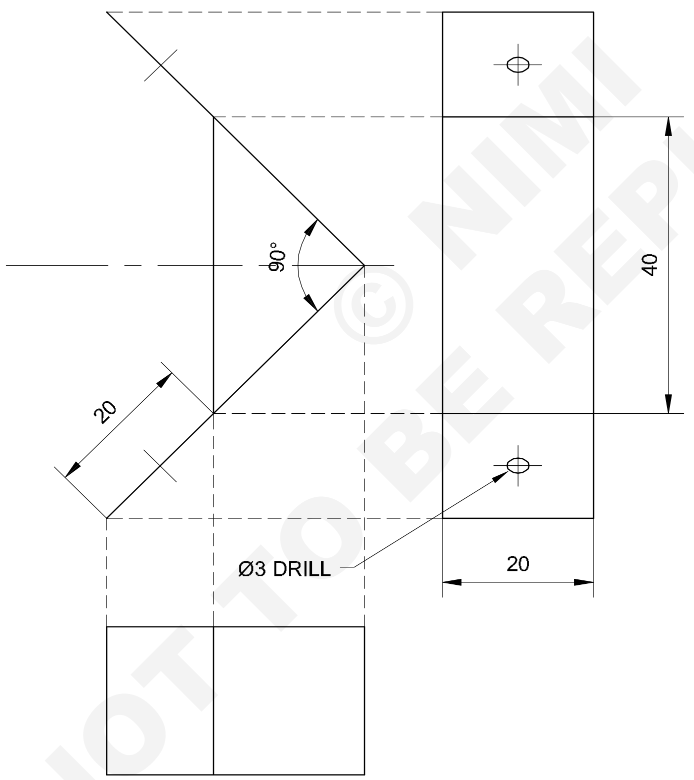
2	ISSH 480 - 1.2 - 170	–	G.I. SHEET	18	5	84
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

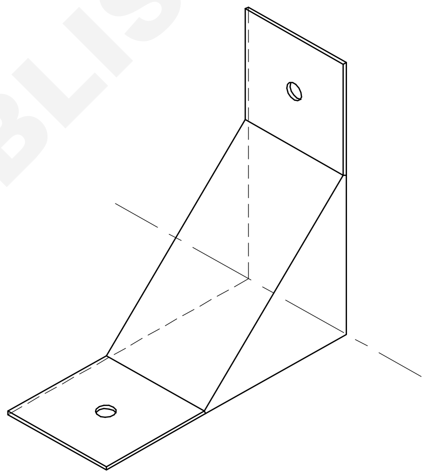
SCALE NTS	PROJECT: **TRUNK BOX** PART: **HAT SECTION CHANNEL (BASE OF THE BODY)**	DEVIATIONS ±2	TIME
		CODE NO. SM20N11084E9	





PART - 6, CORNER BRACKET





PART - 7, SIDE CLAMP

4	ISSH 110 x 0.61 - 95	–	G.I. SHEET	18	7	84
4	ISSH 55 x 0.61 - 95	–	G.I. SHEET	18	6	84
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1

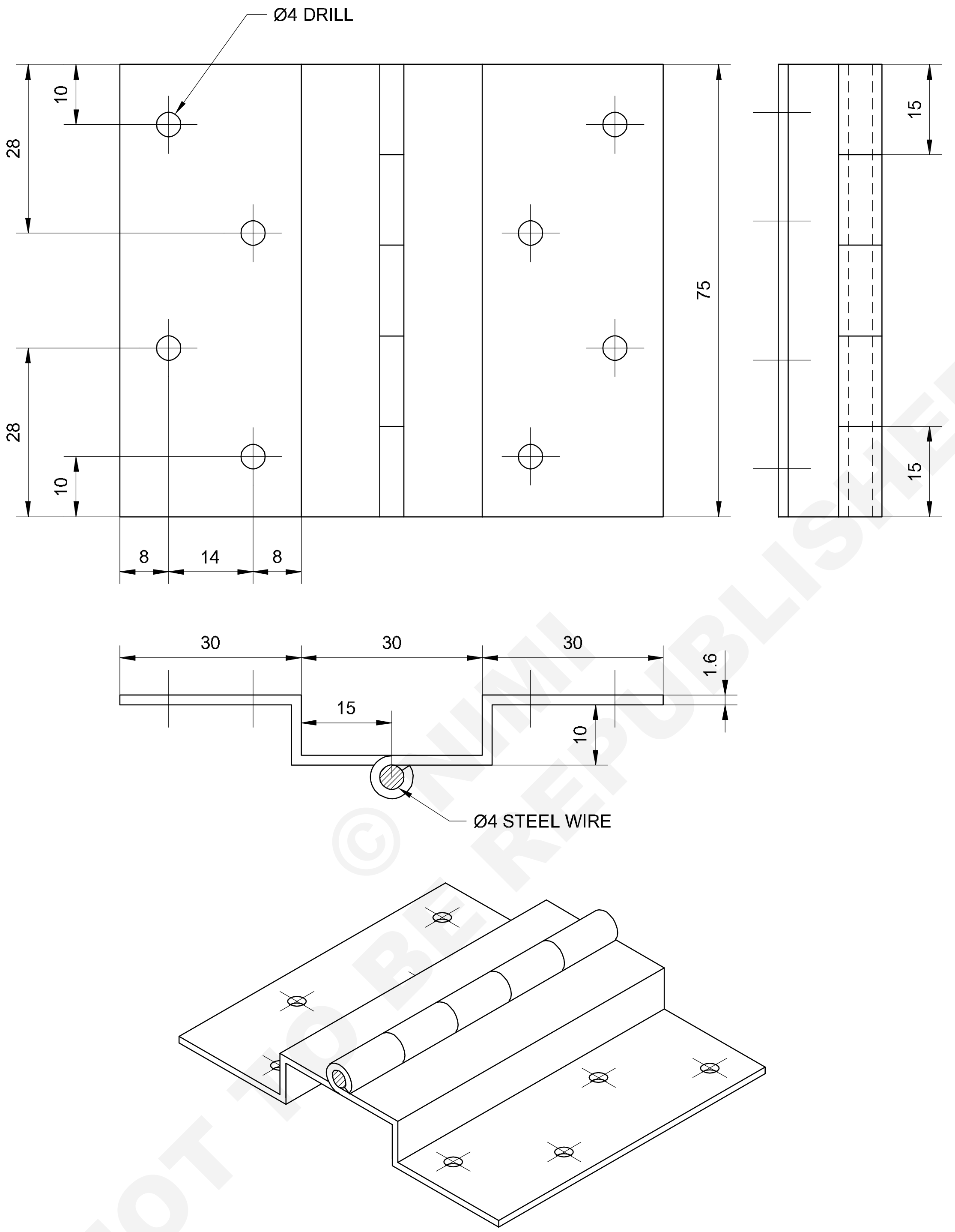
PROJECT: TRUNK BOX

PART: **6. CORNER BRACKET**
7. SIDE CLAMP

DEVIATIONS ±1

TIME h

CODE NO. SM20N11084EA



2	Fe - Ø4 - 85	–	M.S. ROD	18	8	84
2	ISSH 85 x 1.6 - 75	–	M.S. SHEET	18	8	84
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1

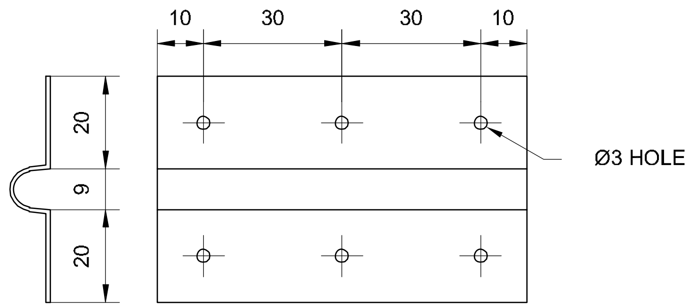
PROJECT: TRUNK BOX

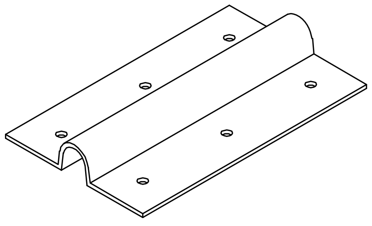
PART: **HINGE**

DEVIATIONS ±1

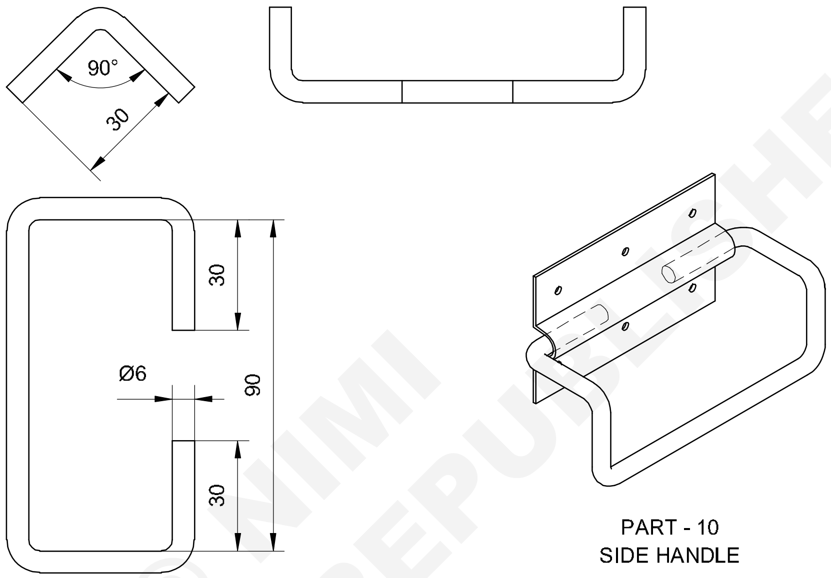
TIME h

CODE NO. SM20N11084EB

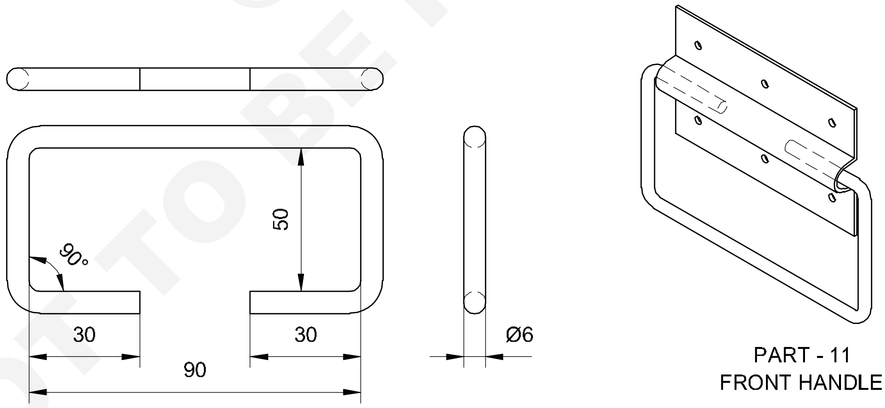




PART - 9
HANDLE COVER PLATE



PART - 10
SIDE HANDLE



PART - 11
FRONT HANDLE

1	Fe - Ø6 - 270	–	M.S. WIRE	18	11	84
2	Fe - Ø6 - 300	–	M.S. WIRE	18	10	84
3	ISSH 90 x 1.2 - 65	–	M.S. SHEET	18	9	84
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS

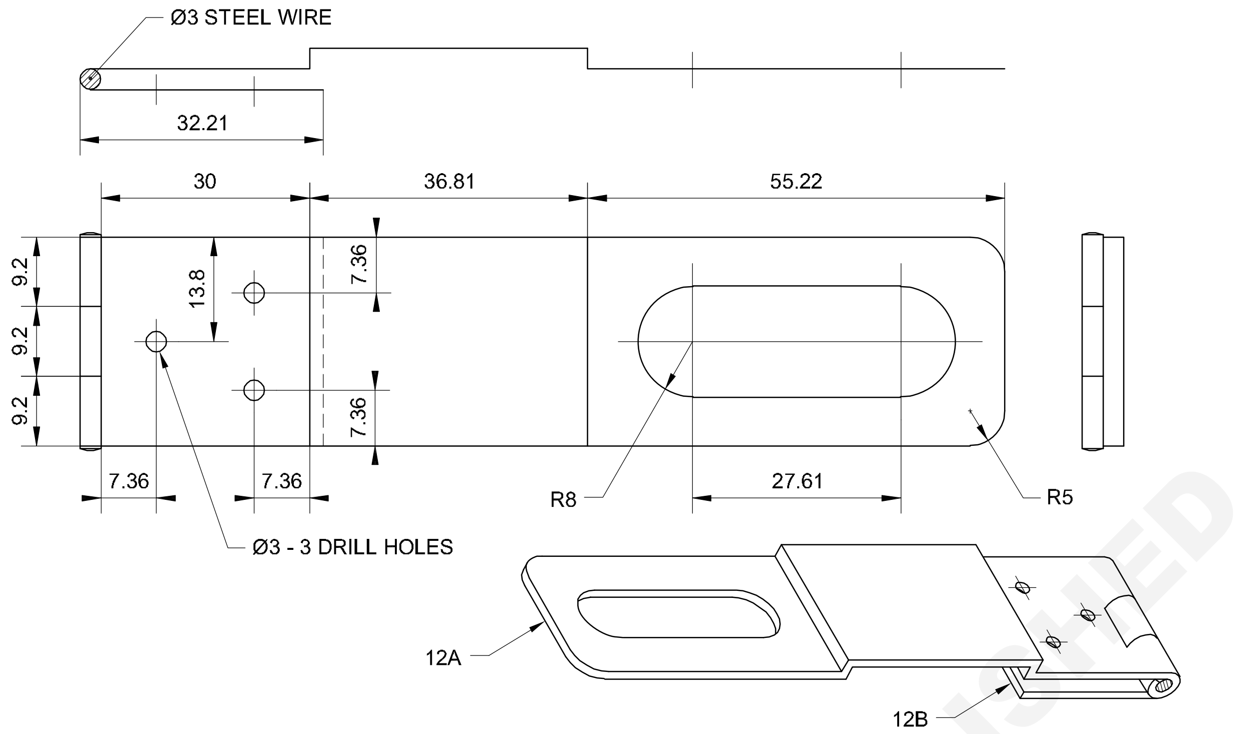
PROJECT: TRUNK BOX

PART: **9. HANDLE COVER PLATE**
10. SIDE HANDLE **11. FRONT HANDLE**

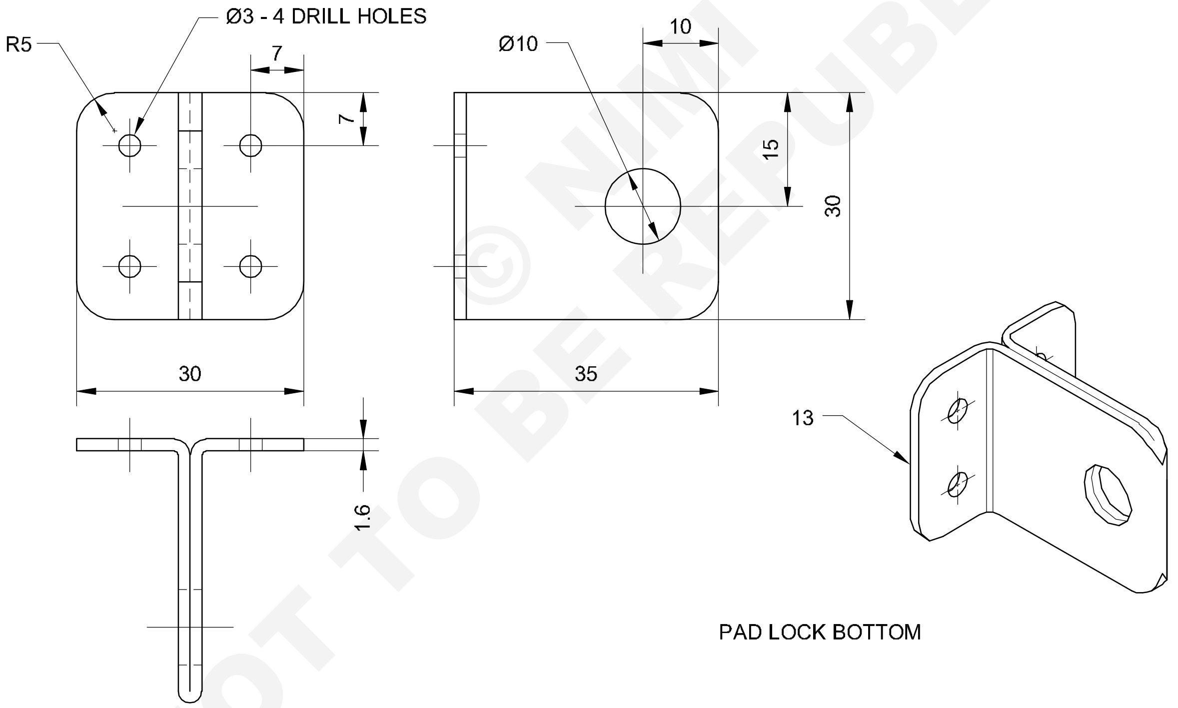
DEVIATIONS ±1

TIME h

CODE NO. SM20N11084EC



PAD LOCK TOP



PAD LOCK BOTTOM

1	ISSH 1100 x 35 - 1.6	–	M.S SHEET	18	13	84
1	Fe Ø 3.5 - 40	–	M.S WIRE	18	12	84
1	ISSH 200 x 35 - 1.6	–	M.S SHEET	18	12	84
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1

PROJECT: TRUNK BOX (ASSEMBLY)
PART: **12. PAD LOCK TOP**
PART: **13. PAD LOCK BOTTOM**

DEVIATIONS ±

TIME h

CODE NO. SM20N11084ED

Skill sequence

Preparation hinges with free movement by hand process.

Objective : This shall help you to

- **to make hinges with free movement by hand process.**

Preparation hinge

Mark out wire edge and tabs allowance as in Fig 1.

For better illustration let us take the following dimensions.

X = $2\frac{1}{2}$ d = 4 x 2.5 = 10 mm

XX = 45 mm

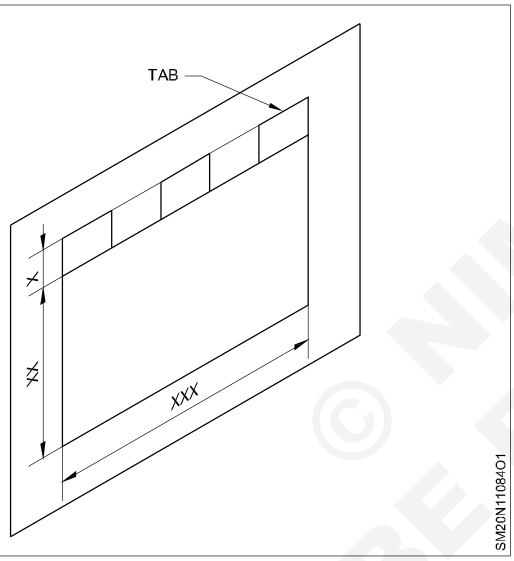
XXX = 75 mm

Tab width = 15 mm

d = diameter of wire 4 mm

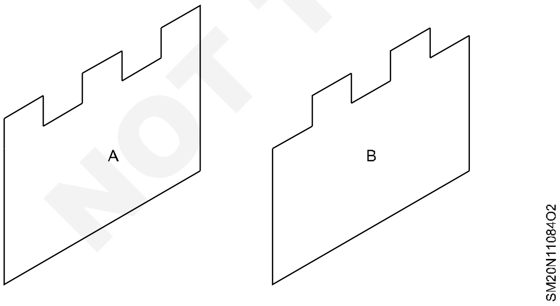
Use fixed marking gauge, steel rule, try square and scriber.

Fig 1



Cut unwanted material along the outer line, form taps by slitting, using bench lever shears. Cut off unwanted taps using chisel and hammer and deburr the cut area. (Fig 2)

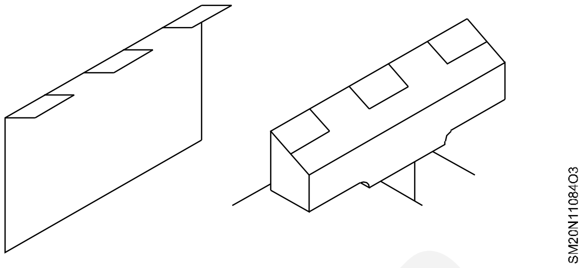
Fig 2



Bend sheet 'A' to right angle along the scribed line on the benchvice. Then fold down to sharp angle using hatched stake and hammer. (Fig 3)

Take 90 mm long 4 mmϕ wire and deburr the ends.

Fig 3



Place the wire as in Fig 4 and tap over the edge by keeping the sheet on the anvil stake. (Fig 5)

Fig 4

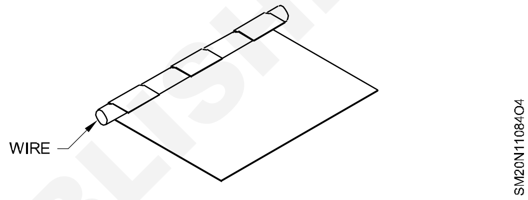
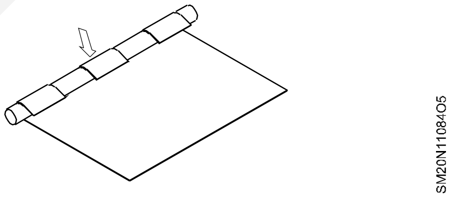


Fig 5



If the edge is too narrow after tapping, give below in the direction, indicated in Fig 6. If the edge is too wide give blows in the direction. Indicated in Fig 7, 8 & 9.

Fig 6

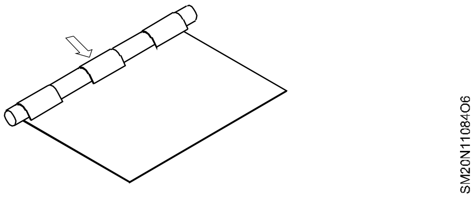


Fig 7

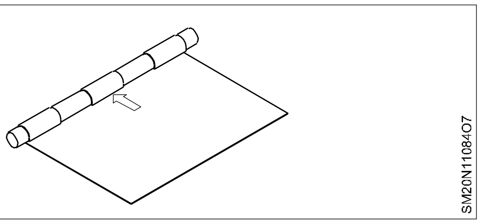


Fig 8

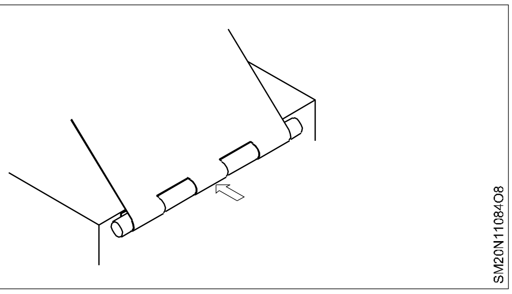
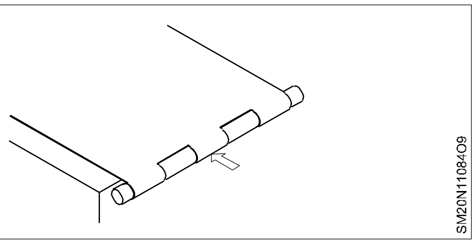
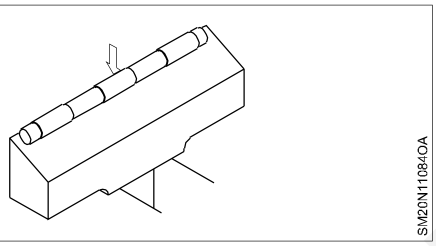


Fig 9



Finish the wired edge step by step by giving blows in the direction, indicated by arrow as shown in Fig 10. First two steps should be done on the edge of the anvil stake and final step on the hatchet stake.

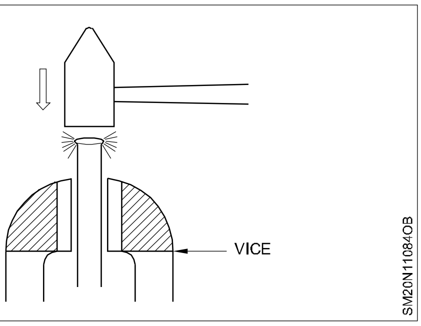
Fig 10



Remove the wire from the wired edge. Take sheet 'B' and make wired edge as is done for 'A' and remove the wire.

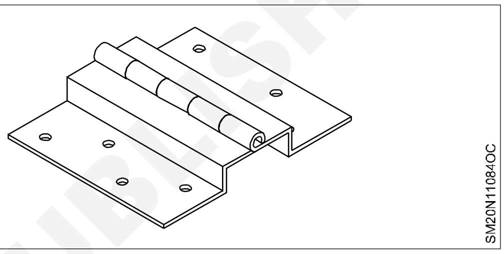
Hold ϕ 4 mm wire on the benchvice and form, snap on one end by hammer as shown in Fig 11.

Fig 11



Place two wired edges opposite to one another (if the wired edge is not meshed with one another, file the edge by flat file gently and mesh it) and insert the snap formed wire and form snap on the other end and finish the hinge. (Fig 12)

Fig 12



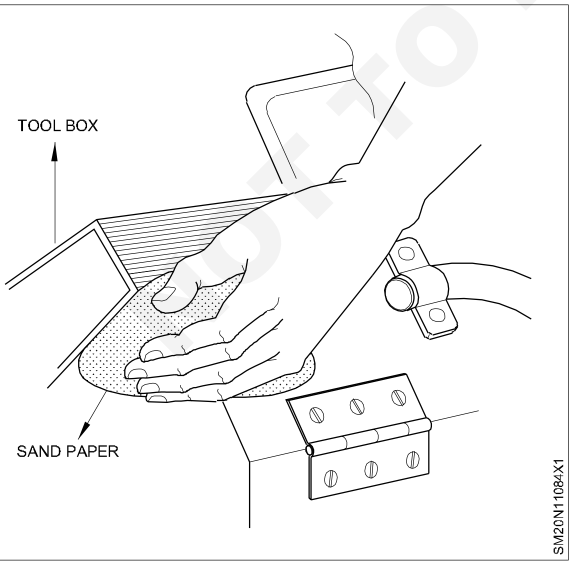
Preparing the surfaces for painting

Objective : This shall help you to

- **prepare the surface for painting, making the surface uniform, free of dents, ridge etc by hand process.**

Remove dust and dirt with cloth. Remove coarse rust with wire brush and rub with fine emery paper on the bare metal to remove fine rust or corrosion. (Fig 1)

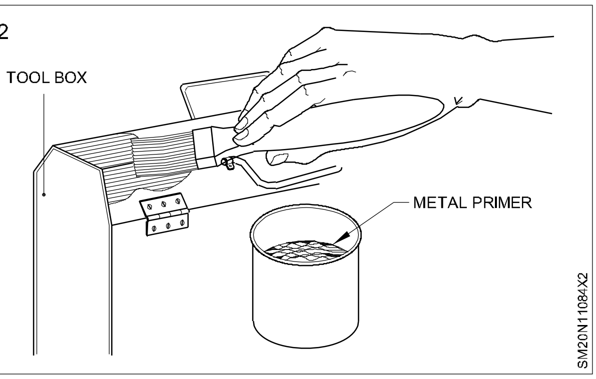
Fig 1



Wash the metal article with caustic soda and hot water to make it free from oil and grease. Sometimes white spirit is used as solvent to remove oil, grease on the surface to be painted. Wipe the surface dry with a clean cloth.

Apply metal primer as undercoat before painting over the surfaces by brush. (Fig 2)

Fig 2



After the metal primer get dried, apply metal putty on the surface.

After the putty gets dried, rub it with emery paper to make the surface uniform, removing all surface defects like dents, ridges etc. Now once again apply 2nd layer of metal primer and allow it to dry.

Painting sheet metal article with brush

Objectives : This shall help you to

- **paint the sheet metal article with uniform layer using brush for surface protection and good appearance.**

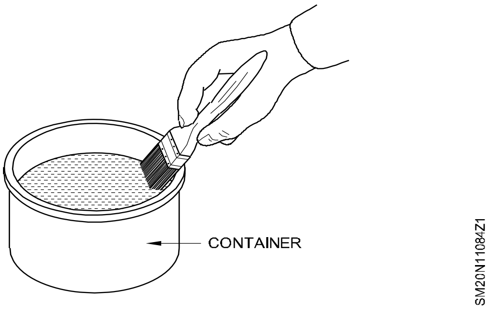
Select the required shade of paint.

Shake the Paint Tin thoroughly before opening the lid.

Add thinner to paint in a proper proportion and mix it uniformly in a container or use custom mixed paint available (readymade) in the container.

Dip the tip of the brush in the container, to pick up small quantity of the paint. (Fig1)

Fig 1



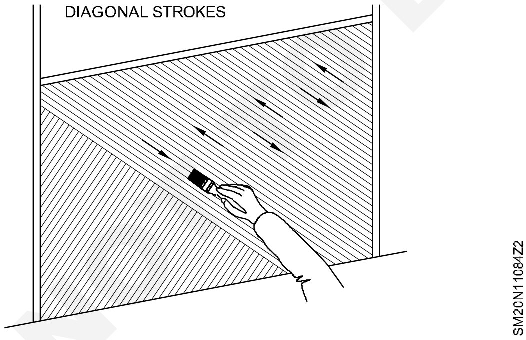
Start painting the undercoat at the top corner when the surface is vertical.

If the surface is horizontal, hold the brush straight and paint diagonally in the shortest possible time. (Fig 2)

Finish the whole surface before changing the direction of the brush stroke.

Now paint using diagonal strokes at right angles over the first stroke. Diagonal strokes helps to completethe painting in a shortest possible time. (Fig 2) Spread out the paint away from the places where the layer is thick to the places where the layer is thin.

Fig 2



Identify the thick layer when the brush glides easily over it. But when the brush drags, it is thin layer. By this way, apply uniform layer of undercoat.

Now brush the paint horizontally to prepare for laying off. (Fig 3)

Now remove any excess paint from the brush. See that the brush remains wet.

Now lay off the paint by brushing slightly downward. (Fig 4)

Fig 3

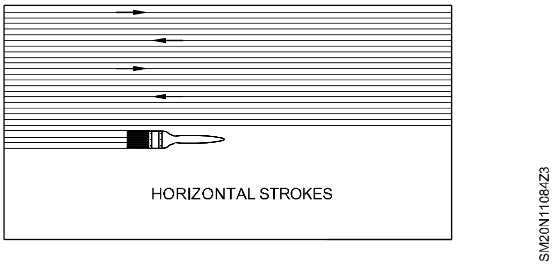
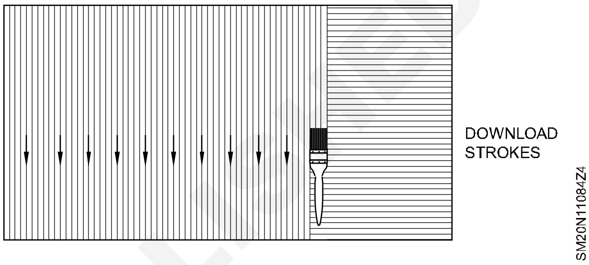


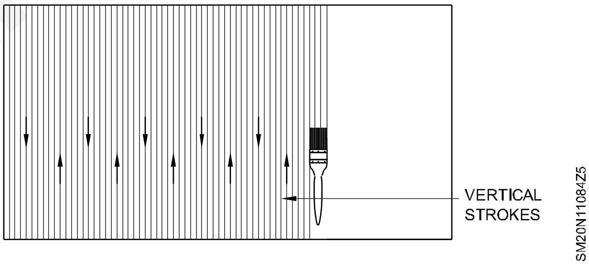
Fig 4



Here the application of undercoat is over.

Now apply the final coat quickly in vertical band. (Fig 5)

Fig 5



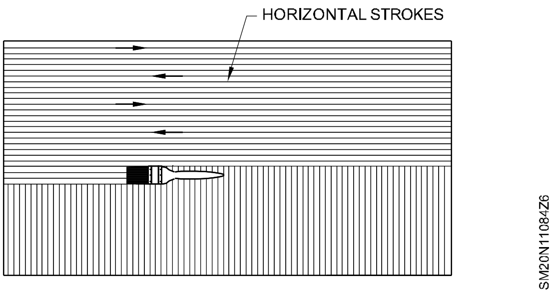
After that, apply the brush horizontally to spread the paint uniformly.

If the paint does not dry too quickly further vertical and

horizontal brushing must be carried out.

Keep in mind, that always finish the surfaces with a horizontal brushing. (Fig 6)

Fig 6

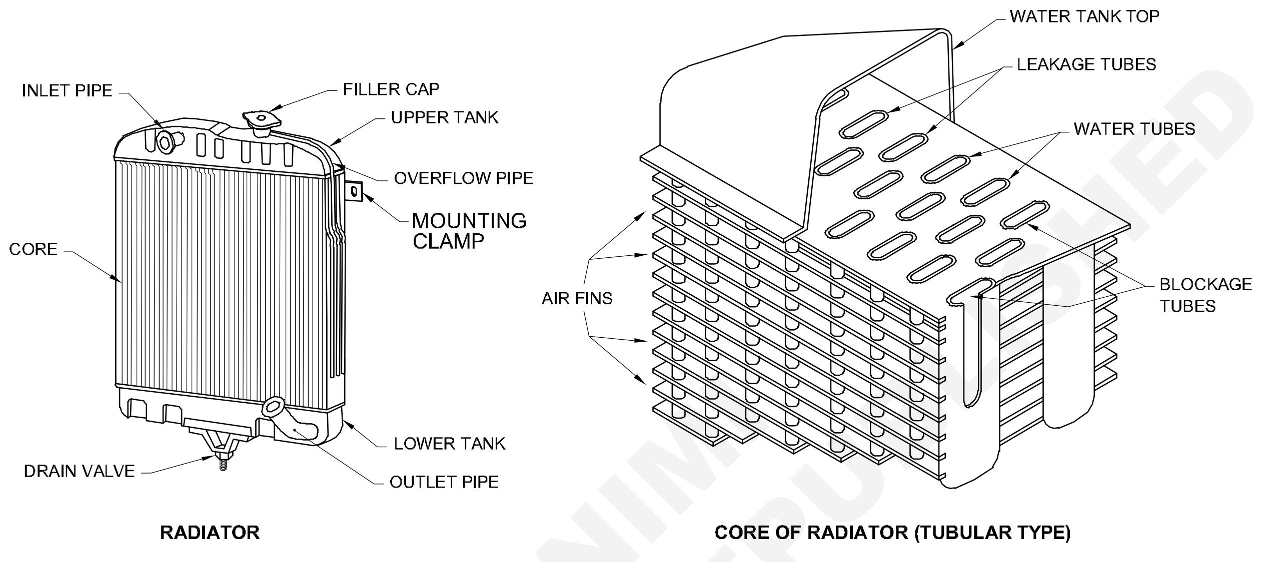


While applying final coat of paint remove the excess paint from the bruss to avoil the paint running off the edge and the surface.

Repairingthe defective radiator

Objectives : At the end of this exercise you shall be able to
- **identify the defects in the radiator**
- **dismantle the parts of the radiator**
- **rectify the defects of the radiator**
- **assemble and check the radiator after reapairing.**

Fig 1



RADIATOR

CORE OF RADIATOR (TUBULAR TYPE)

Job Sequence

- Inspect the radiator and identify the defect whether it is leakage or blockage of tubes or both.

  (a) Rectifying leakage of tubes: If the leakage is identified in tubes, dismantle the top & bottom tanks and plug the tubes at both ends by soldering.

  (b)Rectifying blockage of tubes: Dismantle the top and bottom tanks of the radiator. Check each tube by filling water from the top and observe whether water comes out from the bottom. If water is not coming out, identify the tube as blocked tube.

Clean the tube by passing flexible steel strip or wire through the tube and rotating it till the tube gets cleared.

- Reassemble the parts by soldering.
- Check the radiator after repairing.

Skill sequence

Repairs of defective radiators

Objectives : This shall help you to
- **rectifying the leakages of tubes**
- **rectifying the blockages of tubes**

a) Rectifying the leakages of tubes (Fig 1)

To identify the defects of leakage in a radiator.

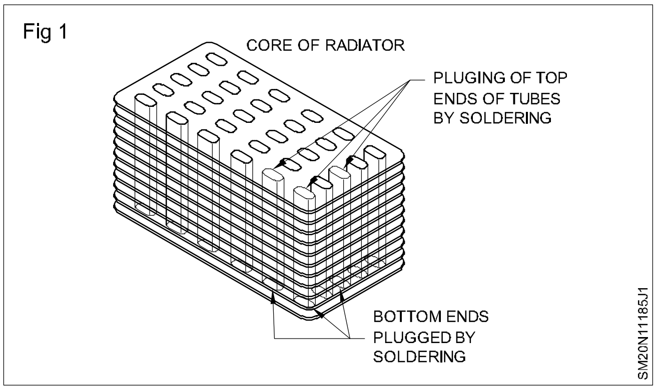
Close the drain valve, water inlet pipe, water outlet pipe, and overflow pipe.

Fill water through the radiator filler cap.

Slightly apply air pressure inside the radiator.

Inspect the leakage from the tubes visually, and mark them for identification using chalk.

Fig 1



Generally, the tubes at outer rows get damaged causing leakages. Inner tubes get leaked rarely.

After the identification of leakage, dismantle the upper tank, core and lower tank by fusing the solder using blow lamp flame.

Plug the leaking tubes at both ends by soldering.

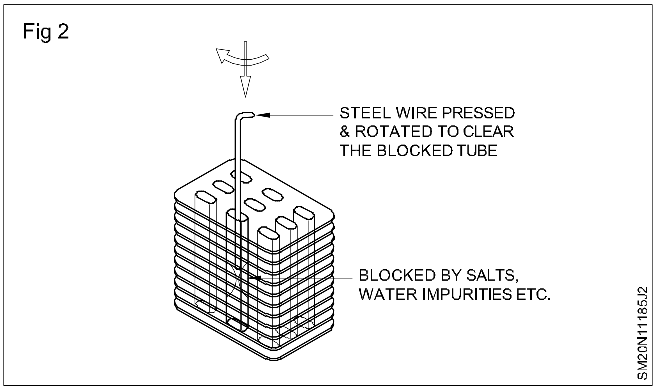
After pluging the leaked tubes, reassemble all the parts of the radiator by soldering.

b) Rectifying the blockage of tubes (Fig 2)

Sometimes there are no leakages but the water in the radiator boils very soon. This happens only when the tubes get blocked by salts, water impurities, chemicals etc.

To rectify the blockage of tubes,

Fig 2



Dismantle the upper tank, core and lower tank by fusing the solder using blow lamp flame.

Now check each tube whether it is clear or blocked by passing water through the tube from top and observing whether water is coming out from the bottom. By this method, identify the blocked tubes.

Clean the blocked tubes by first filling the tube with water and applying compressed air with pressure. Continue this for sometime and observe whether the tube gets cleared from blocking materials.

If the tube does not get cleared, insert the flexible steel wire or strip into the blocked tubes and clean it.

After rectifying the blockage, reassemble the parts of the radiator by soldering.

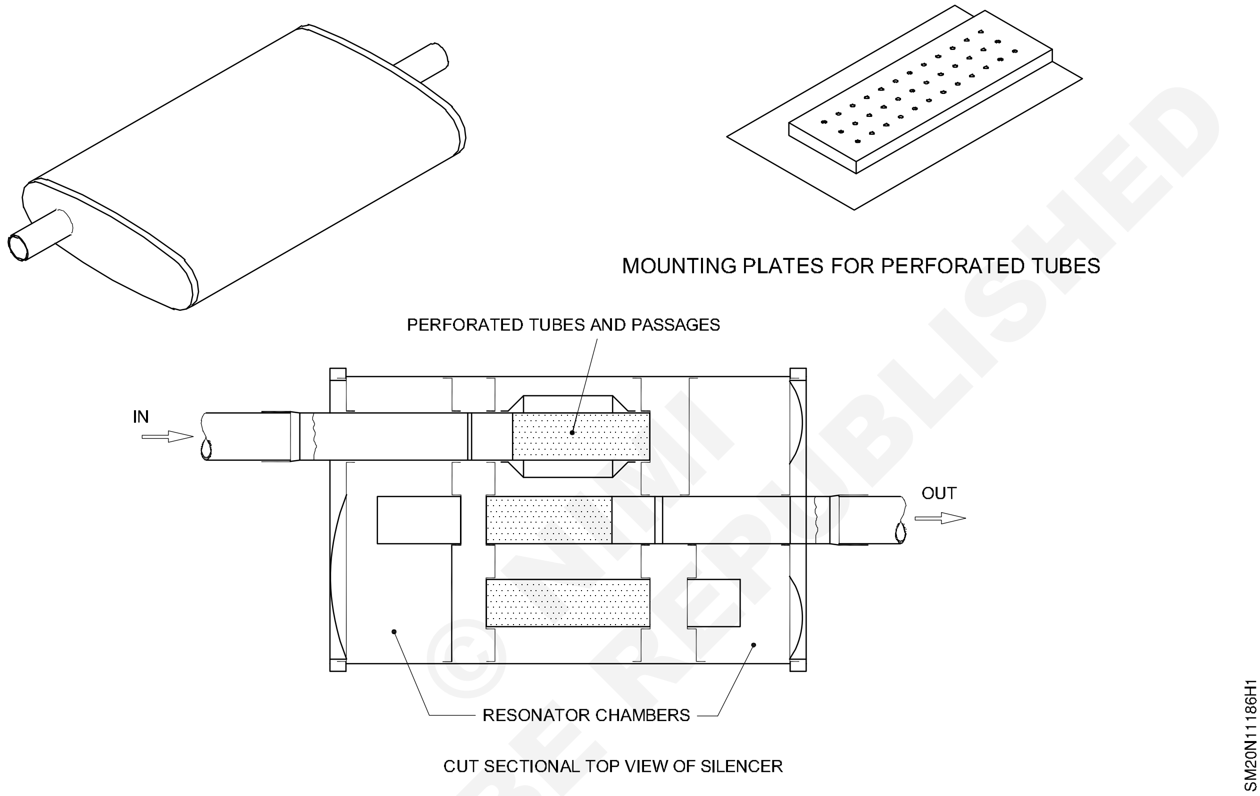
Capital Goods & Manufacturing
Sheet Metal Worker- Mudguard and Radiator

Exercise 1.11.86

Repairing blocked silencer and fuel tank

Objectives : At the end of this exercise you shall be able to
- **cut the blocked silencer**
- **turn the soots and oil slurry in the perforated tubes**
- **assemble the path and weld the joints by gas.**

Fig 1



MOUNTING PLATES FOR PERFORATED TUBES

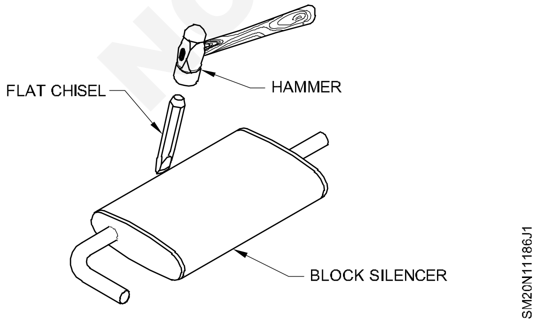
CUT SECTIONAL TOP VIEW OF SILENCER

Job sequence

Dismantle the silencer from the vehicle. (Scooter)

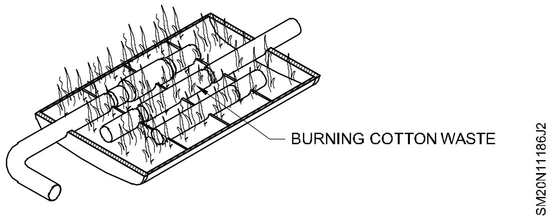
Cut and open the silencer into equal halves along the welded joint using a flat chisel and a suitable hammer. (Fig 1)

Fig 1



Soak a little cotton waste in kerosene and put it into the open parts and burn it. (Fig 2)

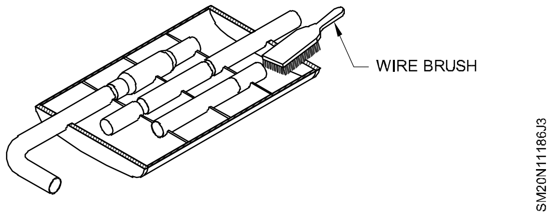
Fig 2



This will burn off the oil deposits inside the silencer.

Clean the burnt cotton waste residues with the help of a wire brush. (Fig 3)

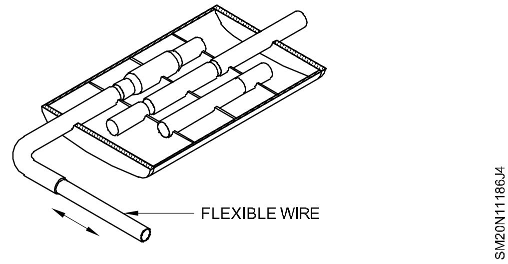
Fig 3



This will remove the dust and carbon particles accumulated inside the silencer.

Choose a suitable flexible wire, insert it into the bent portion of the inlet pipe to clean the dust and carbon particles collected inside the pipe. (Fig 4)

Fig 4



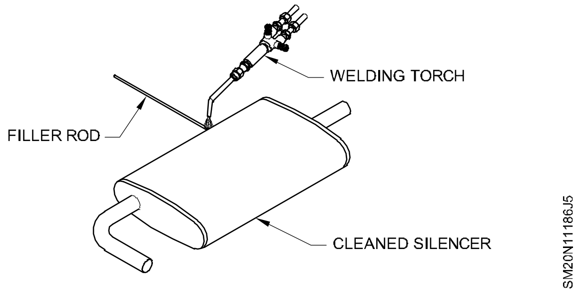
Remove the dust holding the silencer by hand and shake off the silencer until the dust are fallen out.

Check for any holes or leakages on both the inlet and outlet pipes by poring water in it.

Rectify by welding, if any holes or leakages are present.

Clean the inner side of the silencer thoroughly. Assemble it in position and gas weld it to correct shape. (Fig 5)

Fig 5



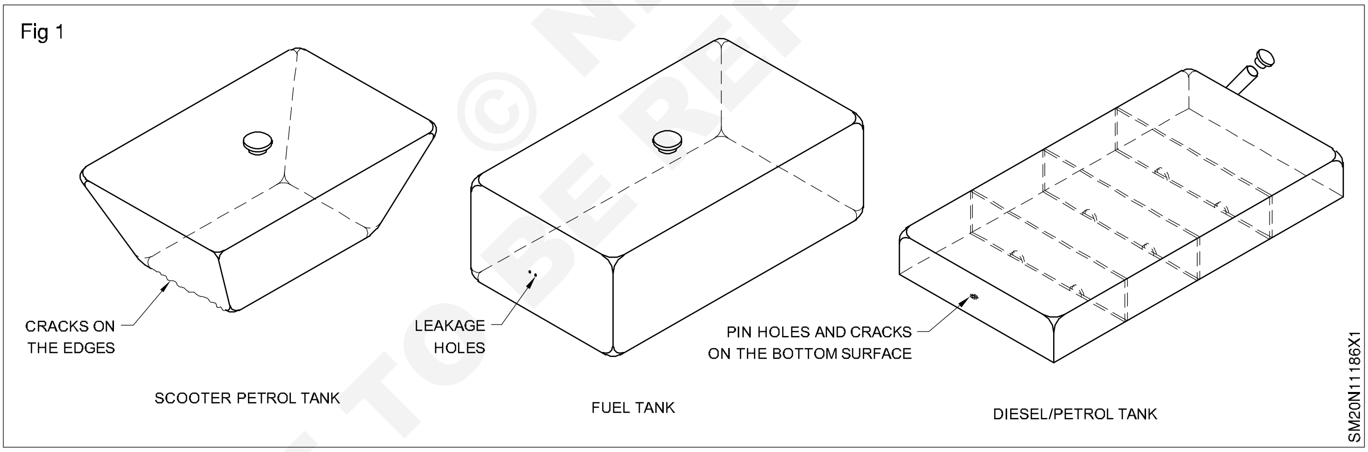
Cool the silencer and clean it.

Wire brush or Emery sheet should not be used on absorber type silencer, as this will spoil and remove the packing material.

Rectifying the leakage of fuel tank

Objectives : At the end of this exercise you shall be able to
- **rectify the leakages of the fuel tank by sweating**
- **rectify the leakages of the fuel tank by gas welding.**

Fig 1



Job sequence

1 Rectifying by sweating

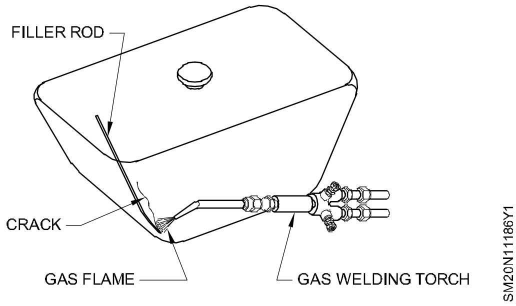
- Remove the fuel from the fuel tank.
- Ensure that the fuel tank is completely empty.
- Store the fuel away from the work area at a safe place preventing it from heat and fire.

Remember that the fuel like petrol is highly imflammable and a volatile substance.

- Clean the fuel tank from inside with a cotton cloth and make it completely dry.

  If it is a petrol tank, wash the tank with water, mixed with caustic soda and clean with cotton cloth, ensuring that the tank is completely free from petrol.
- Fill water into the empty tank.
- Check and identify the leakage spot visually.
- Mark the leakage spot using a chalkpiece.
- Remove the water from the tank and make it dry.
- Clean the leakage spot area using a smooth emery paper.
  - a) If the leakage is observed from a hole or few holes at a smaller area, gas weld the leakage area using a hand torch and filler rods.
  - b) If the leakage is observed from a crack at the corner edges, gas weld along the crack. (Fig 1)

Fig 1



c) If the leakage is observed from a larger surface area having pin holes and cracks on it, rectify the leakages on the surface by sweating. (Fig 2 & 3)

Fig 2

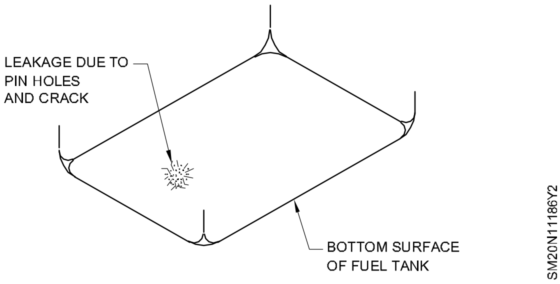
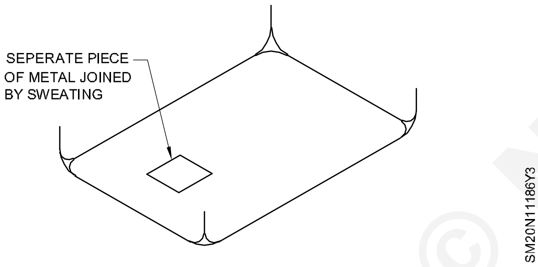


Fig 3



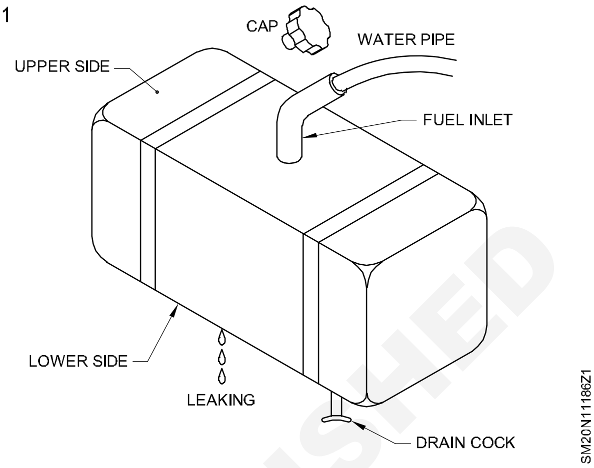
Do not close the mouth of the fuel tank, till the work is completed. Otherwise the fumes of gas welding will be trapped inside the fuel tank and may cause explosion.

- After the surface gets cooled, finish the welded/ sweatened area using a smooth emery paper.
- Fill water into the tank and apply compressed air into it and ensure that the leakage is stopped.
- If not, rectify the leakage.
- Remove the water from the fuel tank and clean it with a cloth.
- Position the fuel tank and fix it in its place and refill the fuel.

2 Rectifying by gas welding

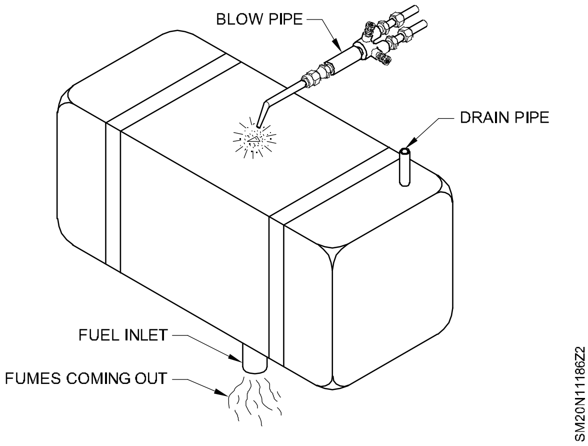
- Remove the fuel from the fuel tank. Store the fuel in a container in a safe place . Fill the pressurized water in the empty fuel tank. (Fig 1)
- Check the spot where the water leaks from the tank and mark the leak portion with a chalk.

Fig 1



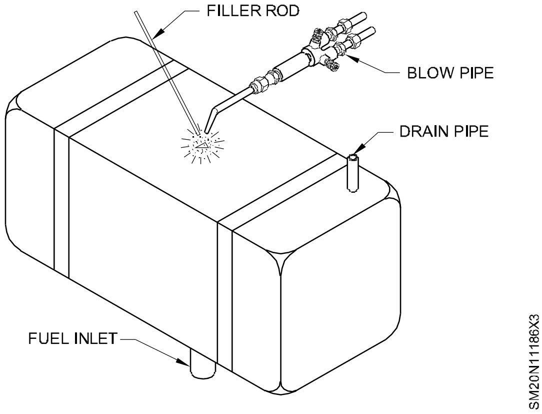
- Drain the water and empty the tank (allow it to dry).
- Take out water from the tank, make the tank empty and allow it to dry.
- Clean the leak portion of the metal surface by applying kerosene first and then by emery papers.
- Make sure that not a single drop of fuel is present inside the tank.
- Now apply heat at the leakage portion of the surface by brazing torch slowly.
- Hold the brazing torch in one hand and apply heat to the leakage surface till the metal becomes red and hot fumes will come out from the drain pipe and the fuel inlet. (Fig 2)

Fig 2



- Now take the brazing rod in the other hand and apply heat to the tip of the rod, then apply fluxide powder on the hot tip of the rod.
- Place the tip of the hot rod at the leakage portion and heat the tip of the rod .
- Now the brazing rod starts getting melted on the surface.
- Spread the molten metal on and around the leakage spot with the flame. Continue this till the molten metal is spread sufficiently and uniformly over the leakage portion of the surface. (Fig 3)
- Complete the brazing process slowly, because it may distort the base metal at the cracks and the pin holes of the leakage area.
- Allow the fuel tank to cool in air after brazing. If you use water for cooling, the brazed portion will distort and it is possible that the leakage may not stop.

Fig 3



- Fill water in the tank and ensure that it is not leaking. If it leaks, rectify it as described above.