WELDER

NSQF LEVEL - 3

TRADE PRACTICAL

SECTOR: CAPITAL GOODS & MANUFACTURING

(As per revised syllabus July 2022 - 1200 hrs)

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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

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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 2022 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 comprising various stakeholders viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **Welder - Trade Practical - NSQF Level - 3 (Revised 2022) in C G & M Sector under** Annual pattern. The NSQF Level - 3 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

Ms.TRISHALJIT SETHI,
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PREFACE

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

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

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

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

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

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

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

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

Chennai - 600 032 **EXECUTIVE DIRECTOR**

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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 **Welder - NSQF Level - 3** (Revised 2022) under the **C G & M** Sector for ITIs.

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

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

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

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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 **Welder** supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF LEVEL - 3 (Revised 2022) syllabus are covered.

The manual is divided into Seven modules.

Module 1	-	**Induction Training & Welding Process**
Module 2	-	**Welding Techniques**
Module 3	-	**Weldability of Steels (OAW, SMAW)**
Module 4	-	**Inspection and Testing**
Module 5	-	**Gas Metal Arc Welding**
Module 6	-	**Gas Tungstan Arc Welding**
Module 7	-	**Repair and Maintenance**

The skill training in the shop floor is planned through a series of practical exercises centred around some practical object. 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 **Welder - 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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It will be preferable to teach/learn the trade theory connected to each exercise atleast one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

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

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LEARNING/ ASSESSABLE OUTCOME

On completion of this book you shall be able to

Sl.No	Learning Outcome	Exercise No
1	Set the gas welding plant and join MS sheet in different position following safety precautions. [Different position: - 1F, 2F, 3F, 1G, 2G, 3G.]	1.1.01 - 1.1.04
2	Set the SMAW machine and perform different type of joints on MS in different position observing standard procedure. [different types of joints Fillet (T-joint, lap & Corner), Butt (Square & V); different position - 1F, 2F, 3F,4F, 1G, 2G, 3G, 4G]	1.1.05 - 1.1.08
3	Set the gas welding plant and join MS sheet in different position following safety precautions. [Different position: - 1F, 2F, 3F, 1G, 2G, 3G.]	1.1.09 - 1.1.10
4	Set the SMAW machine and perform different type of joints on MS in different position observing standard procedure. [different types of joints Fillet (T-joint, lap & Corner), Butt (Square & V); different position - 1F, 2F, 3F,4F, 1G, 2G, 3G, 4G]	1.1.11 - 1.1.12
5	Set the oxy- acetylene cutting plant and perform different cutting operations on MS plate. [Different cutting operation - Straight, Bevel, circular]	1.1.13-1.1.17
6	Set the gas welding plant and join MS sheet in different position following safety precautions. [Different position: - 1F, 2F, 3F, 1G, 2G, 3G.]	1.1.18-1.2.20
7	Set the SMAW machine and perform different type of joints on MS in different position observing standard procedure. [different types of joints Fillet (T-joint, lap & Corner), Butt (Square & V); different position - 1F, 2F, 3F,4F, 1G, 2G, 3G, 4G]	1.2.21-1.3.37

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8	Set the SMAW machine and perform different type of joints on MS in different position observing standard procedure. [different types of joints Fillet (T-joint, lap & Corner), Butt (Square & V); different position - 1F, 2F, 3F,4F, 1G, 2G, 3G, 4G]	1.3.38 - 1.3.41
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12	Choose appropriate welding process and perform joining of different types of metals and check its correctness. [appropriate welding process - OAW, SMAW; Different metal - SS, CI, Brass, Aluminium]	1.3.52 - 1.3.54
13	Choose appropriate welding process and perform joining of different types of metals and check its correctness. [appropriate welding process - OAW, SMAW; Different metal - SS, CI, Brass, Aluminium]	
	Demonstrate arc gauging operation to rectify the weld joints.	1.3.55 - 1.3.57
14	Choose appropriate welding process and perform joining of different types of metals and check its correctness. [appropriate welding process - OAW, SMAW; Different metal - SS, CI, Brass, Aluminium]	1.3.58 - 1.3.59
15	Test welded joints by different methods of testing. [different methods of testing- Dye penetration test, Magnetic particle test, Nick break test, Free band test, Fillet fracture test]	1.3.60 - 1.4.64
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22	Repair Cast Iron machine parts by selecting appropriate welding process. [Appropriate welding process- OAW, SMAW]	
	Hard facing of alloy steel components / MS rod by using hard facing electrode.	1.7.101 - 1.7.104

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SYLLABUS

Duration	Ref. Learning Outcome	Process Code	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 47Hrs; Professional Knowledge 11Hrs	Set the gas welding plant and join MS sheet in different position [Different position:1F, 2F, 3F, 1G, 2G, 3G] Set the SMAW machine and perform different type of joints on MS in different position observing standard procedure [different types of joints- Fillet (T-joint, lap & Corner), Butt (Square & V); different position - 1F, 2F, 3F,4F, 1G, 2G, 3G, 4G]		1 Demonstration of Machinery used in the trade 2 Identification to safety equipment and their use etc. 3 Hack sawing, filing square to dimensions 4 Marking out on MS plate and punching	- Importance of Trade Training - General discipline in the Institute - Elementary First Aid - Importance of welding in industry - Safety precautions in Shielded Metal Arc Welding, and Oxy - Acetylene Welding and Cutting.
		OAW-01 SMAW-01	5 Setting of oxy-acetylene welding equipment, Lighting and setting of flame. 6 Perform fusion run without filler rod on MS sheet 2mm thick in flat position. 7 Setting up of Arc welding machine & accessories and striking an arc. 8 Deposit straight line bead on MS plate in flat position.	- Introduction and definition of welding. - Arc and Gas Welding Equipments, tools and accessories. - Various Welding Processes and its applications. - Arc and Gas Welding terms and definitions.
Professional Skill 21Hrs; Professional Knowledge 05Hrs	Set the gas welding plant and join MS sheet in different position following safety precautions. [Different position: - 1F, 2F, 3F, 1G, 2G, 3G.]	OAW-02 OAW-03	9 Depositing bead with filler rod on M.S. sheet 2 mm thick in flat position. 10 Edge joint on MS sheet 2 mm thick in flat position without filler rod.	- Different process of metal joining methods: Bolting, riveting, soldering, brazing, seaming etc. - Types of welding joints and its applications. Edge preparation and fit up for different thickness. - Surface Cleaning
Professional Skill 23Hrs; Professional Knowledge 05Hrs	Set the SMAW machine and perform different type of joints on MS in different position observing standard procedure. [different types of joints- Fillet (T-joint, lap & Corner), Butt (Square & V); different position - 1F, 2F, 3F,4F, 1G, 2G, 3G, 4G]	SMAW-02 SMAW-03	11 Straight line beads on M.S. plate 10 mm thick in flat position. 12 Weaved bead on M. S plate 10mm thick in flat position.	- Basic electricity applicable to arc welding and related electrical terms &definitions. - Heat and temperature and its terms related to welding - Principle of arc welding. And characteristics of arc.
Professional Skill 23Hrs; Professional Knowledge 05Hrs	Set the oxy- acetylene cutting plant and perform different cutting operations on MS plate. [Different cutting operation - Straight, Bevel, circular]	OAGC-01 OAGC-02 OAGC-03	13 Setting up of oxy-acetylene and make straight cuts (freehand) 14 Perform marking and straight line cutting of MS plate 10 mm thick by gas. Accuracy within ±2mm. 15 Beveling of MS plates 10 mm thick, cutting regular geometrical shapes and irregular shapes, cutting chamfers by gas cutting.	- Common gases used for welding & cutting, flame temperatures and uses. - Types of oxy-acetylene flames and uses. - Oxy-Acetylene Cutting Equipment principle, parameters and application.

		OAGC-04 OAGC-05 OAGC-06	16 Marking and perform radial cuts, cutting out holes using oxy-acetylene gas cutting. 17 Identify cutting defects viz., distortion, grooved, fluted or ragged cuts; poor draglines; rounded edges; tightly adhering slag.	
Professional Skill 126Hrs; Professional Knowledge 31Hrs	Set the gas welding plant and join MS sheet in different position following safety precautions. [Different position: - 1F, 2F, 3F, 1G, 2G, 3G.] Set the SMAW machine and perform different type of joints on MS in different position observing standard procedure. [different types of joints- Fillet (T-joint, lap & Corner), Butt (Square & V); different position - 1F, 2F, 3F,4F, 1G, 2G, 3G, 4G]	OAW-04 SMAW-04 OAW-05	18 Square butt joint on M.S. sheet 2 mm thick in flat Position. **(1G)** 19. Fillet "T" joint on M.S. Plate 10 mm thick in flat position. **(1F)** 20. Open corner joint on MS sheet 2 mm thick in flat Position **(1F)**	- Arc welding power sources: Transformer, Rectifier and Inverter type welding machines and its care &maintenance.. - Advantages and disadvantages of A.C. and D.C. welding machines
		SMAW-05 OAW-06 SMAW-06	21 Fillet lap joint on M.S. plate 10 mm thick in flat position. **(1F)** 22 Fillet "T" joint on MS sheet 2 mm thick in flat position. **(1F)** 23 Open Corner joint on MS plate 10 mm thick in flat position. **(1F)**	- Welding positions as per EN &ASME: flat, horizontal, vertical and over head position. - Weld slope and rotation. - Welding symbols as per BIS & AWS.
		OAW-07 SMAW-07 I&T-01	24 Fillet Lap joint on MS sheet 2 mm thick in flat position. **(1F)** 25 Single "V" Butt joint on MS plate 12 mm thick in flat position **(1G).** 26 Testing of weld joints by visual inspection. 27 Inspection of welds by using weld gauges.	- Arc length - types - effects of arc length. - Polarity: Types and applications. - Weld quality inspection, common welding mistakes and appearance of good and defective welds - Weld gauges & its uses.
		OAW-08 SMAW-08 SMAW-09	28 Square Butt joint on M.S. sheet. 2 mm thick in Horizontal position. (2G) 29 Straight line beads and multi layer practice on M.S. Plate 10 mm thick in Horizontal position. 30 Fillet "T" joint on M.S. plate 10 mm thick in Horizontal position. (2F)	- Calcium carbide uses and hazard. - Acetylene gas properties and flash back arrestor.
		OAW-09	31 Fillet Lap joint on M.S. sheet 2 mm thick in horizontal position **(2F)**	- Oxygen gas and its properties, uses in welding. - Charging process of oxygen and acetylene gases
		SMAW-10	32 Fillet Lap joint on M.S. plate 10 mm thick in horizontal position. **(2F)**	- Oxygen and Dissolved Acetylene gas cylinders and Color coding for different gas cylinders. - Uses of single and double stage Gas regulators.

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		OAW-10 OAW-11 SMAW-11	33 Fusion run with filler rod in vertical position on 2mm thick M.S sheet. 34 Square Butt joint on M.S. sheet. 2 mm thick in vertical position **(3G)** 35 Single Vee Butt joint on M.S. plate 12 mm thick in horizontal position **(2G).**	- Oxy acetylene gas welding Systems (Low pressure and High pressure). Difference between gas welding blow pipe(LP &HP) and gas cutting blow pipe - Gas welding techniques. Rightward and Leftward techniques.
		SMAW-12 OAW-12 SMAW-13	36 Fillet "T" joint on M.S sheet 2 mm thick in vertical position. **(3F)** 37 Fillet "T" joint on M.S. plate 10 mm thick in vertical position. **(3F)**	- Arc blow - causes and methods of controlling. - Distortion in arc & gas welding and methods employed to minimize distortion - Arc Welding defects, causes and Remedies.
Professional Skill 80 Hrs; Professional Knowledge 17Hrs	Set the SMAW machine and perform different type of joints on MS in different position observing standard procedure. [different types of joints- Fillet (T-joint, lap & Corner), Butt (Square & V); different position - 1F, 2F, 3F,4F, 1G, 2G, 3G, 4G] Perform welding in different types of MS pipe joints by Gas welding (OAW). [Different types of MS pipe joints - Butt, Elbow, T-joint, angle (45°) joint, flange joint]	OAW-13 SMAW-14	38 Structural pipe welding butt joint on MS pipe Ø 50 and 3mm WT in 1G position. 39 Fillet Lap joint on M.S. Plate 10 mm in vertical position. **(3G)**	- Specification of pipes, various types of pipe joints, pipe welding all positions, and procedure. - Difference between pipe welding and plate welding.
		SMAW-15 OAW-14	40 Open Corner joint on MS plate 10 mm thick in vertical position. **(2F)** 41 Pipe welding - Elbow joint on MS pipe Ø 50 and 3mm WT. **(1G)**	- Pipe development for Elbow joint, "T" joint, Y joint and branch joint - Brief use of Manifold system
		OAW-15 SMAW-16	42 Pipe welding "T" joint on MS pipe Ø 50 and 3mm WT. **(1G)**	- Gas welding filler rods, specifications and sizes. - Gas welding fluxes - types and functions.
			43 Single "V" Butt joint on MS plate12 mm thick in vertical position (3G).	- Gas Brazing & Soldering : principles, types fluxes & uses - Gas welding defects, causes and remedies
		OAW-16 SMAW-17	44 Pipe welding 45 ° angle joint on MS pipe Ø 50 and 3mm WT. **(1G)** 45 Straight line beads on M.S. plate 10mm thick in over head position.	- Electrode : types, functions of flux, coating factor, sizespecifications of electrode, Coding of electrode as per BIS, AWS, - Effects of moisture pick up. - Storage and baking of electrodes.
Professional Skill 61Hrs; Professional Knowledge 06Hrs	Set the SMAW machine and perform different type of joints on MS in different position observing standard procedure. [different types of joints- Fillet	SMAW-18 SMAW-19	46 Pipe Flange joint on M.S plate with MS pipe Ø 50 mm X 3mm WT **(1F)** 47 Fillet "T" joint on M.S. plate 10 mm thick in over head position. **(4F)**	- Weldability of metals, importance of pre heating, post heating and maintenance of inter pass temperature.

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	(T-joint, lap & Corner), Butt (Square & V); different position - 1F, 2F, 3F,4F, 1G, 2G, 3G, 4G] Set the SMAW machine and perform welding in different types of MS pipe joints by SMAW. [Different types of MS pipe joints - Butt, Elbow, T-joint, angle (45) joint, flange joint]	SMAW-20 SMAW-21	48 Pipe welding butt joint on MS pipe Ø 50 and 5 mm WT. in 1G position. 49 Fillet Lap joint on M.S. plate 10 mm thick in over head position. **(4G).**	- Welding of low, medium and high carbon steel and alloy steels.
		SMAW-22 SMAW-23	50 Single "V" Butt joint on MS plate 10mm thick inover head position**(4G)** 51 Pipe butt joint on M. S. pipe Ø 50mm WT 6mm (**1G** Rolled).	- Stainless steel types-weld decay and weldability.
Professional Skill 25 Hrs; Professional Knowledge 04Hrs	Choose appropriate welding process and perform joining of different types of metals and check its correctness. [appropriate welding process - OAW, SMAW; Different metal - SS, CI, Brass, Aluminium]	OAW-17 SMAW-24 OAW-18	52 Butt joint of copper pipe ½ inch by brazing process by induction welding machine 53 Square Butt joint on S.S. Sheet 2 mm thick in flat position. **(1G)** 54 Corner/T joint of copper pipe of ½ inch and of length 75 mm	- Induction welding, brazing of copper tubes. - Brass - types - properties and welding methods. - Copper - types - properties and welding methods. - Brazing cutting tools.
Professional Skill 21Hrs; Professional Knowledge 04Hrs	Choose appropriate welding process and perform joining of different types of metals and check its correctness. [appropriate welding process - OAW, SMAW; Different metal - SS, CI, Brass, Aluminium] Demonstrate arc gauging operation to rectify the weld joints.	OAW-19 SMAW-25 AG-01	55 Square Butt & Lap joint on M.S. sheet 2 mm thick by brazing in flat position. 56 Single "V" butt joint C.I. plate 6mm thick in flat position. **(1G)** 57 Arc gouging on MS plate 10 mm thick.	- Aluminium properties and weldability, Welding methods - Arc cutting & gouging,
Professional Skill 20Hrs; Professional Knowledge 04Hrs	Choose appropriate welding process and perform joining of different types of metals and check its correctness. [appropriate welding process - OAW, SMAW; Different metal - SS, CI, Brass, Aluminium]	OAW-20 OAW-21	58 Square Butt joint on Aluminium sheet. 3 mm thick in flat position. 59 Bronze welding of cast iron (Single "V" butt joint) 6mm thick plate **(1G).**	- Cast iron and its properties types. - Welding methods of cast iron.
Professional Skill 25 Hrs; Professional Knowledge 04Hrs	Test welded joints by different methods of testing. [different methods of testing- Dye penetration test, Magnetic particle test, Nick break test, Free band test, Fillet fracture test]	I&T-02 I&T-03 I&T-04 I&T-05 I&T-06	60 Dye penetrant test. 61 Magnetic particle test. 62 Nick- break test. 63 Free bend test. 64 Fillet fracture test.	- Types of Inspection methods - Classification of destructive and NDT methods - Welding economics and Cost estimation.

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Professional Skill 166Hrs; Professional Knowledge 32Hrs	Set GMAW machine and perform welding in different types of joints on MS sheet/plate by GMAW in various positions by dip mode of metal transfer. [different types of joints- Fillet (T-joint, lap, Corner), Butt (Square & V); various positions- 1F, 2F, 3F,4F, 1G, 2G, 3G]	GMAW-01 GMAW-02	65 Introduction to safety equipment and their use etc. 66 Setting up of GMAW welding machine & accessories and striking an arc. 67 Depositing straight line beads on M.S Plate. 68 Fillet weld - "T" joint on M.S plate 10mm thick in flat position by Dip transfer. **(1F)**	- Safety precautions in Gas Metal Arc Welding and Gas Tungsten Arc welding. - Introduction to GMAW - equipment - accessories. - Various other names of the process. (MIG/MAG/ CO_2 welding.)
		GMAW-03 GMAW-04 GMAW-05	69 Fillet weld - Lap joint on M.S. sheet 3mm thick in flat position by Dip transfer. **(1F)** 70 Fillet weld - "T" joint on M.S. sheet 3mm thick in flat position by Dip transfer. **(1F)** 71 Fillet weld - corner joint on M.S. sheet 3mm thick in flat position by Dip transfer. **(1F)**	- Advantages of GMAW welding over SMAW , limitations and applications - Process variables of GMAW.
		GMAW-06 GMAW-07	72 Butt weld - Square butt joint on M.S sheet 3mm thick in flat position **(1G)** 73 Butt weld - Single "V" butt joint on M.S plate 10 mm thick by Dip transfer in flat position. **(1G)**	- Wire feed system - types - care and maintenance. - Welding wires used in GMAW, standard diameter and codification as per AWS.
		GMAW-08 GMAW-09	74 Fillet weld - "T" joint on M.S plate 10mm thick in Horizontal position by Dip transfer. **(2F)** 75 Fillet weld - corner joint on M.S plate 10mm thick in Horizontal position by Dip transfer. **(2F)**	- Name of shielding gases used in GMAW and its applications. - Flux cored arc welding - description, advantage, welding wires, coding as per AWS.
		GMAW-10 GMAW-11	76 Fillet weld - "T" joint on M.S. sheet 3mm thick in Horizontal position by Dip transfer. **(2F)** 77 Fillet weld - corner joint on M.S. sheet 3mm thick in Horizontal position by Dip transfer. **(2F)**	- Edge preparation of various thicknesses of metals for GMAW. - GMAW defects, causes and remedies
		GMAW-12 GMAW-13	78 Fillet weld - "T" joint on M.S plate 10mm thick in vertical position by Dip transfer. **(3F)** 79 Fillet weld - corner joint on M.S plate 10mm thick in vertical position by dip transfer. **(3F)**	- Heat input and techniques of controlling heat input during welding. - Heat distribution and effect of faster cooling
		GMAW-14 GMAW-15	80 Fillet weld - Lap joint on M.S. sheet 3mm thick in vertical position by Dip transfer. (3F) 81 Fillet weld - corner joint on M.S. sheet 3mm thick in vertical position by Dip transfer. (3F)	- Pre heating & Post Weld Heat Treatment - Use of temperature indicating crayons.
		GMAW-16 GMAW-17	82 Fillet weld - Lap and "T" joint on M.S sheet 3mm thick inoverhead position by Dip transfer. (4F) 83 Tee Joints on MS Pipe Ø 60 mm OD x 3 mm WT 1G position - Arc constant (Rolling)	- Submerged arc welding process -principles, equipment, advantages and limitations

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		GMAW-18 GMAW-19	84 Depositing bead on S.S sheet in flat position. 85 Butt joint on Stainless steel 2 mm thick sheet in flat position by Dip transfer.	- Thermit welding process- types, principles, equipments, Thermit mixture types and applications. - Use of backing strips and backing bars
Professional Skill 80 Hrs; Professional Knowledge 14Hrs	Set the GTAW machine and perform welding by GTAW in different types of joints on different metals in different position and check correctness of the weld. [different types of joints- Fillet (T-joint, lap, Corner), Butt (Square & V) ; different metals- Aluminium, Stainless Steel; different position- 1F & 1G]	GMAW-01 GMAW-02	86 Depositing bead on Aluminium sheet 2 mm thick in flat position. 87 Square butt joint on Aluminium sheet 1.6mm thick in flat position.	- GTAW process - brief description. Difference between AC and DC welding, equipments, polarities and applications. - Power sources for GTAW - AC &DC
		GMAW-03 GMAW-04	88 Fillet weld - "T" joint on Aluminium sheet 1.6 mm thick in flat position. **(1F)** 89 Fillet weld - Outside corner joint on Aluminium sheet 2 mm thick in flat position. **(1F)**	- Tungsten electrodes - types & uses, sizes and preparation - GTAW Torches- types, parts and their functions - GTAW filler rods and selection criteria.
		GMAW-05	90 Butt weld - Square butt joint on Stainless steel sheet 1.6 mm thick in flat position with purging gas **(1G)**	- Edge preparation and fit up. - GTAW parameters for welding of different thickness of metals
		GMAW-06	91 Fillet weld - "T" joint on Stainless steel sheet 1.6 mm thick in flat position. **(1F)**	- Argon / Helium gas properties - uses. - GTAW Defects, causes and remedy.
Professional Skill 20Hrs; Professional Knowledge 04Hrs	Perform Aluminium & MS pipe joint by GTAW in flat position.	GMAW-07	92 Pipe butt joint on Aluminium pipe Ø 50 mm x 3 mm WT in Flat position. **(1G)**	- Friction welding process-equipment and application - Laser beam welding (LBW).
Professional Skill 20Hrs; Professional Knowledge 03Hrs	Perform Aluminium & MS pipe joint by GTAW in flat position. Set the Plasma Arc cutting machine and cut ferrous & non-ferrous metals.	GMAW-08 PAC-01	93 "T" Joints on MS Pipe Ø 50 mm OD x 3 mm WT, position - Flat **(1F)** 94 Straight cutting on ferrous and non ferrous	- Plasma Arc Welding (PAW) and cutting (PAC) process - equipments and principles of operation. - Types of Plasma arc, advantages and applications.
Professional Skill 20Hrs; Professional Knowledge 02Hrs	Set the resistance spot welding machine and join MS & SS sheet.	RW-01 RW-02	95 Lap joint on Stainless steel sheet by Resistance Spot welding. 96 MS sheets joining by Resistance Spot welding	- Resistance welding process -types, principles, power sources and welding parameters. - Applications and limitations.

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Professional Skill 41 Hrs; Professional Knowledge 10Hrs	Perform joining of different similar and dissimilar metals by brazing operation as per standard procedure. [different similar and dissimilar metals- Copper, MS, SS]	OAW-01 OAW-02	97 Square butt joint on Copper sheet 2mm thick in flat position. **(1G)** 98 "T" joint on Copper to MS sheet 2mm thick in flat position by Brazing **(1F)**	- Metalizing - types of metalizing principles. - Manual Oxy - acetylene powder coating process- principles of operation and applications
		OAW-03 OAW-04	99 Silver brazing on S.S Sheet with copper sheet "T" joint. 100 Silver brazing on copper tube to tube.	- Reading of assembly drawing - Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR)
Professional Skill 24Hrs; Professional Knowledge 01Hrs	Repair Cast Iron machine parts by selecting appropriate welding process. [Appropriate welding process- OAW, SMAW] Hard facing of alloy steel components / MS rod by using hard facing electrode.	OAW-05 SMAW-01 SMAW-02	101 Repair welding of broken C.I. machine parts by oxy-acetylene welding with C.I and bronze filler rod. 102 Repair welding of broken C.I machine parts by C.I. electrode. 103 Repair plastic broken parts or pipes by plastic welding machine. 104. Make a plastic tank with plastic sheet of PVC. Dimensions 150*100*100	- Hard facing/ surfacing necessity, surface pre paration, various hard facing alloys and a dvantages of hard facing. - Plastic welding machine with hot air gun and plastic material: Polypropylene (PP) Polyethylene (PE) Polyvinylchloride (PVC)

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Demonstration of machinery used in welding trades

Objectives: At the end of this exercise you shall be able to
- **explain the machinery used in welding shop**
- **record the name and its uses of each machine in the given table.**

Fig 1

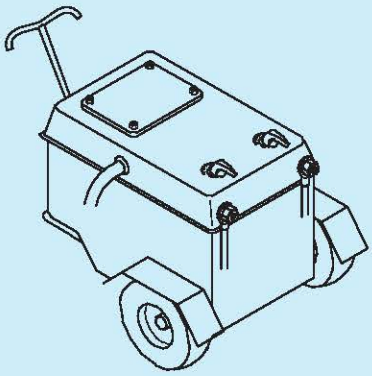


Fig 2

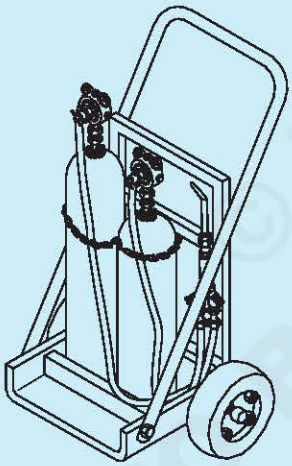


Fig 3

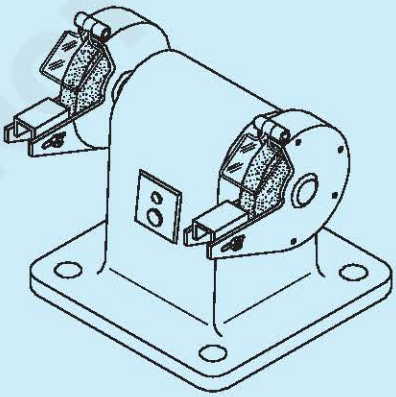


Fig 4

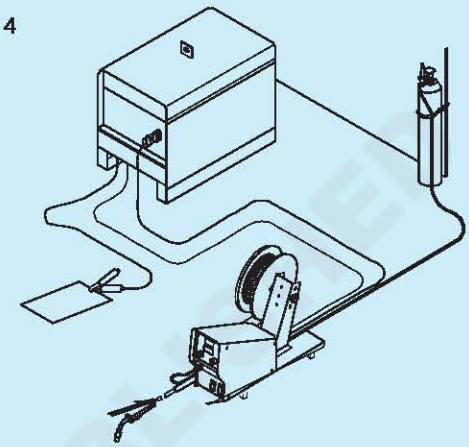


Fig 5

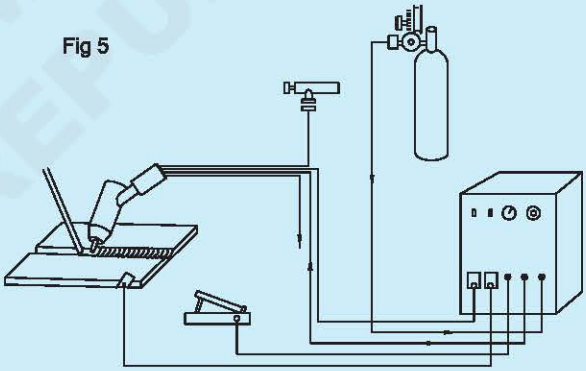
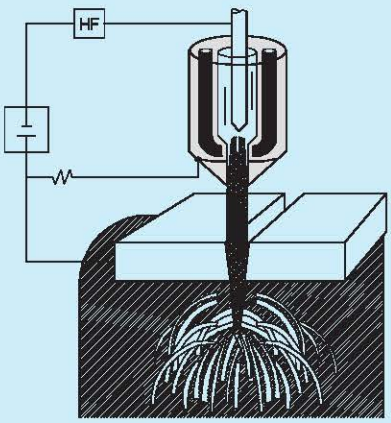


Fig 6



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Fig 7

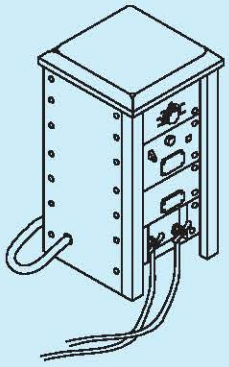


Fig 8

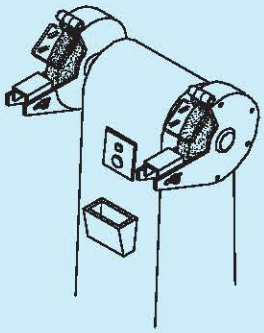


Fig 9

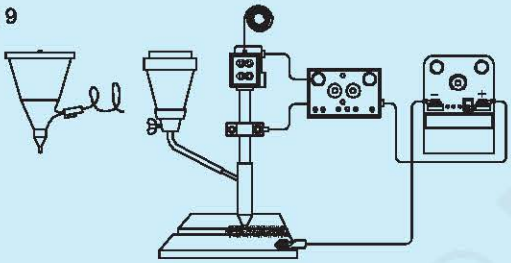


Fig 10

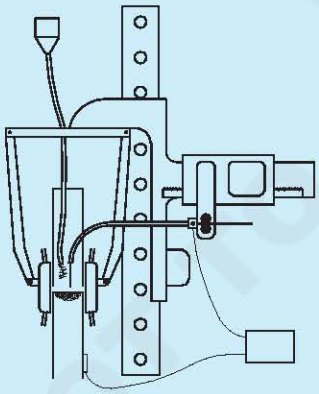


Fig 11

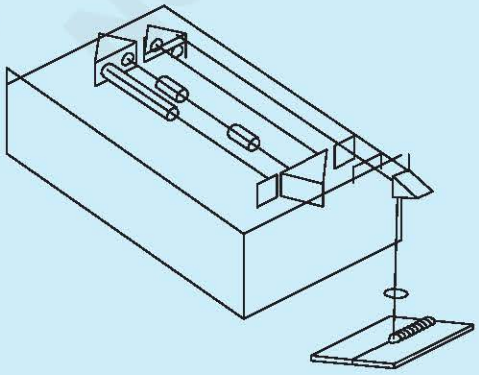


Fig 12

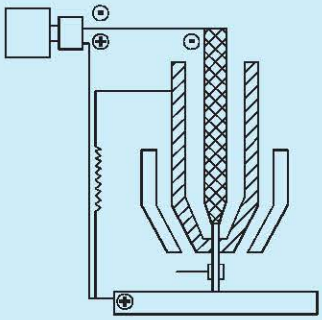


Fig 13

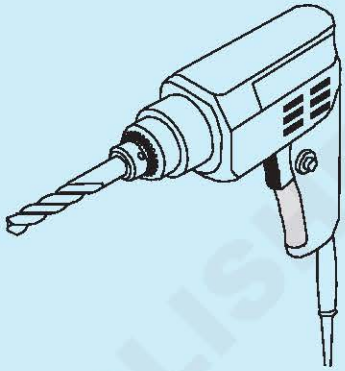


Fig 14

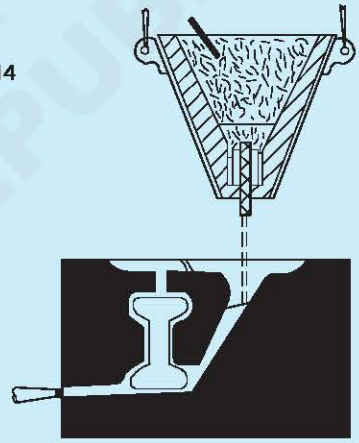
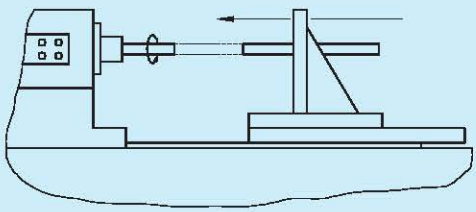
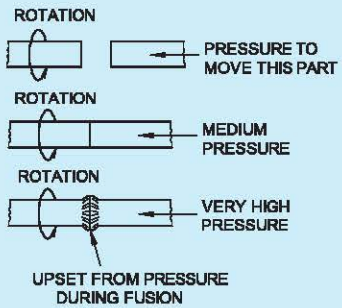


Fig 15





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Fig 16

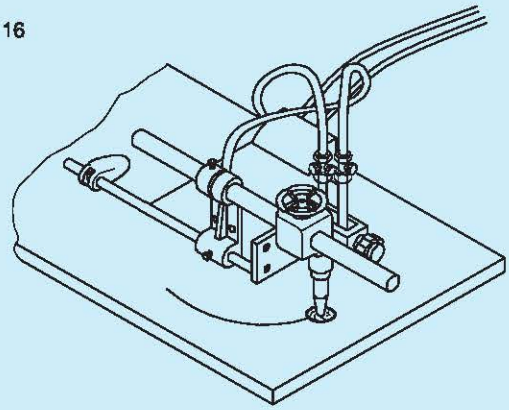


Fig 17

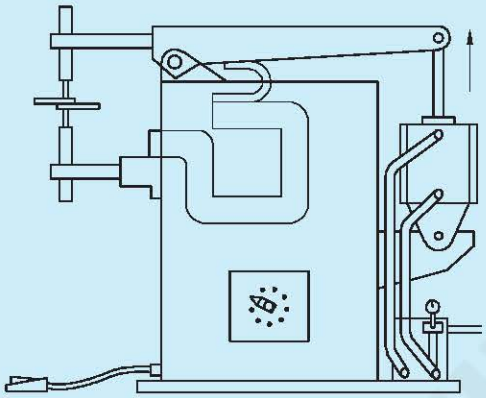


Fig 18

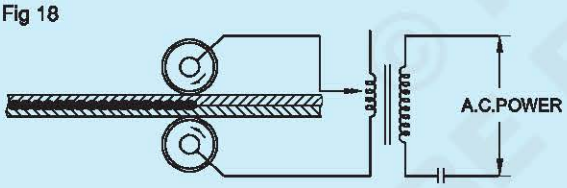


Fig 19

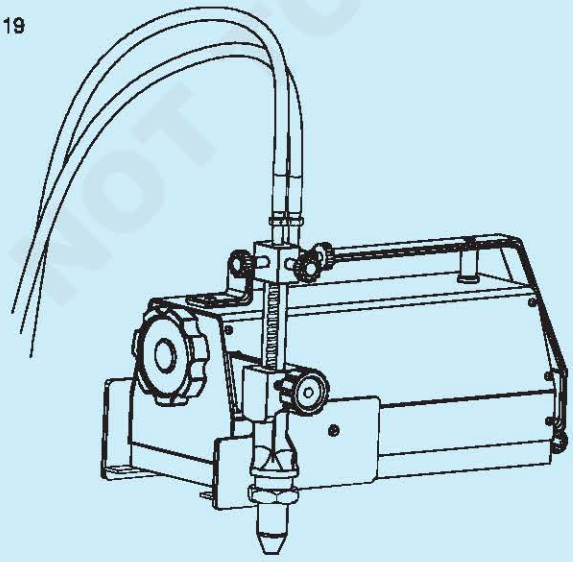


Fig 20

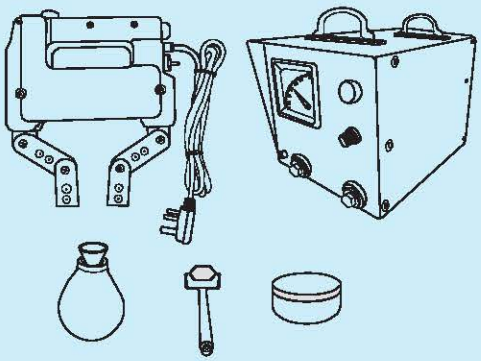


Fig 21

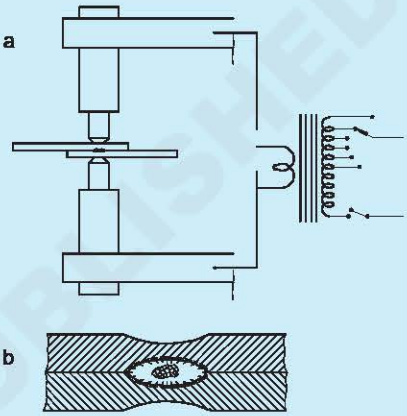


Fig 22

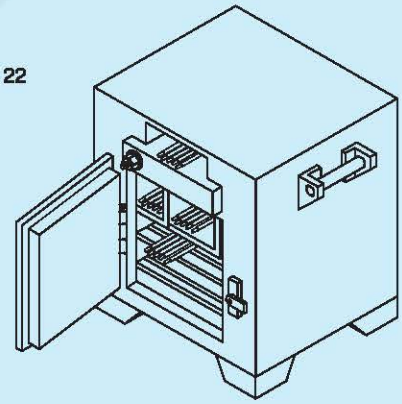
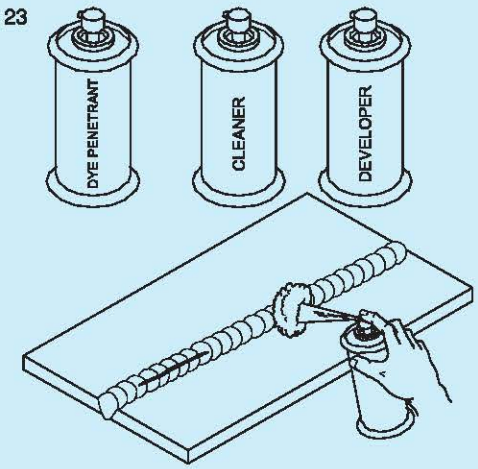


Fig 23



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W.20N1101E3

Job Sequence

- Identify the machinery in your work shop.
- Name the machine and explain their uses.
- Record it in table 1.
- **Get it checked by your instructor.**

TABLE 1

Name of the machine and write its uses

Sl. No.	Name of the machine	Uses
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		

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Exercise 1.1.02

Identification of safety equipment and their use etc.,

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

- **identity the safety equipment given in the drawing**
- **record the uses of respective safety equipment in the table.**

Scan the QR Code to view the video for this exercise

Fig 1

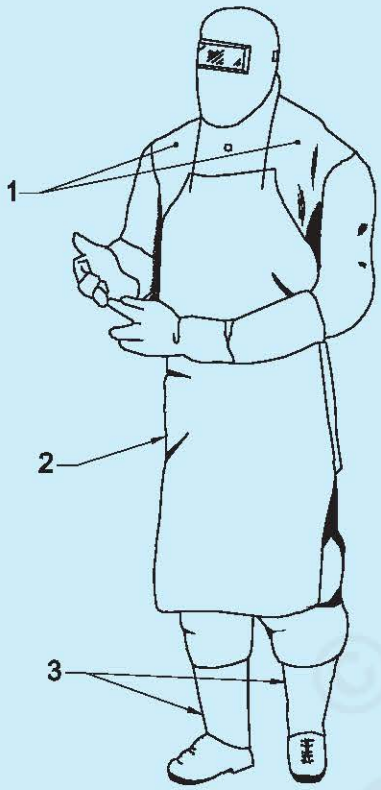


Fig 4

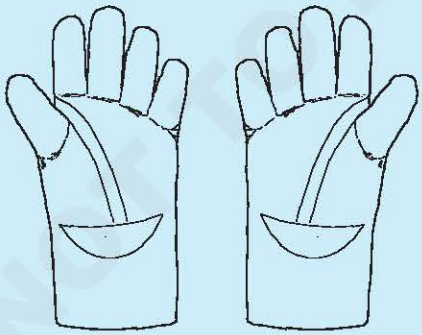


Fig 5

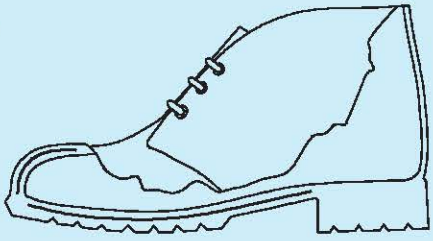


Fig 6

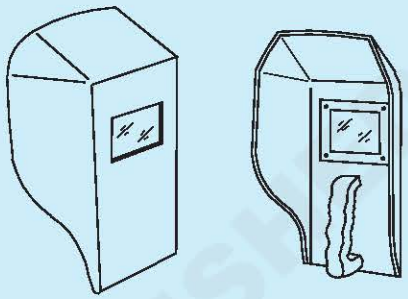


Fig 7

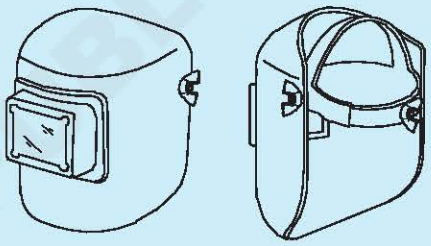


Fig 8

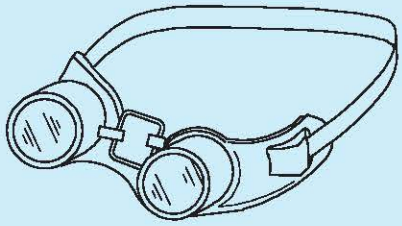
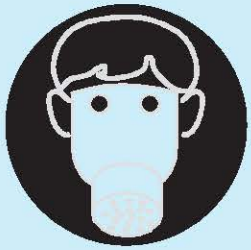


Fig 9



Fig 10



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WL20N1102E1

Note: The instructor may provide different types of personal protection equipment's explain how to identify and select the PPE devices suitable for the part cuter work and ask the trainees to write the names and its uses in the table given below.

Job Sequence

- Read and interpret the personal protection equipment visually on real devices or from the charts.
- Identify and select the personal protection equipment suitable for particular type of protection.
- Write the name of PPE to the corresponding type of protection in table 1.

TABLE 1

S. No.	Name of the PPE	Related Hazards	Type of protection
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

- **Get it checked by your instructor.**

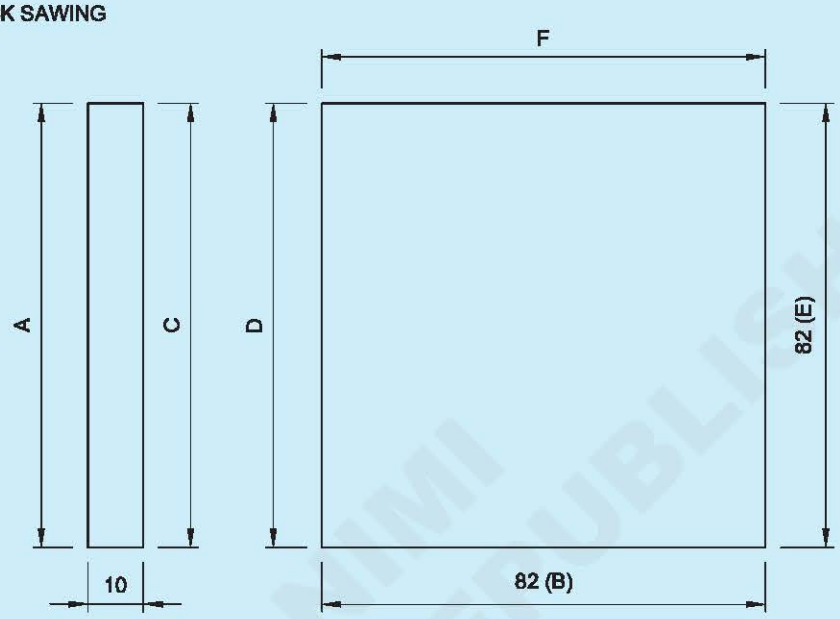
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Hack sawing, filing square to dimension

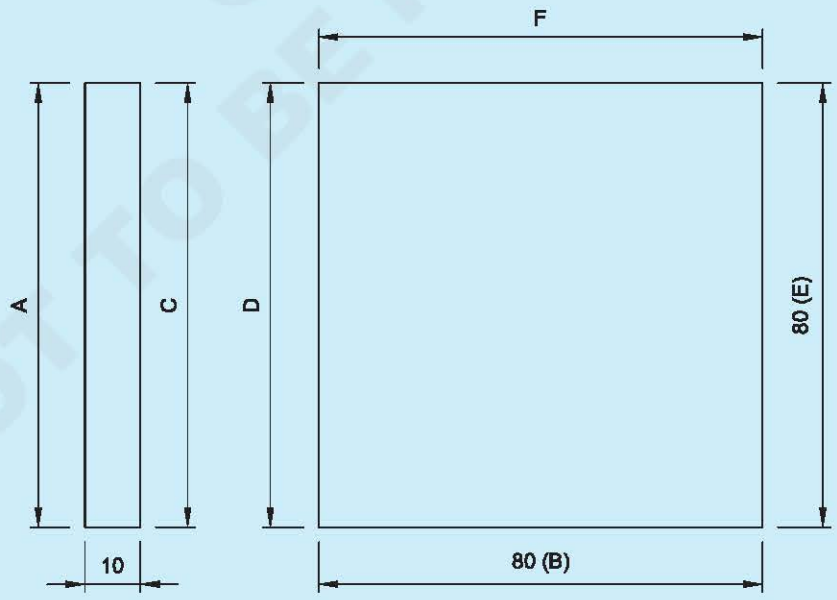
Objectives: At the end of this exercise you shall be able to

- **state the use of bench vice**
- **describe the method of hack sawing**
- **file to square and maintain the dimension.**

TASK : 1 HACK SAWING



TASK : 2 FILING SQUARE TO DIMENSION



1	100ISF x 10-100	-	Fe310	-	-	1.1.03
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

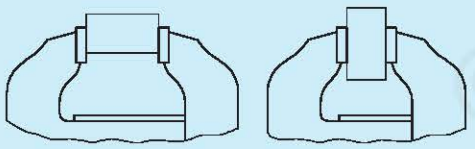
SCALE 1:1	HACK SAWING,FILING SQUARE TO DIMENSION	DEVIATIONS ±0.5	TIME
		CODE NO. WL20N1103E1	

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TASK 1: **Sawing along a line**

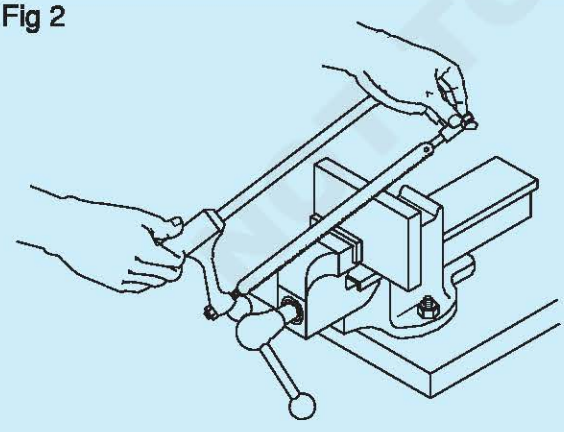
- Check the pre machined size of 75 x 75 x mm using rule
- Apply marling media
- Mark 82mm keeping side B.
- Similarly mark 82mm on side 'e'
- Punch the marked line.
- Hold the job in the bench-vice keeping 10 mm away from the marked line.
- Make a notch on the line to start hack sawing.
- Cut along the marked line.
- Similarly cut on the other side.
- Apply pressure in the forward stroke
- Release the pressure in the return stroke
- Use full length of the blade while blade while sawing
- Check the size cut the steel rule.
- Clamp the job to be cut according to the cross-section for sawing.
- As far as possible hold the job in such a way that the flat or long side can be cut rather than the edge. (Fig 1)

Fig 1



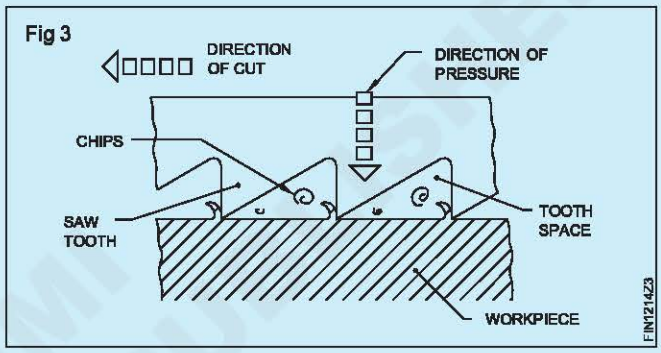
- In case the job has a profile (like steel angle), clamp the job so that sawing can be done towards the overhanging end. (Fig 2)

Fig 2



- Clamp the job as long as possible on the vice and make sure that the marked sawing line is close to the side of the vice jaws in order to achieve maximum firmness.
- Tighten the jaws firmly to avoid tilting and shifting of the job.
- Whenever the section being cut shows chattering effect or vibration, the clamping needs improvement.
- Select the correct pitch blade for cutting.
- Shorter the cutting section is, finer the blade pitch. Make sure that atleast four teeth are cutting at a time.
- Harder the material finer the blade pitch should be.
- Fix the blade in such a way that the teeth are in the direction of cut. (Fig 3)

Fig 3



- Tighten and tension the blade by hand using only the wing nut.

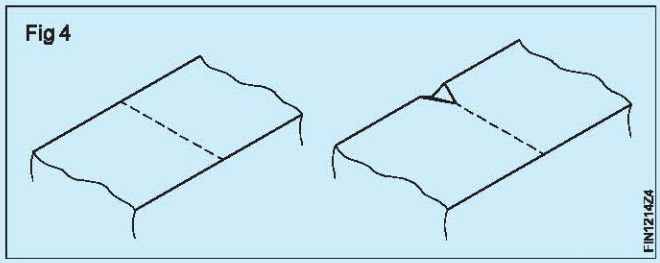
Caution

Insufficient blade tension-cut will not be straight.

Over tension-blade will break.

File a notch at the starting point on smooth and hard jobs to avoid slipping of the hacksaw. (Fig 4)

Fig 4



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- Apply a little downward hand force as long as only a few teeth are cutting. Press down only during forward (cutting) stroke.
- Use the full length of the blade in order to avoid early dulling of the teeth in the middle portion of the blade.
- Move the blade strictly in line with the marked direction. Do not tilt the frame while sawing because bending to the blade can cause sudden breakage of the blade.
- Resort to cutting from the opposite side in case the deviation from the marked line is excessive.

Slow down the cutting while completing the cut to avoid breakage of the blade and injury to yourself.

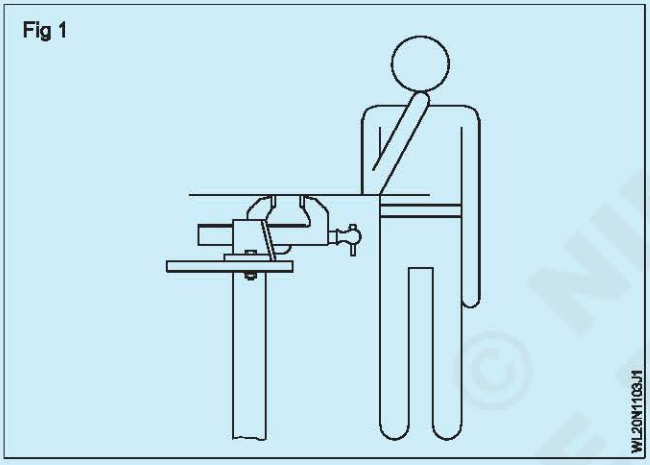
TASK 2: **Filing square to dimension**

Check the height of the bench vice. (Fig 1) If the height is more, use a platform and if it less, select and use another workbench.

Hold the job in the bench vice with a projection of 5 to 10 mm from the top of the vice jaw.

Select the files of various grades and length according to the

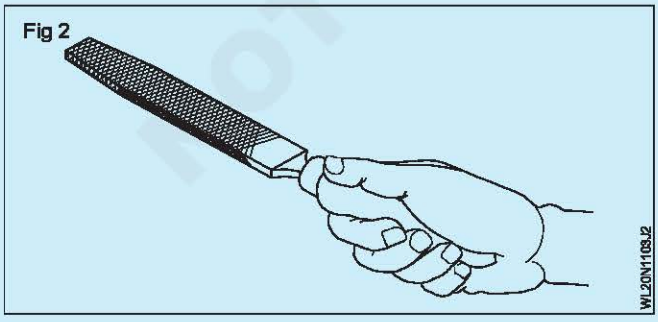
Fig 1



– size of the job
– quantity of metal to be removed
– material of the job.

Check whether the handle of the file fits tightly. Hold the handle of the file (Fig 2) and push the file forward using your right hand palm.

Fig 2



Hold the tip of the file according to the quantity of the metal to be removed.

For heavy filing. (Fig 3)

For light filing. (Fig 4)

Fig 3

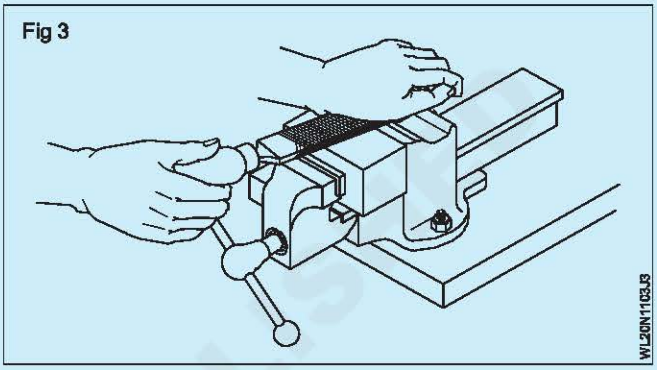
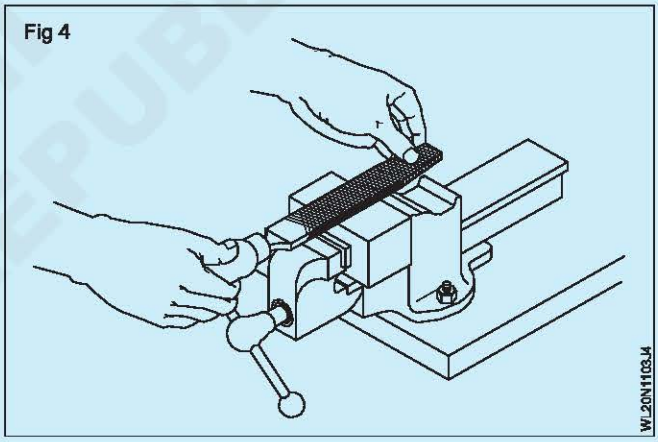
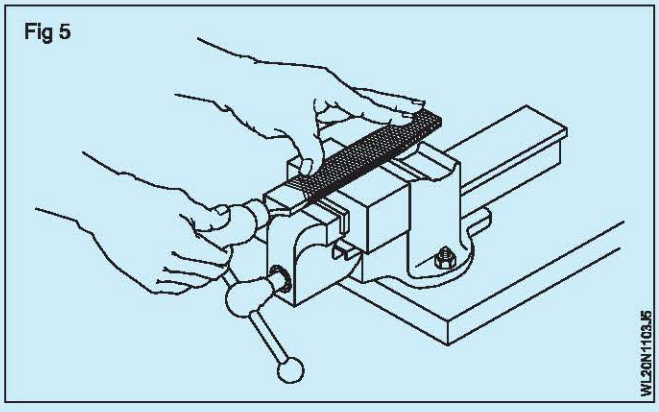


Fig 4



For removing local unevenness. (Fig 5)

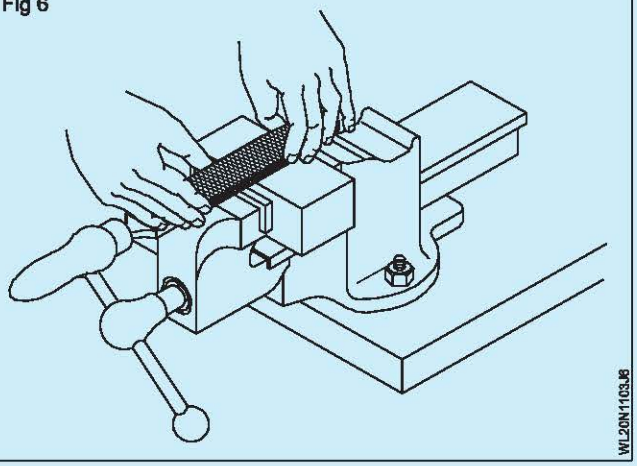
Fig 5



For removing the local unevenness draw filing can also be done. (Fig 6) The same filing can also be done for fine finishing.

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Fig 6



WI.20N1103.J6

Start filing by pushing the file uniformly during the forward stroke and release the pressure during the return stroke.

Continue giving strokes. Balance the pressure of the file in such a way that the file always remains flat and straight over the surface to be filed.

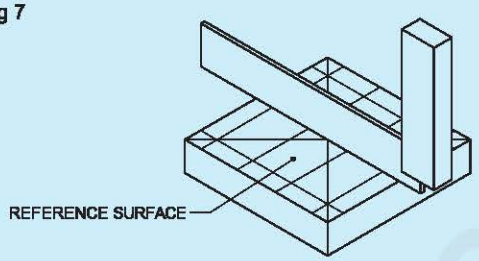
Checking flatness (Fig 7)

Use the blade of the try square as a straight edge for checking flatness.

Place the blade of the try square on the surface to be checked in all directions so as to cover the entire surface.

Do the checking face the light. Light gap will indicate high and low spots.

Fig 7

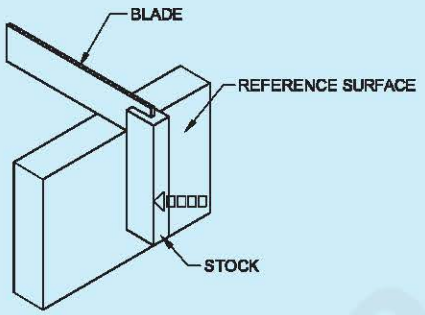


WI.20N1103.J7

Checking squares: Consider the large finished surface as the reference surface. Ensure that the reference surface is filed perfectly and is free from burrs.

Butt and press the stock against the reference surface. (Fig 8)

Fig 8

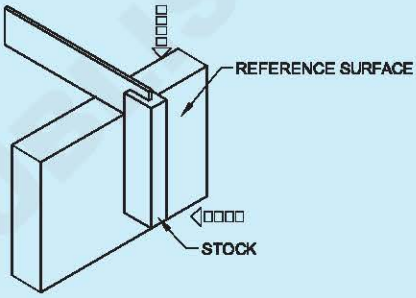


WI.20N1103.J8

Bring down slowly (Fig 9) and make the blade touch the second surface with which the squares is to be checked.

Light gap will indicate the high and low spots.

Fig 9

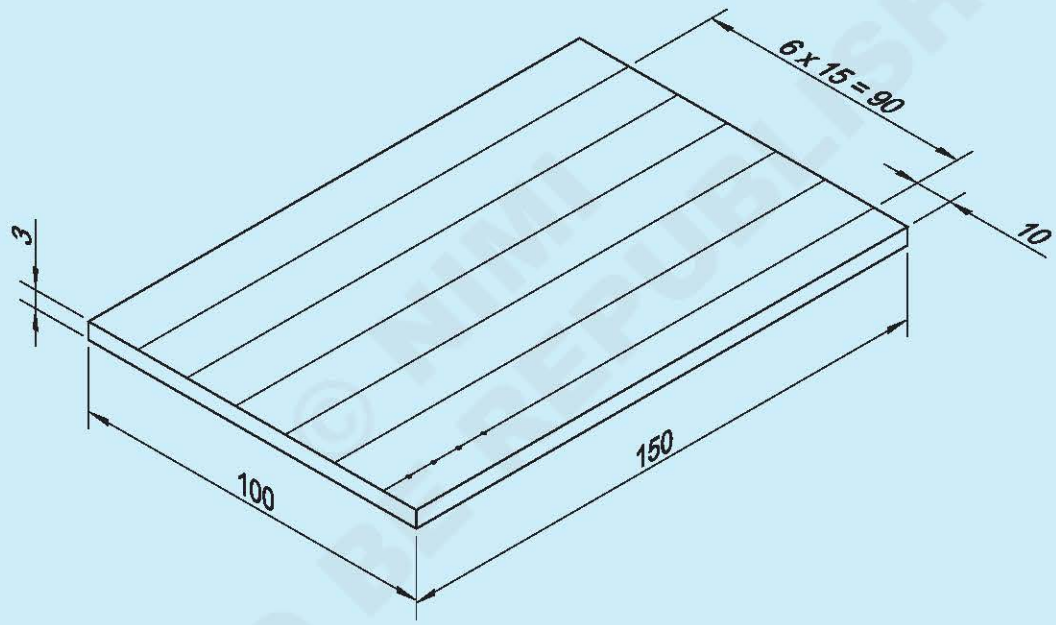


WI.20N1103.J9

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Marking out on MS plate and punching

Objectives: At the end of this exercise you shall be able to
- **prepare the job as per drawing**
- **explain the marking media**
- **describe the uses of steel rule and punch.**



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Job Sequence

- Check the size of the given MS sheet as per drawing.
- Apply copper sulphate/chalk powder solution and allow it to dry.
- Keep the plate or flat on the work bench and mark points A, B, C, D, E & F and A_1, B_1, C_1, D_1, E_1 & F_1 as per dimensions given on the job drawing.
- Draw the 6 lines joining the points A and A_1, B and B_1 etc upto F and F_1.
- Check the marked lines for the correctness and parallelism visually.
- Using a dot punch and a hammer make punch marks on all the lines with a pitch of 4mm.

1	100 ISF 3x150	-	Fe 310	-	-	1.1.04
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	MARKING OUT ON M.S. PLATE AND PUNCHING	TOLERANCE ±1	TIME
		CODE NO. WL20N1104E1	

Skill Sequence

Marking out on MS plate and punching

Objectives: At the end of this exercise you shall be able to
- **scribe straight and parallel lines on the surface of the plate**
- **make punch marks on the lines by using dot punch**

The marking media, copper sulphate or chalk powder solution, is applied on the job surface and dried so that the lines scribed on it will be clearly visible.

Apply the marking media uniformly with a 15mm painting brush.

Using steel rule and scriber point mark points A, B,C,D,E & F from the 150mm long edge of job at 10, 25, 40, 55, 70 and 85mm distances. Similarly mark points A_1,B_1,C_1,D_1,E_1 & F_1 (Fig 1) The edge of the steel rule may have damaged. To avoid wrong measurement coincide or set the 1st or 2nd cm graduation mark of the steel rule against the 150mm long edge of the job for taking measurements and marking of points A to F and A_1 to F_1. Ensure that there is no parallax error (observation error) while using the scale to mark the points A to F and A_1 to F_1 (Fig 2)

Fig 1

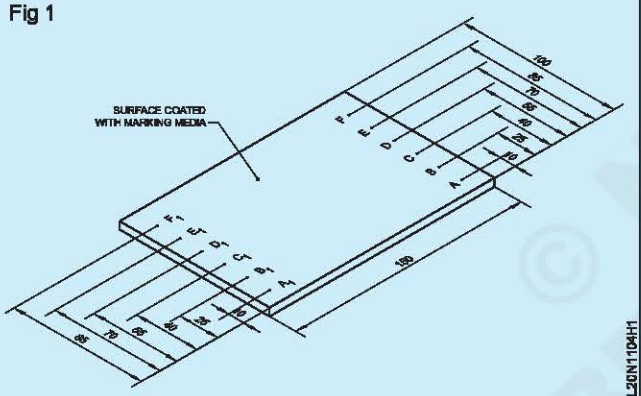
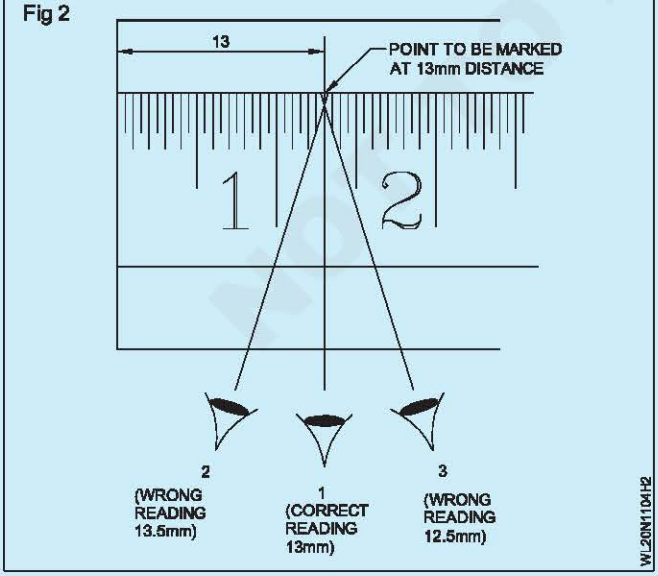


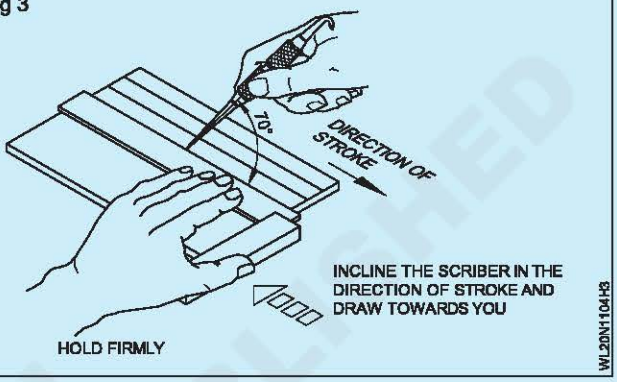
Fig 2



Using the steel rule and scriber, draw the lines AA_1, BB_1, CC_1, DD_1, EE_1 & FF_1.

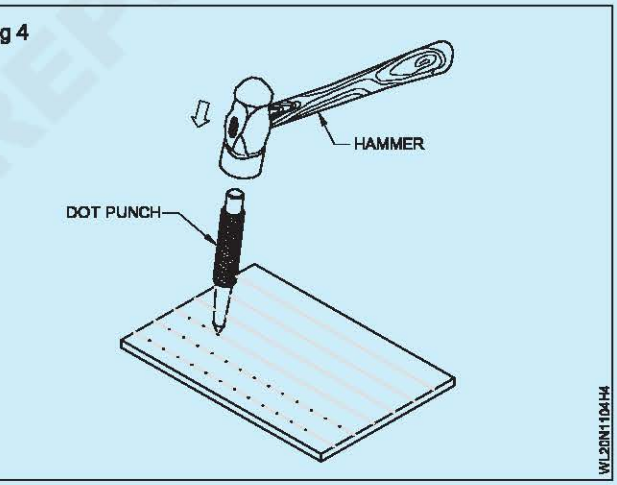
Incline the scriber in the direction of stroke and draw towards you (Fig 3)

Fig 3



Using the dot punch and the hammer, punch small dots on the 6 lines. (Fig 4 and Fig 5) While hammering hold at the extreme end of the handle.

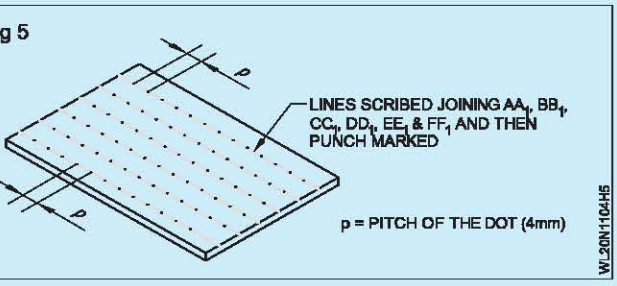
Fig 4



Maintain a pitch of 4mm approximately between the dots. Pitch is the distance between two consecutive dots.

Check whether the lines are straight and parallel using steel rule and the punch marks are clear and visible.

Fig 5



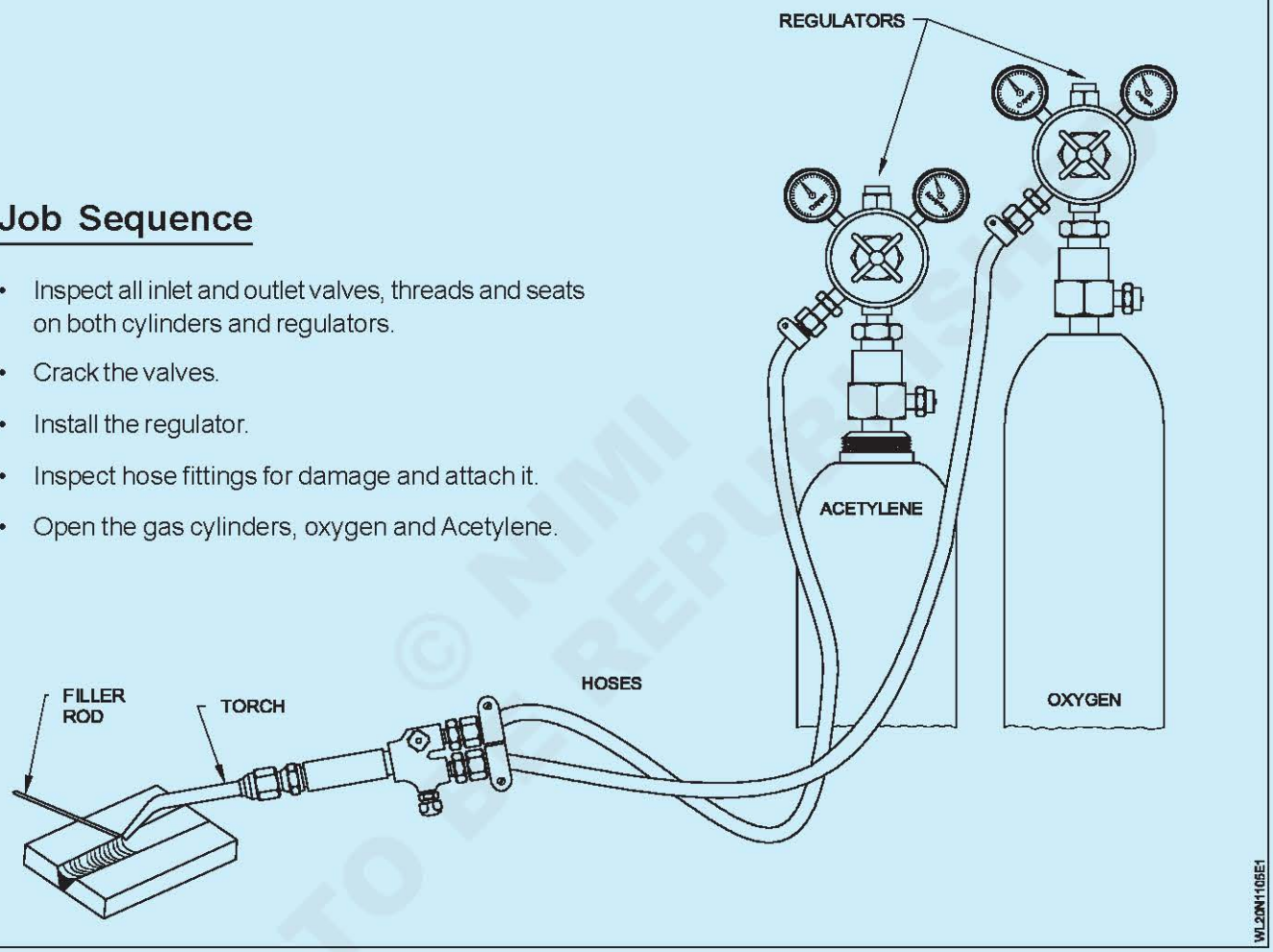
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Setting of oxy-acetylene welding equipment, lighting and setting of flame

Objectives: At the end of this exercise you shall be able to
- **setup the oxy-acetylene gas welding plant by connecting all components**
- **test for gas leakages at all connections**
- **set the required gas pressure on the regulators.**

Job Sequence

- Inspect all inlet and outlet valves, threads and seats on both cylinders and regulators.
- Crack the valves.
- Install the regulator.
- Inspect hose fittings for damage and attach it.
- Open the gas cylinders, oxygen and Acetylene.



- Purge both hoses by opening the regulator valve correctly as per gas, one at a time.
- Inspect torch handle.
- Assemble the torch handle.
- Attach the hose correctly.
- Leak check and purging.
- Light the flame.
- Adjust the flame to get neutral flame.
- Observe the flame pattern.
- Adjust the flame to get oxidizing flame.
- Observe the flame pattern.
- Adjust the flame to get carburizing flame.
- Observe the flame pattern.
- Shut down the torch flame.
- Shut down and bleed the pressure from the system.

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Skill Sequence

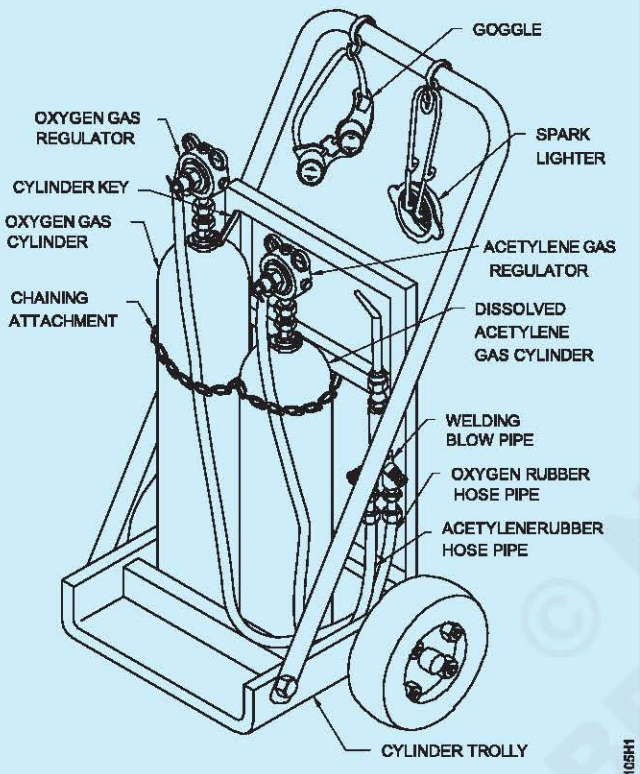
Setting of oxy-acetylene welding equipment, lighting and setting of flame

Objectives: This shall help you to
- **close down the oxy-acetylene gas welding plant maintaining correct sequence**
- **set neutral oxidizing and carburizing flames.**

Setting up oxy-acetylene plant Fig 1

Move oxygen and acetylene cylinders with the caps from the store to the gas welding area.

Fig 1



SETTING OF OXY-ACETYLENE PLANT

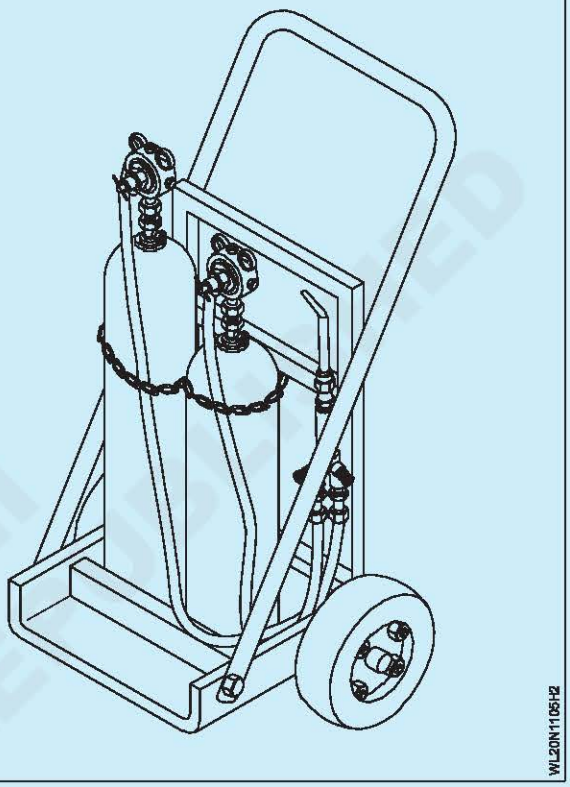
An oxygen cylinder is identified by the black color painted on it. An acetylene cylinder is identified by the maroon color painted on it. Also the oxygen cylinder will be taller than an acetylene cylinder and the diameter of oxygen cylinder will be less than the diameter of an acetylene cylinder.

Ensure full cylinders are kept separately from the empty cylinders.

Position the gas cylinders in a trolley and secure them with a chain.

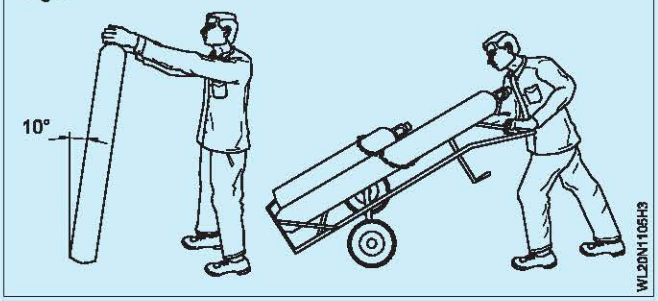
Always keep the cylinders upright/vertically in the cylinder stand/on the floor. (Fig 2)

Fig 2



While moving, the gas cylinders should be kept slightly inclined to the vertical position and the protector cap used to avoid damage to the cylinder valves. (Fig 3)

Fig 3

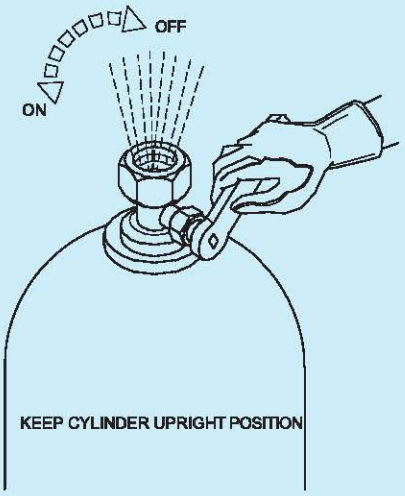


Do not roll the cylinders horizontally on the ground.

Remove the cylinder caps. Crack the gas cylinder valves by quickly opening and closing them using the cylinder key. Fig 4.

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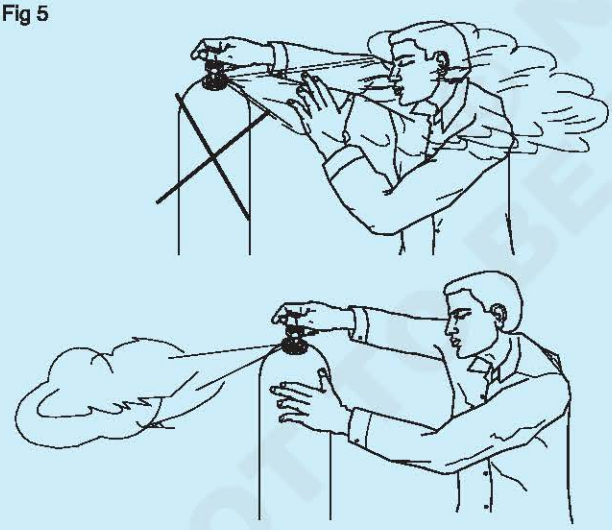
Fig 4



Dirt and dust particles from the cylinder valve sockets are cleaned by cracking the cylinder valve. This will avoid leakage of gas due to improper seating of the cylinder valve and also to prevent the dust particles from entering into the regulators which may cause damage to the regulators.

Always stand opposite to the valve outlet while cracking the cylinders. (Fig 5)

Fig 5



Ensure that your hands are free from grease or oil.

Connect the oxygen regulator to the oxygen gas cylinder (right hand threads).

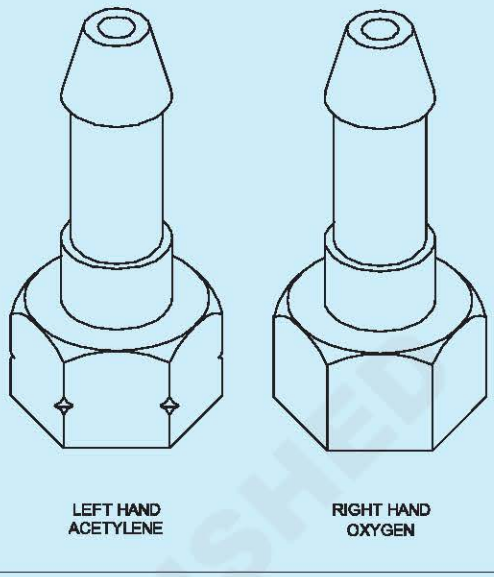
Connect the acetylene regulator to the acetylene gas cylinder (left hand threads).

Ensure the pressure adjusting screws of both regulators are in a released condition.

Connect the correct regulator on cylinders. Acetylene connections have left hand thread and oxygen has right hand thread.

The acetylene regulator connecting nut will have a groove cut on it (Fig 6) and the pressure gauge dial will be of maroon color.

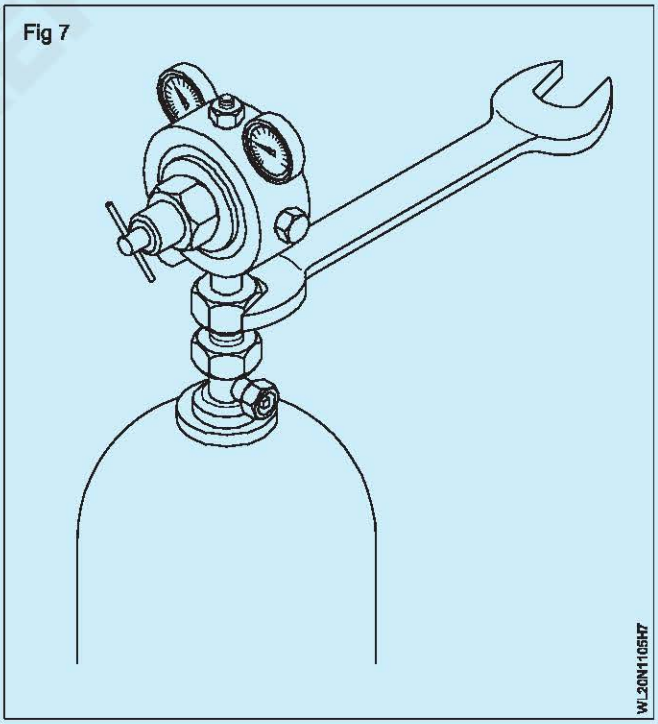
Fig 6



All threaded connections should be fixed initially by tightening by hands and then only a spanner should be used. This will help to avoid assembly with cross thread leading to damage to threads.

Always use the correct size spanner to prevent damage to the threads. (Fig 7)

Fig 7

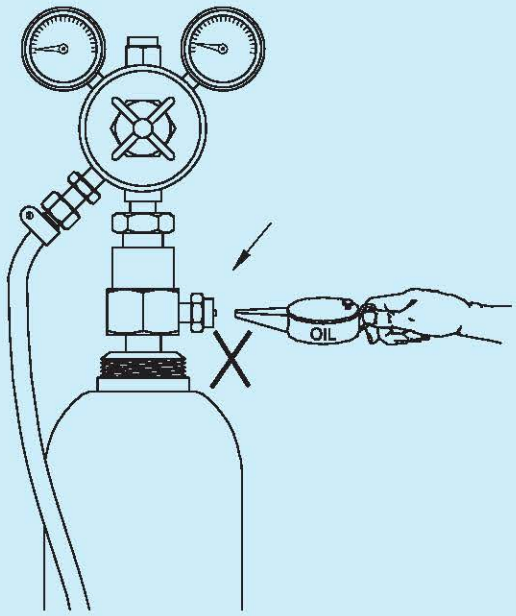


It is dangerous to apply lubricants in the threaded assemblies of gas welding equipment as it can cause fire. (Fig 8)

While tightening avoid undue force. The connections should be just tight.

Connect the hose connector at the regulator end and the hose-protectors at the blowpipe end.

Fig 8

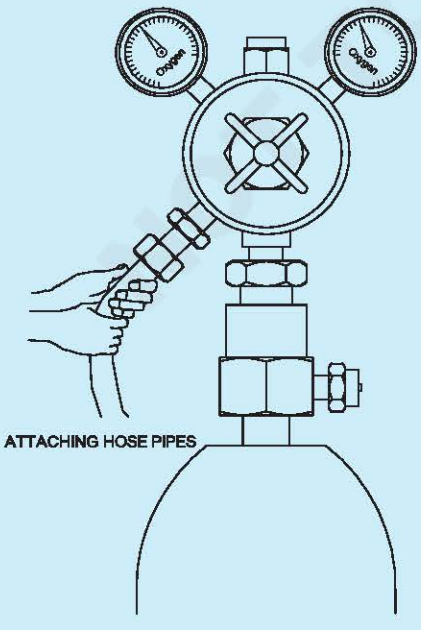


(Use black hose for oxygen line and maroon hose for acetylene line.)

Acetylene connections have left hand threads with a cut on the comers of the nut while oxygen connections have right hand thread without a cut.

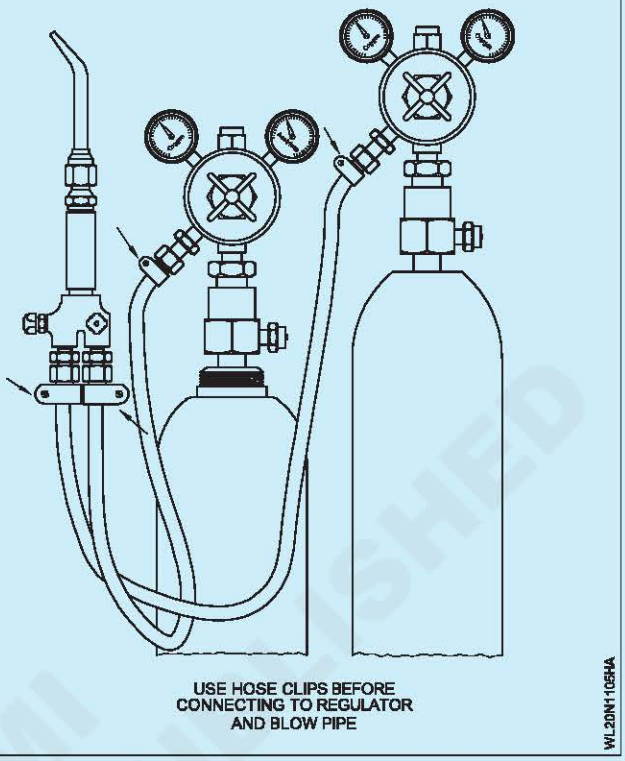
Attach one end of the black hose-pipe to the oxygen regulator outlet and the maroon colored hose-pipe to the acetylene regulator outlet. (Fig 9)

Fig 9



Secure the joints using hose-clips to ensure good grip and to avoid gas leakage. (Fig 10)

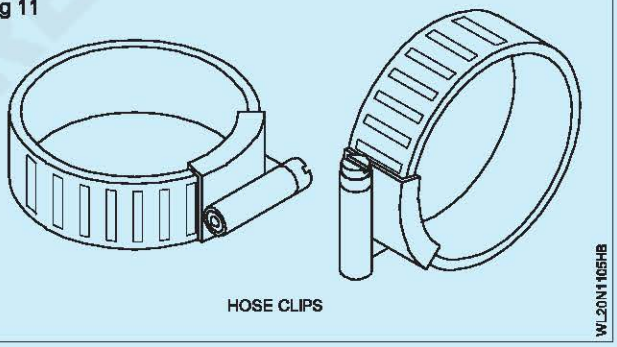
Fig 10



Use a screwdriver to tighten the hose-clips.

Always use the correct size hose-clips. (Fig 11)

Fig 11



Turn on the pressure adjusting screw of the regulator to which the oxygen hose pipe is connected.

Exert sufficient pressure to blow out dust or dirt particles if any are trapped inside the hose-pipe and then release the pressure adjusting screw.

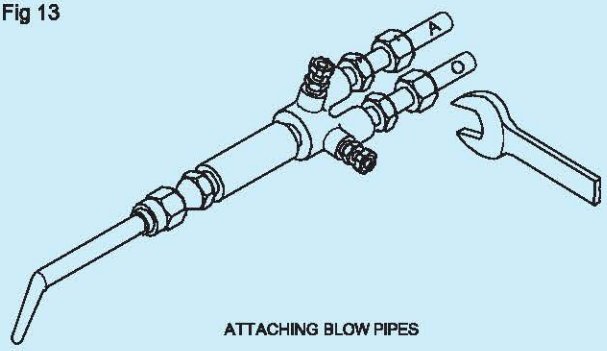
Repeat the same for the acetylene hose also.

Attaching blowpipe

The other end of the hose-pipe is to be attached to the blowpipe inlets. (Fig 12)

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Fig 13

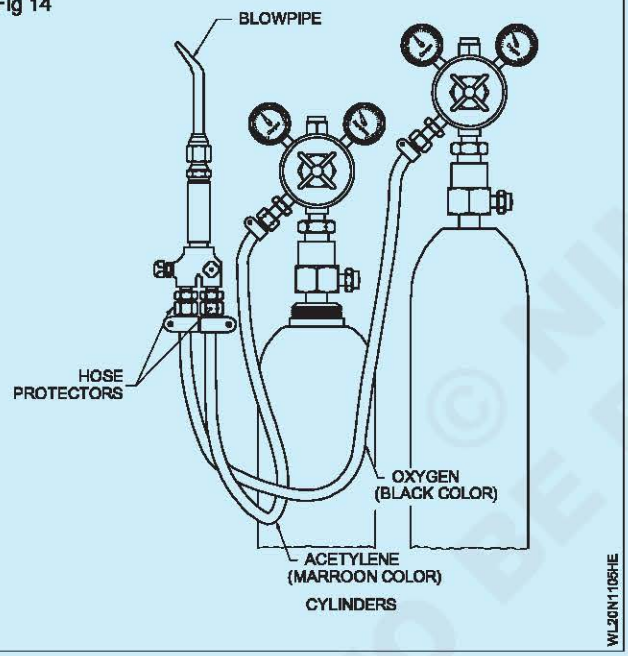


ATTACHING BLOW PIPES

WL20N1105HD

Fix the hose-protectors at the blowpipe ends. The hose-protectors with a groove at the corners are fixed on the acetylene hose-pipe and connected to the acetylene inlet of the blowpipe. The hose-protectors without cutting marks are fixed on the oxygen hose-pipe and connected to the oxygen inlet of the blowpipe. (Fig 14)

Fig 14



WL20N1105HE

The hose-protectors protect against the return flow of gas from the blowpipe to the rubber hoses. They act as non-return valves.

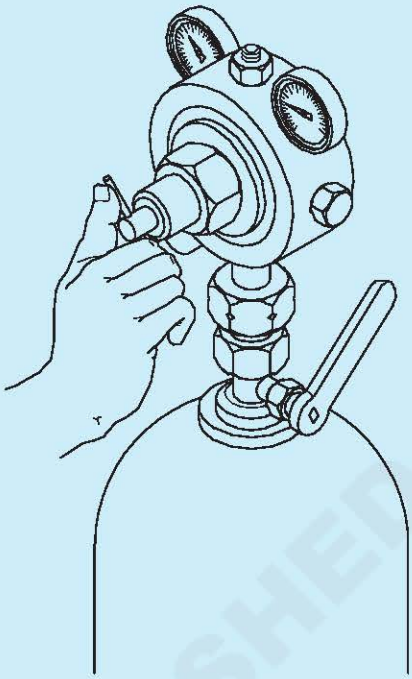
Adjusting the gas pressure

The gas pressure for both oxygen and acetylene has to be adjusted at regulators according to the size of the nozzle. The size of the nozzle is selected according to the job material and thickness.

For adjusting the gas pressure, open the valves of both the cylinders slowly by one turn and set the pressure on both regulators as 0.15 kg/cm^2 for small size nozzles, by tightening the pressure adjusting screws. (Fig 15) Ensure the blow pipe control valves are kept open while setting the gas pressure.

The pressure can be read on the working pressure gauge of gas regulators.

Fig 15



WL20N1105HF

Testing for leakage

All connections must be tested for leakage.

Apply soap water solution for acetylene connections and fresh water for oxygen connections. (Fig 16)

Use of soap water on oxygen connections may lead to fire hazards.

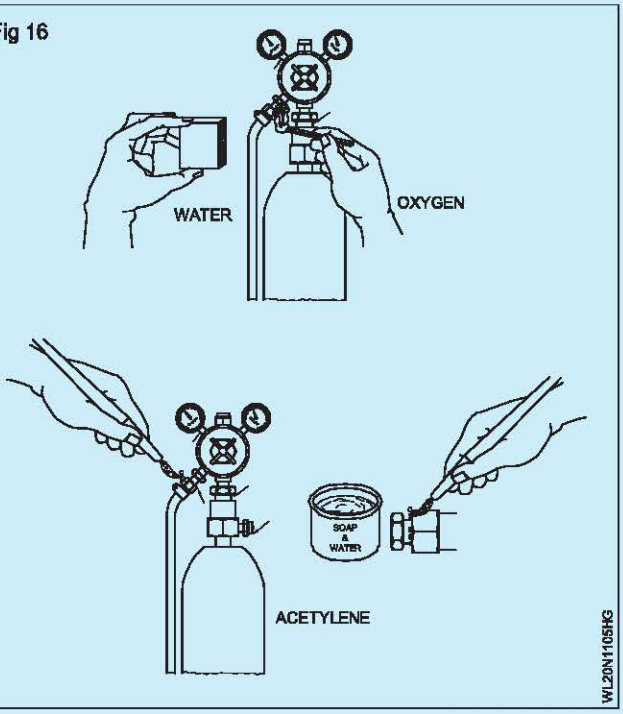
Never use matches or flame light during leakage test.

Lighting the flame

Attach the recommended size of nozzle to the neck of the welding blowpipe i.e. nozzle No. 3.

Open the gas cylinders and adjust the recommended gas pressures on the regulators.

Fig 16



WL20N1105HG

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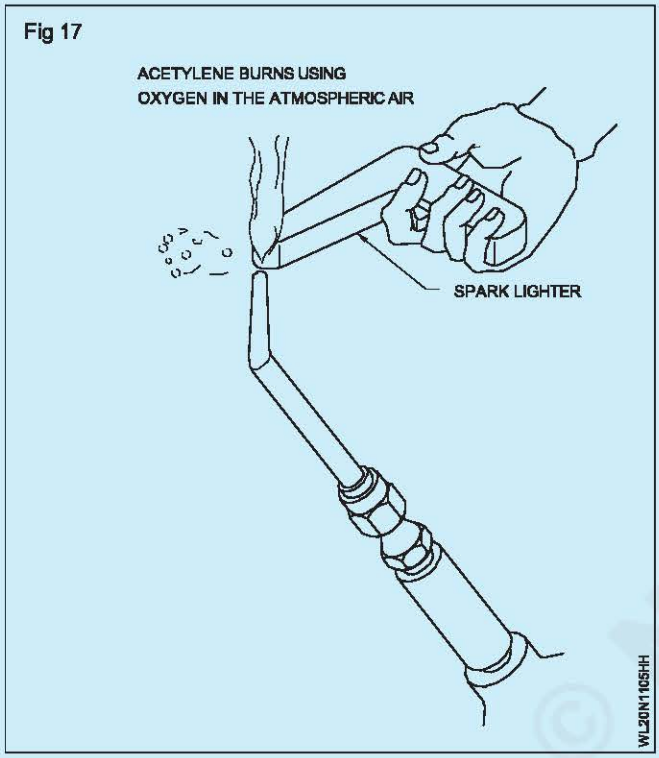
The pressure of oxygen and acetylene is 0.15kgs/cm^2 for nozzle No 3.

Open cylinder valves very slowly.

While setting pressure on the regulator, keep the blowpipe control valve open for accurate setting.

Open the acetylene control valve 1/4 turn on the blowpipe and ignite with a spark lighter. (Fig 17) Acetylene burns using the oxygen in the atmospheric air with a black smoke.

Fig 17

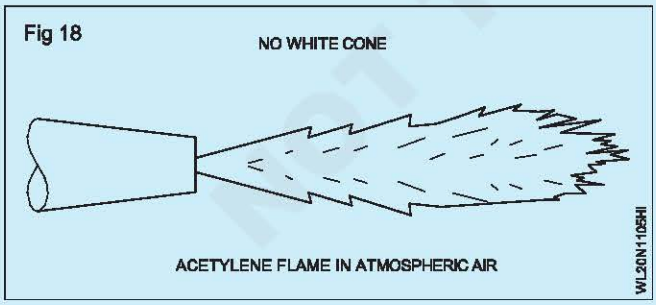


Avoid using any other source of fire other than the spark lighter.

Point the blowpipe in a safe direction in the open space, away from you and others.

Increase the acetylene till the black smoke disappears. (Fig 18)

Fig 18



Observe the flame and add oxygen by opening the oxygen control valve of the blowpipe. Now a bright white cone starts appearing at the tip of the nozzle. (Fig 19)

Flame adjusting to set different types of oxy-acetylene flames.

To adjust the neutral flame, add sufficient oxygen to make the white cone clear and round. (Fig 20)

Fig 19

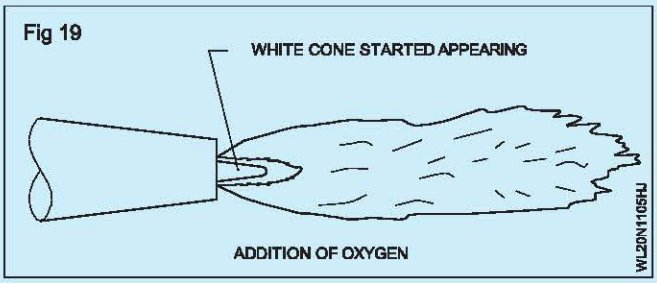
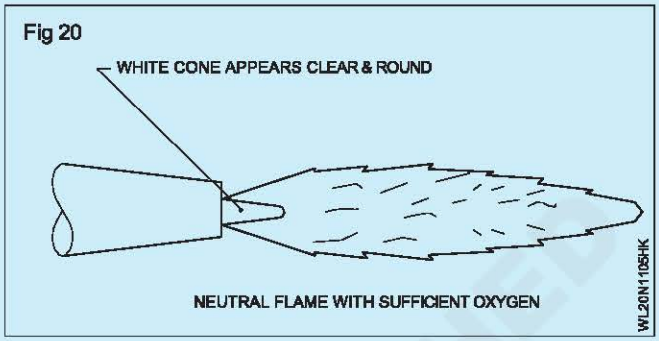


Fig 20



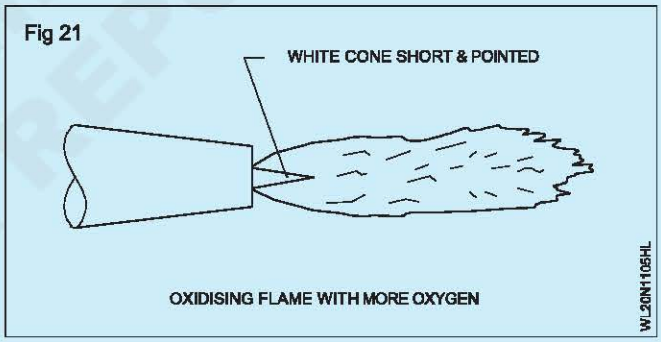
The gas mixture from the blowpipe has equal volume of oxygen and acetylene.

To adjust the oxidizing flame, from neutral flame decrease acetylene flow.

The white cone will become short and sharp.

The flame will produce a hissing sound and will have a short length. (Fig 21)

Fig 21



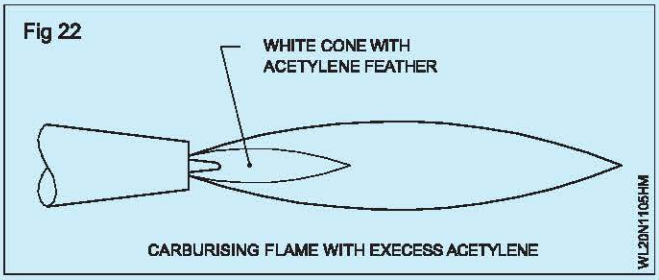
The gas mixture from the blowpipe has more volume of oxygen than acetylene.

To adjust the carburizing flame, adjust the flame to neutral and then add acetylene.

The white cone will become long surrounded by a feather like portion.

The flame will burn quietly having more length. (Fig 22)

Fig 22

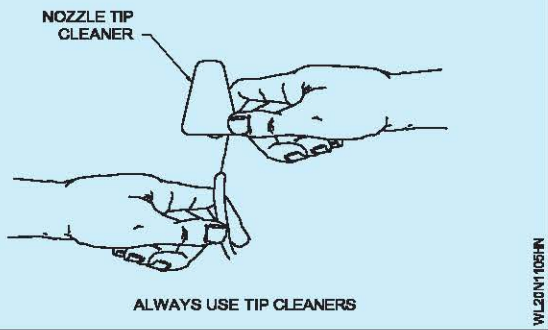


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The gas mixture from the blowpipe has more volume of acetylene than oxygen.

After continuous use of the blow pipe during welding the nozzle may get blocked by metal particles or spatters. This blockage has to be removed to get continuous flow of gases by using a nozzle cleaner. (Fig 23)

Fig 23



Repeat the setting of flames till you manage to set the flame without any backfire or flash back.

Extinguishing the flame

To extinguish the flame, close the acetylene control valve (blowpipe) first and then the oxygen control valve.

Closing down the plant

At the close of work, shut off the plant in the sequence given below.

Close the acetylene cylinder valve.

Close the oxygen cylinder valve.

Open the blowpipe acetylene valve and release all the gas pressure.

Open the blowpipe oxygen valve and release all the gas pressure.

Both the pressure gauges on the regulators should read zero.

Release the acetylene regulator pressure adjusting screw.

Release the oxygen regulator pressure adjusting screw.

Close the blowpipe acetylene valve.

Close the blowpipe oxygen valve.

Ensure

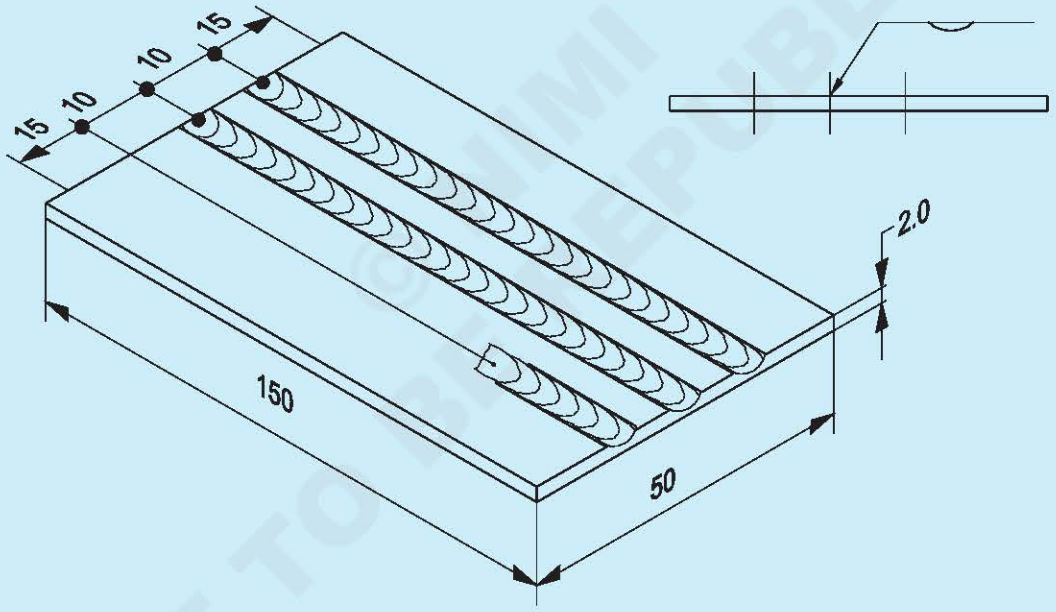
- there is no fire around the equipment
- the gas is completely exhausted by dipping the nozzle in water.

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Perform fusion run without filler rod on MS sheet 2mm thick in flat position (OAW-01)

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

- **prepare the job as per drawing**
- **select and fit the correct size nozzle**
- **set gas pressure according to nozzle size**
- **fusion run without the filler rod in flat position using leftward technique**
- **clean the weldment and visually inspect for weld defects.**



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01	ISST 150 x 2.0-50	-	Fe310-W	-	-	1.1.06
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE : NTS	**PERFORM FUSION RUNS WITHOUT FILLER ROD ON MS SHEET 2mm THICK IN FLAT POSITION (QAW-01)**				DEVIATIONS	TIME :
					CODE NO. WL20N1106E1	

Job Sequence

Fusion runs without filler rod in flat position

- Mark and cut the M.S. sheet pieces of size 150 × 50 × 2mm using a hand lever shear.

Care should be taken to keep the fingers off from the shearing blades. Wear gloves to avoid injury.

- Straighten the cut pieces by hammering on an anvil.
- File and finish the sheet to dimensions as per drawing.
- Mark and punch parallel lines on the sheet surface as per sketch and set the job piece on the welding table in that position with fire brick support.
- Select and attach nozzle size 5 to the blowpipe.

Wear safety apparels and gas welding goggles.

- Set acetylene and oxygen pressure 0.15 kg/cm^2 on the regulators.
- Ignite the oxy-acetylene gases and adjust the neutral flame.
- Hold the blowpipe on the job at its right hand end at the required angle.
- Start heating the surface on the right end of the sheet with slight circular motion to the blowpipe and produce a molten pool on the marked line.
- Move the blowpipe from right to left direction maintaining a uniform speed and blow pipe angle.
- Avoid excessive concentration of heat at any one point.

If the metal becomes too hot, lift the blowpipe momentarily away from the molten pool.

Do not touch the inner cone with the molten pool, to avoid backfire and flashback.

- Keep the molten pool in correct size by adjusting the rate of travel and giving slight circular motion to the blowpipe.
- Stop at the left end and lift and blowpipe quickly.
- Extinguish the flame and cool the blowpipe in water.
- Clean the fused surface with a steel wire brush and inspect for the uniformity of fusion runs.

If the speed of travel and blowpipe motion are correct, the fusion runs will appear with uniform width and even ripples.

Repeat the above 4 more times to achieve uniform fusion and better manipulation of blow-pipe.

Skill Sequence

Fusion run without filler rod

Objectives: This shall help you to

- **set and carry out fusion run without filler rod.**

Cleaning and setting job piece

Remove rust if any using a wire brush and emery paper.

Do not rub with heavy pressure on the wire brush.

Use the emery paper rolled on a piece of wood while cleaning.

Remove paint, oil or grease by dipping the M.S. sheet in a solvent of dilute hydrochloric acid.

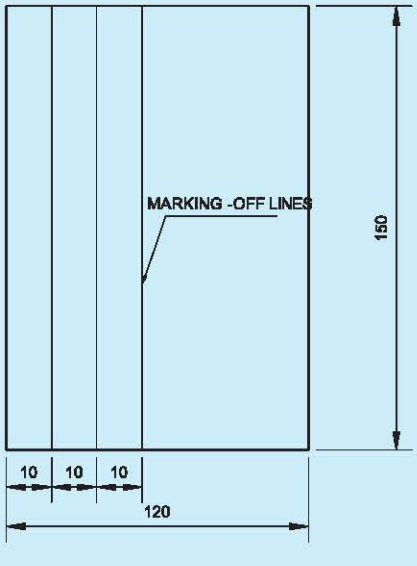
Draw lines parallel to the longer edge of the sheet at 10mm from one edge and punch along the lines to serve as a guide. Fig 1

Keep the job on the work table on a fire brick (Fig 2) to reduce the heat conduction and to position the job flat.

Use welding goggles.

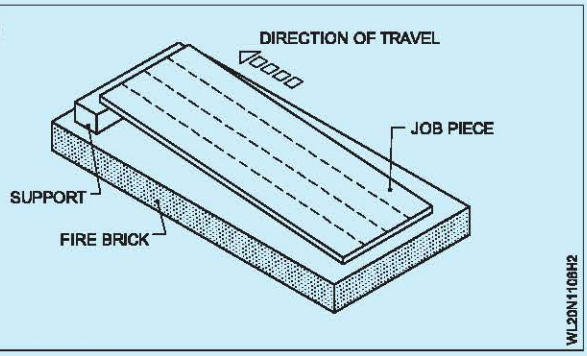
Hold the blowpipe and flame in correct position (angle) for proper fusion.

Fig 1



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Fig 2

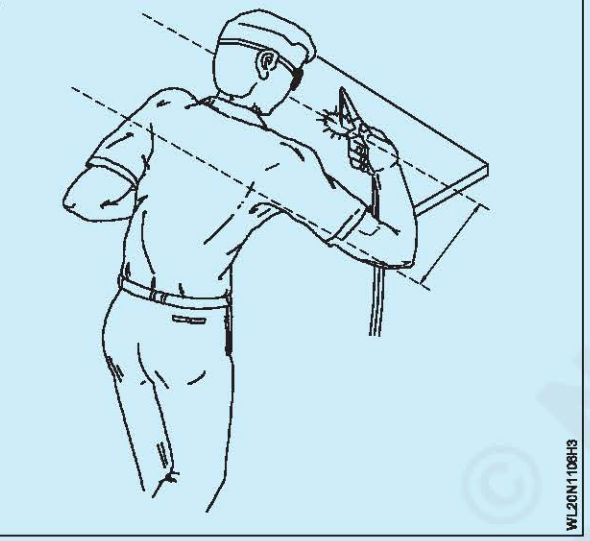


Position the blowpipe in such a way that:

– the punched lines of the sheet is parallel to the operator (Fig 3)

– there is less fatigue to the hand of the operator

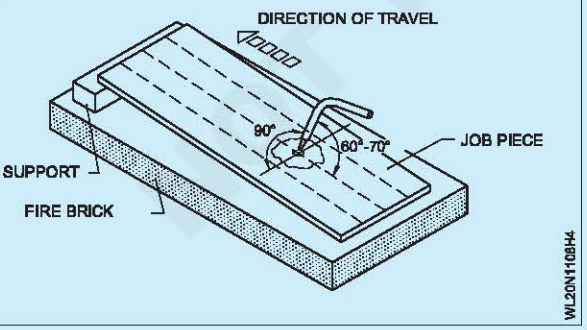
Fig 3



– the angle of the nozzle with the welding line is between 60° - 70°. The angle between the nozzle and the job surface should be 90°. (Fig 4)

Fuse the metal to form a small puddle of molten pool on the job surface at the right end.

Fig 4

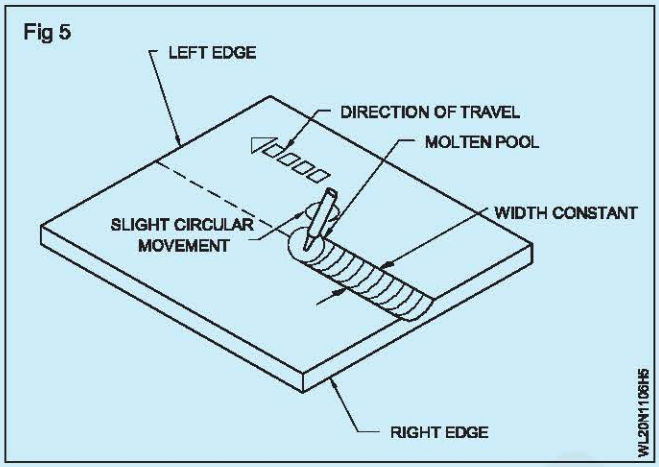


Making fusion run without filler rod

Move the blowpipe in the leftward direction as location fusion is obtained at the right end of a line.

Keep the molten pool on the punch line. (Fig 5)

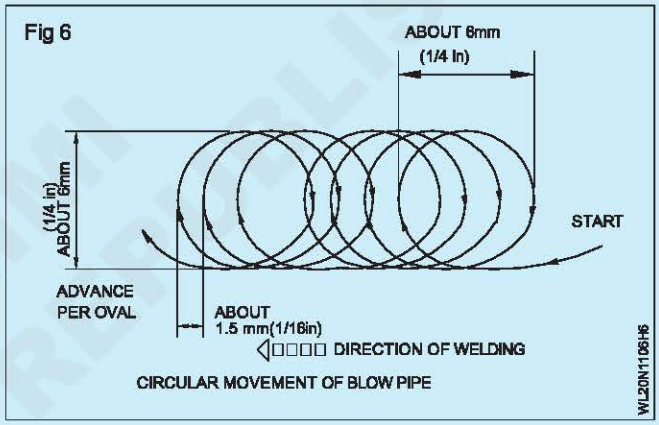
Fig 5



Maintain constant speed of travel with slight circular motion to the blowpipe. (Fig 6)

Reduce the blowpipe angle slightly near the left edge and slowly withdraw the flame to avoid burn through at the end.

Fig 6



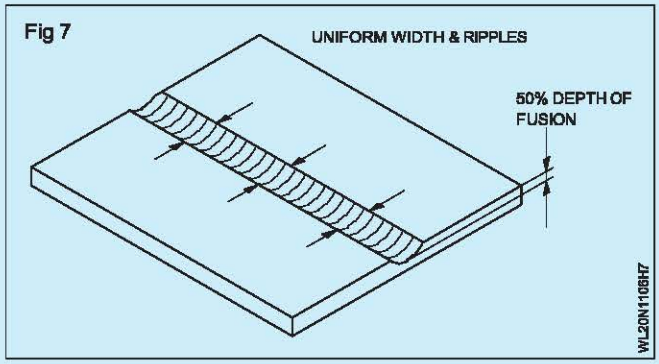
Maintain a constant distance of 2-3mm between the white cone of the flame and the sheet surface for proper heat input and to avoid backfire.

Visual inspection of fusion run

Visual examination can be done to ensure uniform width, ripples and proper depth of fusion (penetration) (Fig 7) for the bead after the welded job is cleaned thoroughly to remove the scales from its surface.

Use tongs while handling hot jobs.

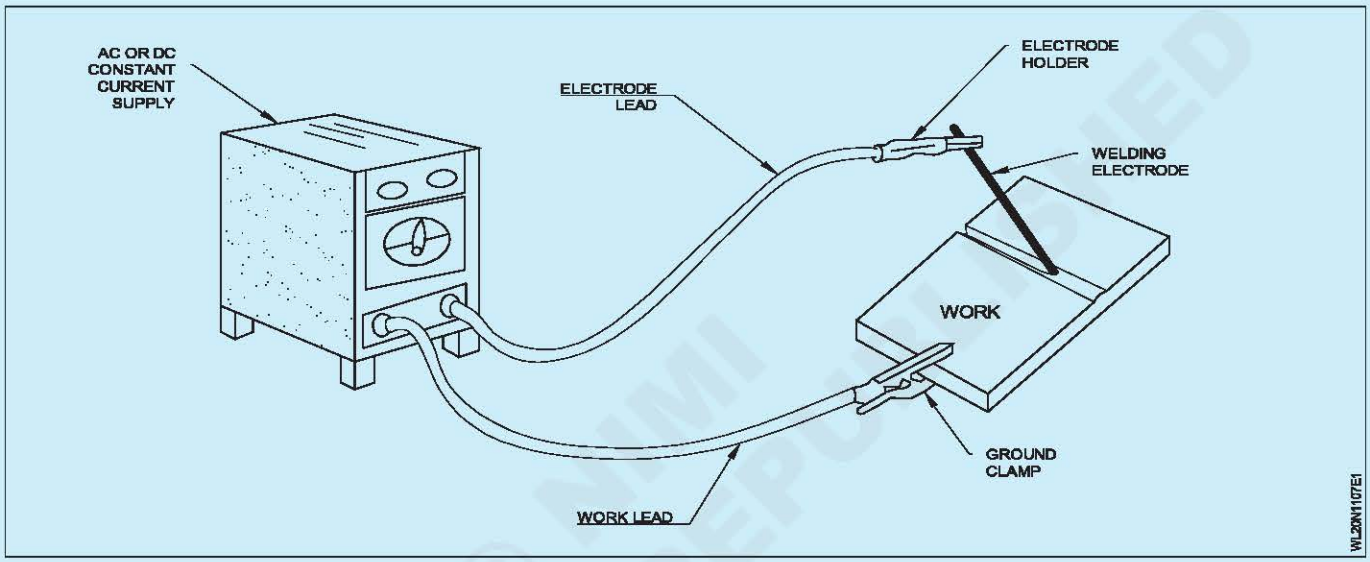
Fig 7



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Setting of arc welding machine & accessories and striking an arc (SMAW-01)

Objectives: At the end of this exercise you shall be able to
- **connect the welding cables between the welding machine, electrode holder and the job**
- **start and operate the controls and stop are welding machine in sequence**
- **set welding current strike and maintain the arc**
- **prepare and set job**
- **deposit uniform straight line bead in flat position**
- **clean and inspect the weld surface.**



Job Sequence

- Set up the equipment in a safe place
- Organize the tools are using.
- Obtain the piece for welding and connect the ground clamp to one of them.
- Turn on the welding transformer.
- Set the amperage as per the suggested list on the machine.
- Position the rod tip 25 to 50mm away from the welding position.
- Wear the helmet and now it is ready to strike the arc.

Skill Sequence

Setting of Arc welding machine and accessories and striking an arc

Objectives: This shall help you to
- **explain the methods of striking an arc**

Setting up Arc Welding plant (Fig 1)

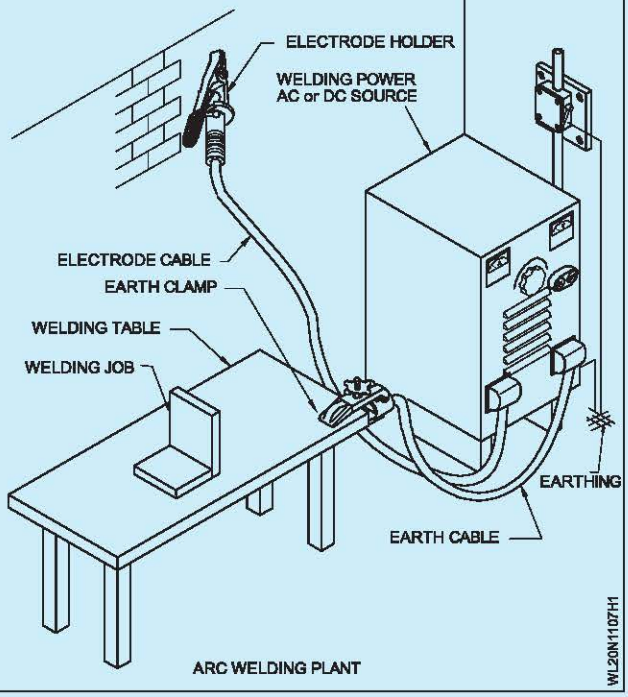
Check the welding machine and other accessories as per sketch. A welding generator or a welding rectifier (Fig 2) gives a direct current for welding and a welding transformer (Fig 3) gives an alternating current for welding.

Connect the welding machine to the power supply.

Be sure that the main supply switch and the welding machine are properly earthed. This will avoid any electric shock to the welder.
Fig 1

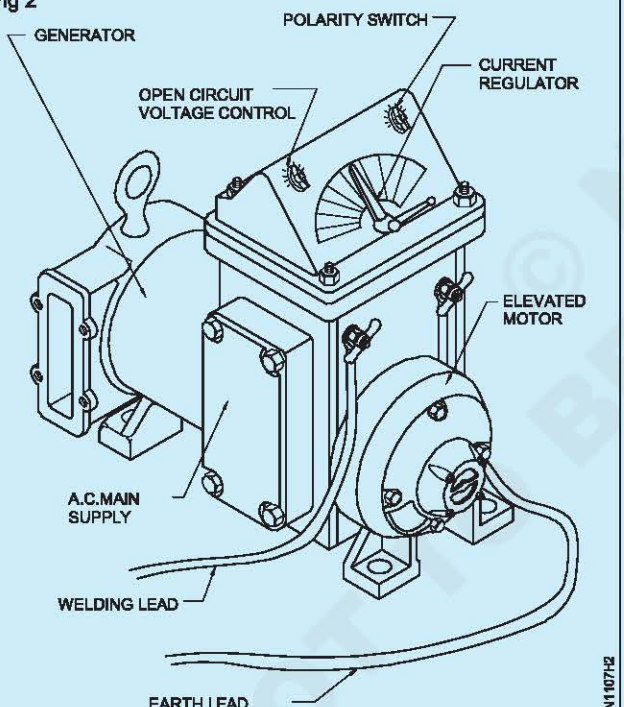
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Fig 1



ARC WELDING PLANT

Fig 2



D.C. WELDING GENERATOR

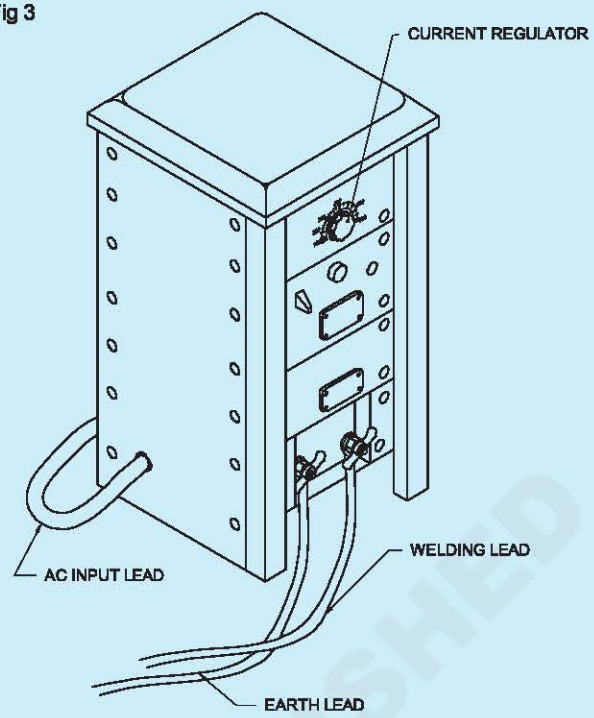
Switch on the starter.

Check and ensure the electrode holder and earth cable are without any loose connection or damage.

Loose cable connections cause spark, heat and unstable arc.

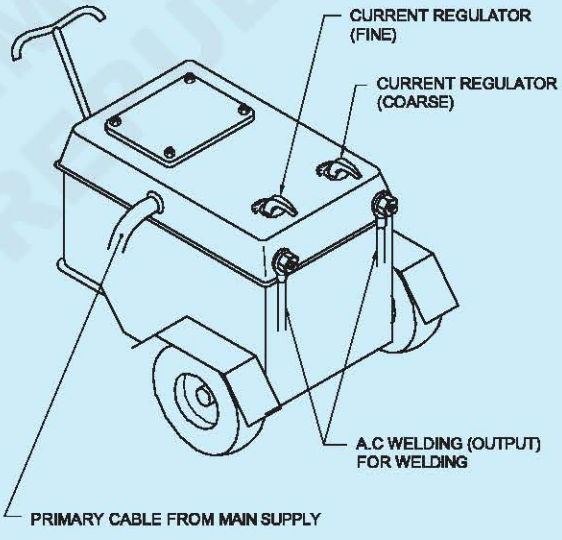
Connect tightly the earth cable to the welding table or work using the earth clamp and the electrode cable with the electrode holder.

Fig 3



DC POWER SOURCE - RECTIFIER

Fig 4



A.C WELDING TRANSFORMER

Hang the electrode-holder on an insulated hook provided near the welding table whenever it is not in use.

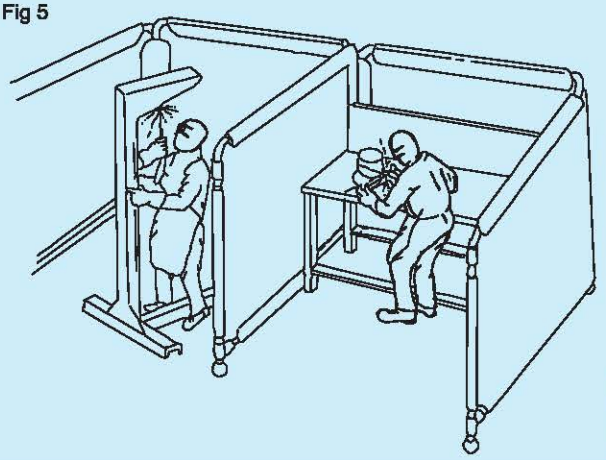
Place portable screens around the welding table for the safety of others. (Fig 5)

Check that the welding accessories such as chipping hammer, carbon steel wire brush, tongs and chipping goggles are in working condition.

Keep ready safety apparels (such as leather apron, gloves, sleeves, leggings, jacket, shoes and cap) to ensure personal safety.

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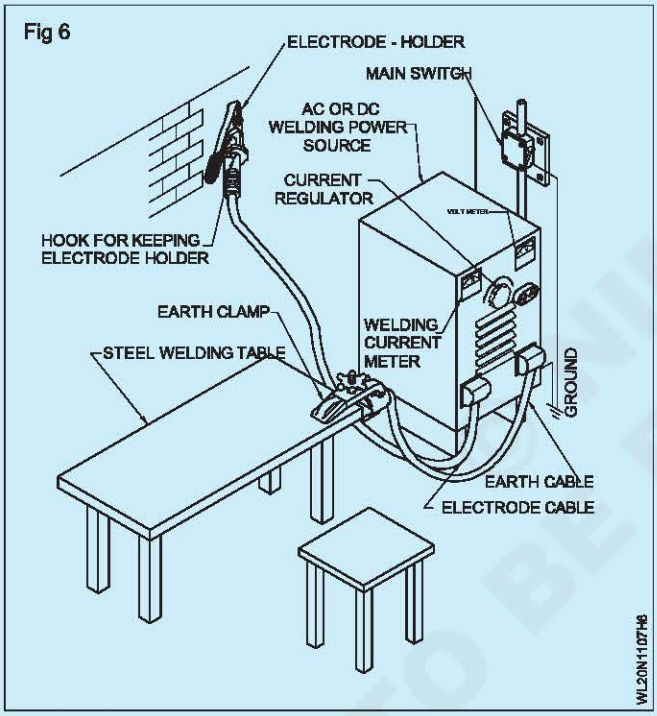
Fig 5



Operating the controls of arc welding machines. (Fig 6)

Arc welding machines are used to get suitable current for welding purposes.

Fig 6



Connect the welding machine to the main supply as follows.

- Install the welding machine near the 3 phase main supply, keeping the mains supply cables as short as possible to avoid electrical power losses.
- Call a skilled electrician for permanent connections to the main supply since it carries dangerously high voltage.

Ensure that the main switch, fuses and power cables electrode holder, earth clamp and cable lugs are of the required ampere capacity.

If the main supply connection is of the plug type, the welder can himself connect the main supply.

Check the proper operation of the main switch.

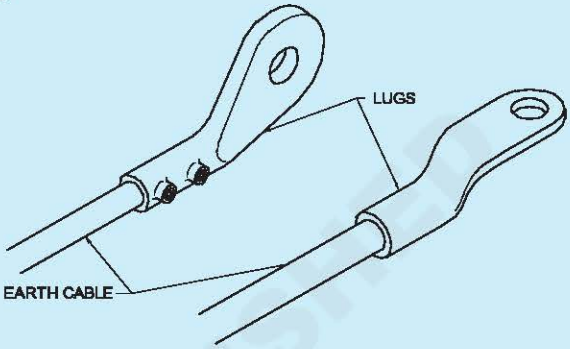
Check the proper operation of the on/off switch of the machine.

Check the proper operation of the current regulator of the welding machine and set the current at 110 ampere for a 3.15mm diameter electrode.

Check the operation of the polarity switch, if it is a DC welding generator or a rectifier.

Welding cables are used to carry the welding current from the welding machine to the electrode-holder and the job and suitable lugs are attached to the earth cable ends (Fig 7).

Fig 7



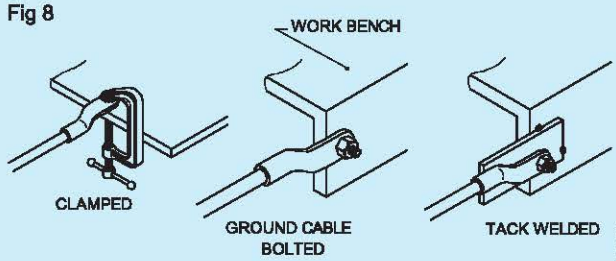
CABLE ATTACHMENTS

Connect one end of the earth cable to one of the output terminal of the machine tightly.

Connect the other end of the earth cable with the welding table or work tightly using the earth clamp as shown in Fig 6. Other methods are shown in Fig 8.

Connect one end of the electrode cable to the second terminal of the machine and the other end to the electrode holder.

Fig 8



METHOD OF ATTACHING EARTH CABLES

Starting and stopping of arc welding machines

Welding transformer

Switch 'on' the main supply of the welding transformer.

Start and stop the welding transformer (2-3 times) using the on/off switch provided on the machine.

Welding rectifier

Switch 'on' the main supply of the welding rectifier.

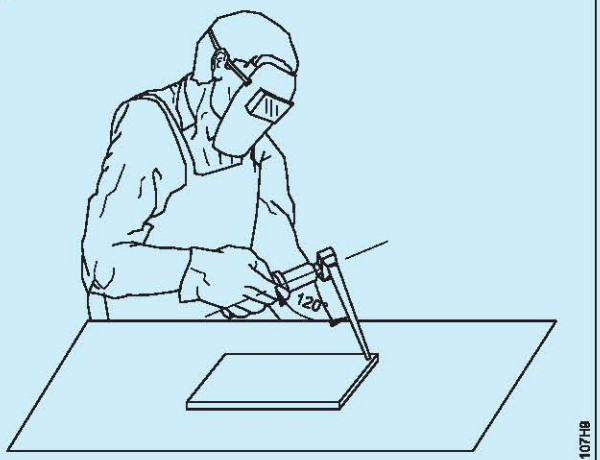
Start and stop the welding rectifier 2-3 times using the 'on' - 'off' switch provided with the machine.

In some of the rectifiers, a transfer switch is provided. By operating this switch the machine can be used as DC welding machine or as AC welding machine.

Striking of arc on mild steel (M.S.) plate in flat position

Fix a 3.15 mm dia medium coated mild steel electrode between the jaws of the electrode holder. (Fig 9).

Fig 9



WELDER ABOUT TO STRIKE AN ARC

Ensure the bare wire end of the flux coated electrode is firmly held in the slot/groove provided in the electrode holder.

Set 110 ampere for the 3.15 ø electrode. All electrode manufacturers indicate the current values for different size electrodes which can be used as a guide while setting currents.

Striking the arc is a basic action whenever a welder has to start welding or an electrode is changed or an arc is put-off during welding.

Connect the electrode to negative if the machine is a DC welding machine.

Clean the given scrap iron plate (work piece) surface with a steel wire brush, and clean the oil or grease, water and paint, if any.

Improper cleaning makes poor electrical contacts and weak welds due to weld defects.

Set the work piece on the welding table in a flat position.

Switch 'on' the input supply and start the welding machine.

Ensure safety apparels are worn. Fig 10

Hold the electrode about 5 mm above the job piece at one end at 75° angle to the line of weld and at 90° to the plate surface. (Fig 11)

Fig 10

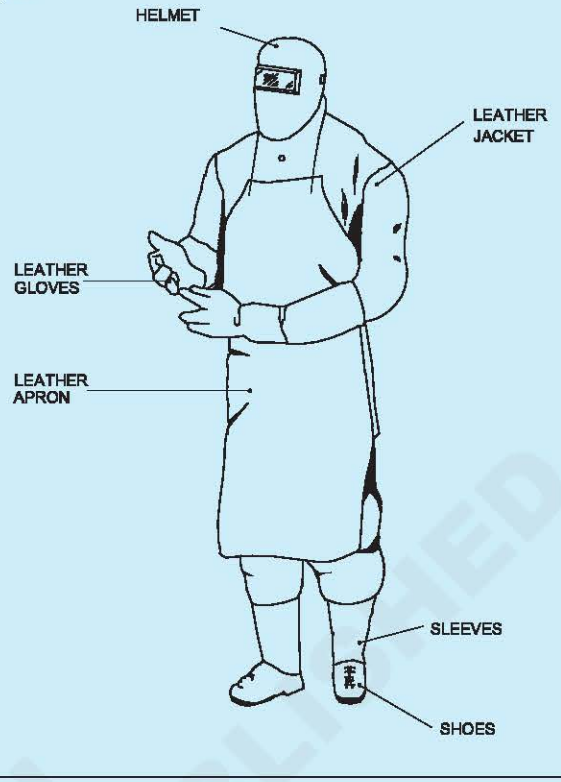
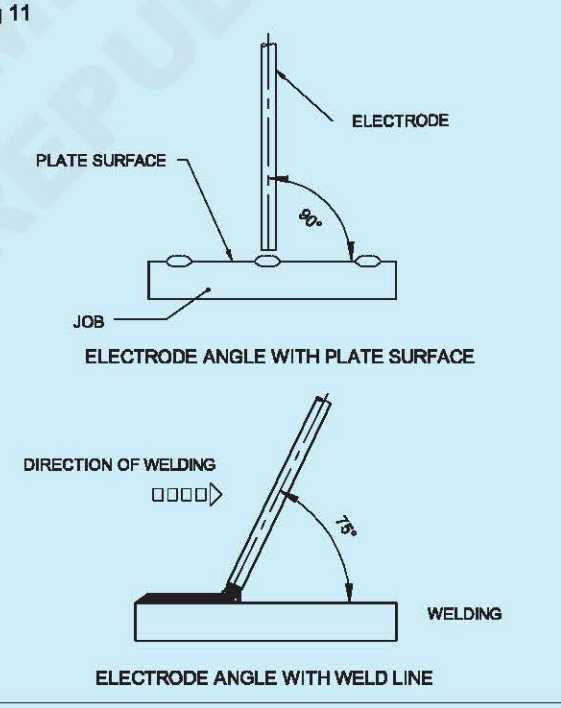


Fig 11



Scratching method (Fig 12)

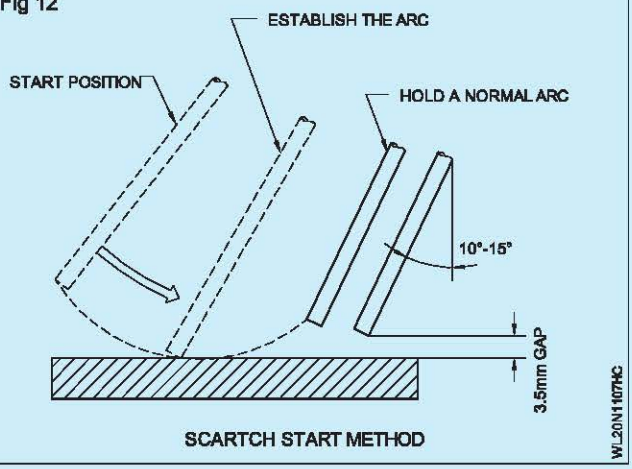
Put on the welding helmet or bring the welding shield in front of your eyes.

Strike the arc by dragging the electrode quickly and softly across the welding job using wrist movement only.

Withdraw the electrode approximately 6 mm from the surface for a few seconds and then lower it to approximately 3 mm distance to maintain the arc. (Fig 12)

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Fig 12



SCARTCH START METHOD

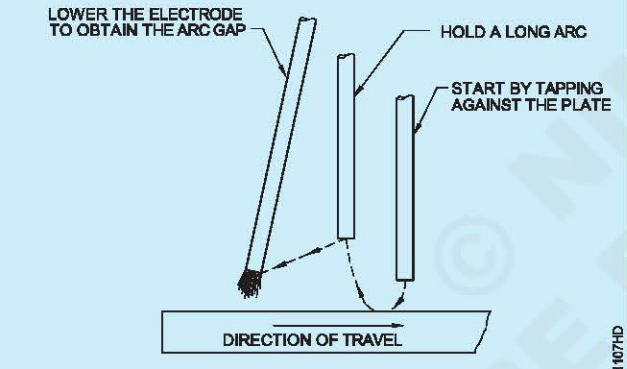
If the arc has been properly struck a 'burst of light with a steady sharp crackling sound' will be produced.

To break the arc quickly withdraw the electrode up.

Tapping method (Fig 13)

Strike the arc by moving the electrode down to touch the job surface lightly.

Fig 13



TAPPING METHOD OF STRIKING AN ARC

Lift the electrode up slowly approximately 6 mm for a few seconds and then lower it to approximately 3 mm from the surface to maintain a correct arc.

The tapping method is mostly recommended as it does not put pit marks on the job surface.

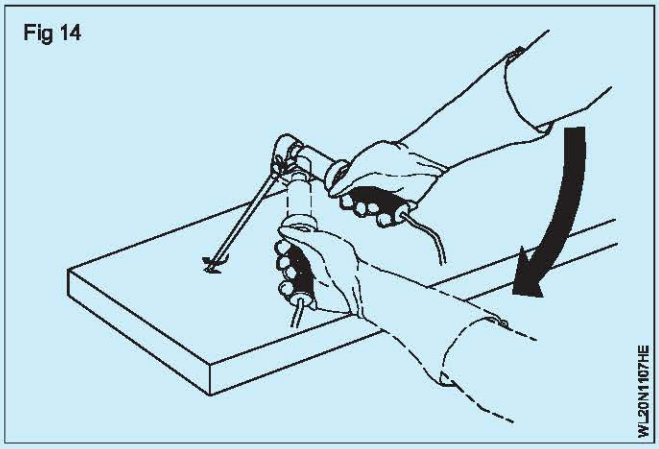
If the electrode freezes (sticks) to the plate, it should be immediately freed by a quick twist of the wrist to avoid its overheating or spoiling. (Fig 14)

Strike the arc by the scratching method.

Look at the arc through the filter glass only fitted in the welding screen/shield or helmet.

Remove the slag covering from the top of the short weld deposits by using a chipping hammer, and clean with a wire brush. Fig 15.

Fig 14



Use chipping goggle or chipping screen, while Deslagging welds. Fig 15

If the welded job is small in size use tongs to hold a hot job.

Repeat striking the arc on the scrap MS plate until the arc can be struck every time without the electrode freezing.

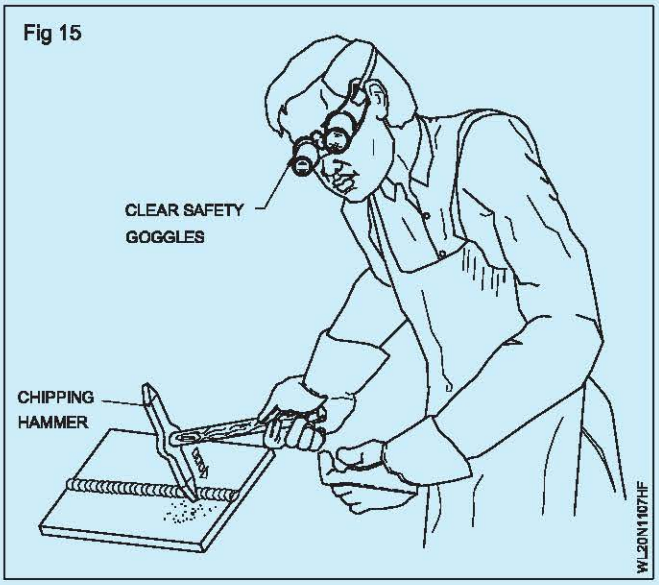
Safety precautions during arc welding

During metal arc welding, the metal is heated and fused by the heating source - electric arc. The following are the common dangers involved.

- Electric shock
- Sparks and spatters
- Smoke and fumes
- Heat radiation
- Chipped and hot slag particles
- Hot jobs and the hot stub ends.

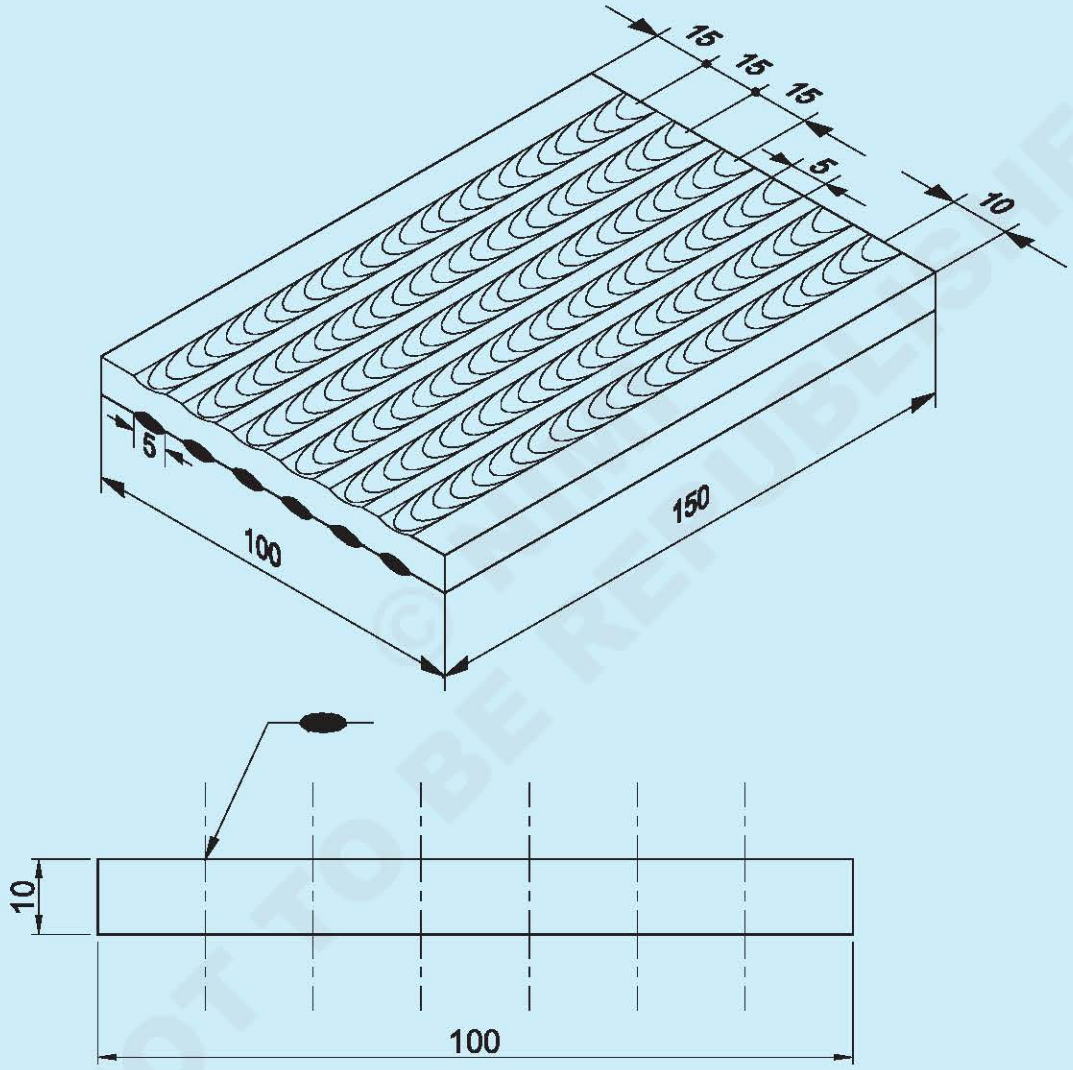
To protect the welder from the above dangers, he has to follow certain safety precautions which are explained in the Related Theory on Induction Training.

Fig 15



Deposit straight line bead on MS plate in flat position

Objectives: At the end of this exercise you shall be able to
- **prepare and set the job as per drawing**
- **select the electrode, current and polarity**
- **deposit uniform straight bead in flat position by arc welding**
- **clean and inspect the weld surface.**



1	100ISF x 10-100	-	Fe310	-	-	1.1.08
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**STRAIGHT LINE BEADS ON M.S PLATE 10mm THICK IN FLAT POSITION.**	DEVIATIONS ±0.5	TIME
		CODE NO. WL20N1108E1	

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Job Sequence

- Prepare the plates to size (as per drawing) by Hacksaw cutting and grinding.
- Clean the plate surface (job) with a stainless steel wire brush and remove the burrs by filing.
- Lay out parallel lines on both sides of the job surface as per sketch and mark with a center punch.
- Set the plate on the welding table in a flat position.
- Ensure the plate is contacting well with the welding table and the earth clamp is not loosely connected with the work table.
- Wear protective clothing safety apparels.
- Use welding goggles.
- Ensure the filter glass of the welding shield is in good condition.
- Fix a 4 mm ø M.S. electrode in the holder.
- Set the welding current to 150 to 160 amps approximately.
- Connect the electrode cable with the transformer welding machine. In case of a DC welding generator or rectifier, connect it to the negative terminal.
- Connect the earth clamp on the right extreme end of the job/work table.
- Start the welding machine.
- Strike the arc on a scrap piece for trial and observe the current setting.
- Ensure the burning of the electrode is normal and the arc is smooth.
- Use a short arc.
- Deposit straight line beads on the work piece along the punched line from the left hand end to the other end.
- Hold the electrode at 70° to 80° to the line of weld. Move it along the line of weld and towards the job at uniform speed.
- Restart the bead whenever the arc is broken and ensure to fill the crater.
- Fill the crater at the end of the bead without fail.
- Remove slag from the weld bead using a chipping hammer and clean with steel wire brush.
- Use a chipping screen while Deslagging.
- Inspect deposited beads for:
  - uniform width and height
  - straightness
  - uniform ripples
  - slag inclusion
  - unfilled crater
  - porosity
  - undercut

Skill Sequence

Deposit straight line bead on MS plate in flat position

Objectives: This shall help you to
- **maintain constant arc length, electrode angle and travel speed.**

Prepare a M.S. plate piece 100×150×10 using a hacksaw and file.

Mark straight line, punch the line keeping 15mm distance in between. (Fig 1)

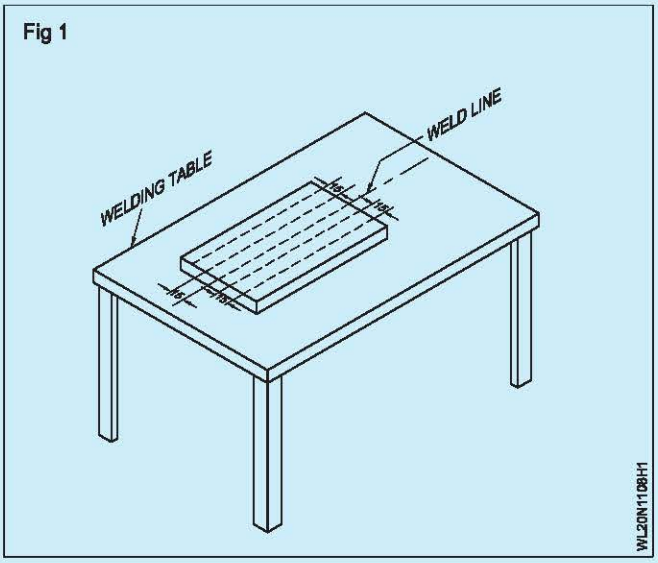
Set the job on the welding table in a flat position with the punched surface facing up. (Fig 1)

The bottom surface of the job should be perfectly clean to get good electrical contact between the job and the welding table.

Always follow the current range according to the diameter of the electrode, as given in the electrode packet by the electrode manufacturer.

Check for proper melting of the job and electrode on a scrap metal piece.

Fig 1



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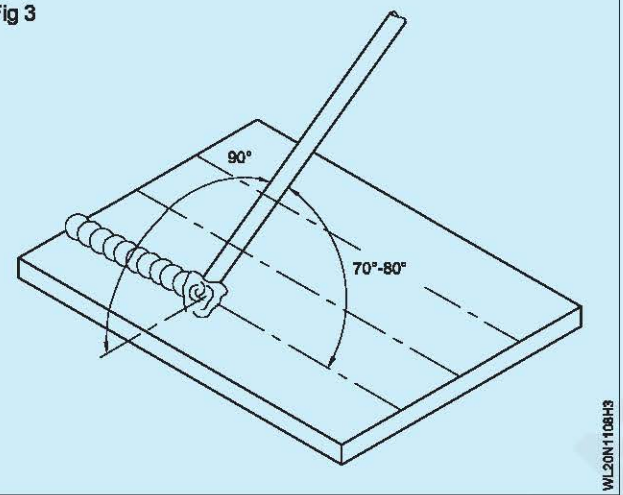
Hold the electrode at an angle of 70° to 80° with weld line/ punched line.

When a DC welding machine is used connecting the earth cable at the right end of the job or work table will help to deposit the weld metal at the correct place in the joint.

Deposit straight line beads taking the punched lines as a guide maintaining:

- the medium arc length (L) (i.e. equal to dia. of electrode used (d). If a DC welding machine is used then use of a short arc length will help to reduce the deviation of the molten metal from its intended path.
- correct travel speed (approximately 150 mm per minute)
- correct electrode position/angles. Fig 2

Fig 3

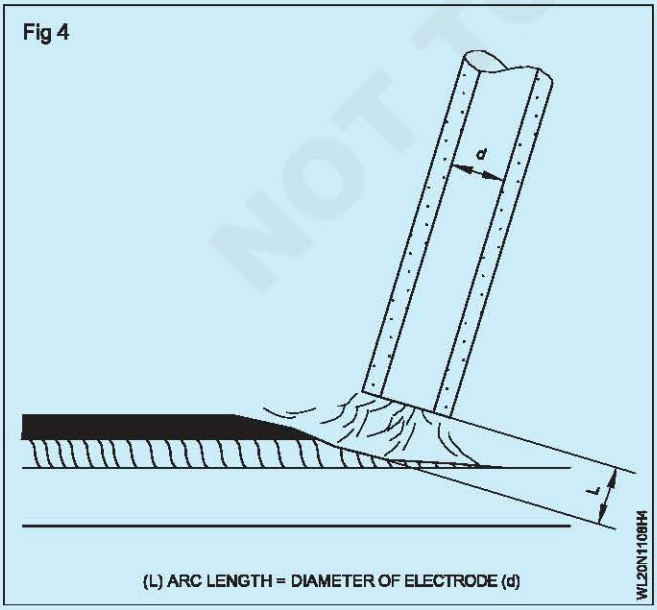


The electrode should be moved towards the job to maintain a gap between the tip of the electrode and the molten pool. (Fig 3)

Welding screen glasses should be clean enough to see the arc action on the molten pool and punched line mark.

Listen to the arc's steady sharp crackling sound while welding. It indicates uniform burning of the electrode.

Fig 4

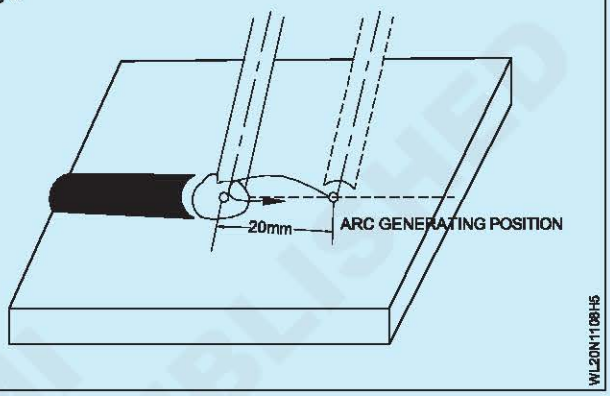


Adjust the travel speed by watching the electrode melting rate and flowing through the molten pool to form the deposited metal. The uniform travel speed of the electrode along and towards the line of the weld gives a uniform bead.

Whenever the arc is broken a depression called crater is formed at the breaking point and this crater has to be filled first while restarting the arc. So clean the crater and generate an arc at about 20mm ahead of the crater and return to the crater at a faster rate.

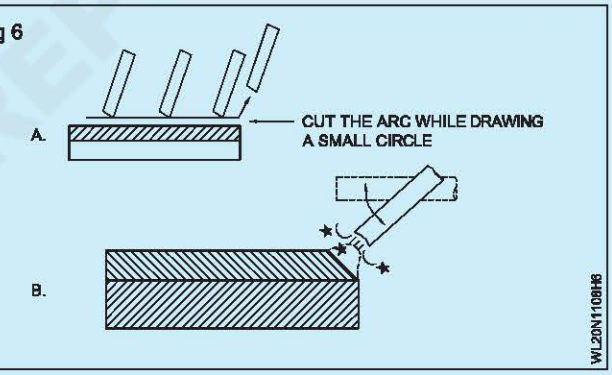
Build the deposit so that it fills the crater, then move the electrode ahead. Fig 4.

Fig 5



Also after completion of each bead fill the crater as follows. Fig 5

Fig 6



Build the deposit on the crater so that it is the same level as the welding bead.

- Let the arc length be shorter at the end of the run and draw a small circle 2 to 3 times.
- Repeat Off and On the arc at the end.

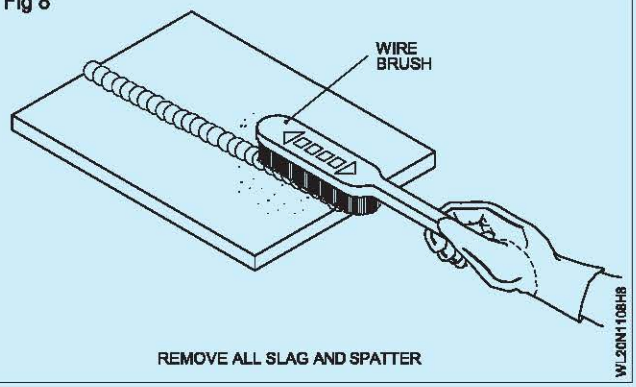
Fill the crater. Fig 5

Remove the slag and spatters from the weldment using a chipping hammer and wire brush, so that the metal surface of the bead is exposed for checking for any defects. (Fig 6)

Determine the causes for the above weld defects and use the remedial/prevention methods in further deposits.

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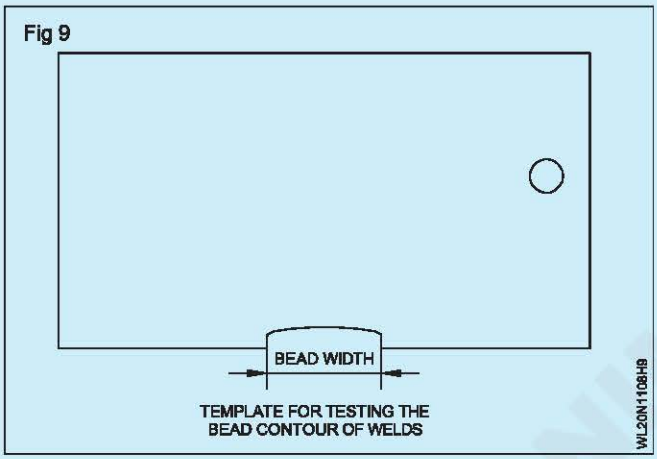
Fig 8



Check the deposited beads and note any variation in the:

– width and height using a weld gauge Fig 7.

Fig 9

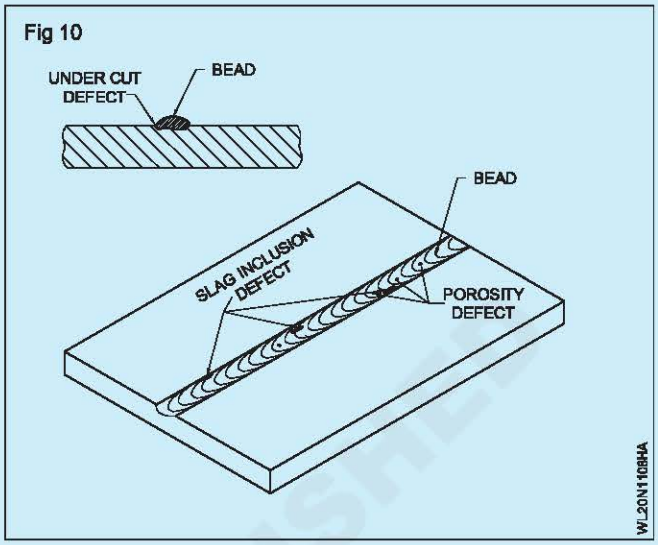


– depth of fusion

– straightness of the run

– check for surface defects such as slag inclusion, surface porosity, undercut, improper bead profile etc. Fig 8

Fig 10



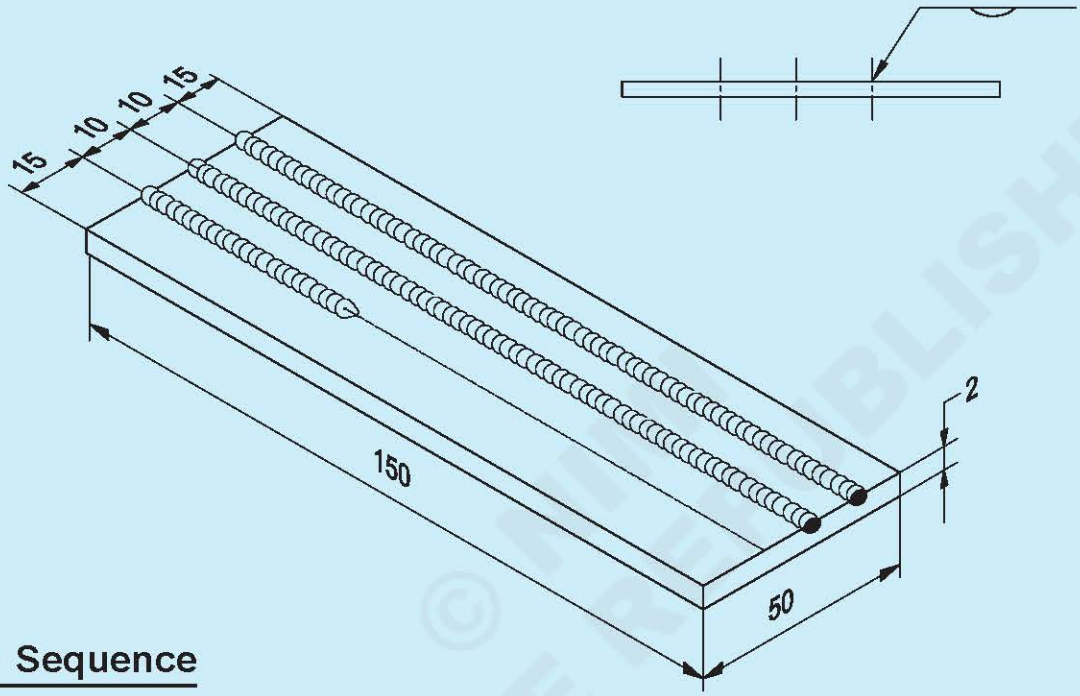
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Exercise 1.1.09

Depositing bead with filler rod on MS sheet 2mm thick in flat position (OAW - 02)

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

- **prepare the job as per drawing**
- **manipulate the blowpipe and set correct nozzle**
- **select filler rod and gas pressure**
- **deposit weld by adding filler metal.**



Job Sequence

Fusion run with filler rod in flat position

- Select and fix the nozzle size 5 and set acetylene / oxygen pressure 0.15 kg/cm^2.
- Select copper-coated mild steel (CCMS) filler rod of ø1.6 mm.
- Wear safety apparels and gas welding goggles.
- Ignite the oxy-acetylene gases and set the neutral flame.
- Hold the blowpipe on the right hand at an angle of 60° - 70° with the punched line of the job and make a small molten pool at the right hand edge of the line.
- Keep the flame cone distance 2.0 to 3.0 mm above the job surface.
- Hold the filler rod in the left hand, pointing near the molten pool with an angle of 30° - 40° with the line of weld.
- Melt the base metal at the right end of a punched line and create a molten pool/puddle.
- Fuse the end of the filler rod by dipping at the center of the molten pool and add filler metal on the job surface to form a weld bead.
- Move both the blow pipe and the filler rod towards left with uniform speed along the punched line with a slight circular motion to the blowpipe.

1	ISSH 150 x 2 x 50	-	Fe310-W	-	-	1.1.09
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : NTS	DEPOSIT BEAD WITH FILLER ROD ON M.S SHEET 2 mm THICK IN FLAT POSITION (OAW 02)	DEVIATIONS	TIME :
		CODE NO. WL20N1109E1	

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- Move the filler rod up and down (piston like motion) at a constant speed.
- Add enough rod into the molten pool to build up the bead evenly in height and width.
- Adjust the rate of travel of the blowpipe with the filler rod to control the size of the bead and the required penetration/depth of fusion.
- Keep the filler rod end within the flame outer flame to avoid oxidation.
- Stop at the left hand end of the punched line by filling the crater properly.
- Extinguish the flame and cool the nozzle.
- Clean the weld surface. Inspect for even ripples and uniform width/height of weld bead.
- Repeat this for the remaining 4 more punched lines to achieve better manipulation of blow pipe and filler rod.

Skill Sequence

Depositing bead with filler rod on MS sheet 2mm thick in the position

Objectives: This shall help you to
- **marking fusion run with filler rod.**

The beginner for gas welding must practice:

– holding the blowpipe in the correct position

– fusing of the metal by using a proper blow pipe manipulation

– getting proper coordination of both hands to manipulate the blow pipe and filler rod together

– deposit fusion run in a straight line from the right end to the left end of the job.

Preparation of sheet for welding

Use gloves while handling sheets.

Shear the MS strip to get job pieces 152 mm long × 52mm wide × 2.0 mm thick.

Remove buckling of sheet due to shearing by hammer on the anvil.

File the irregular edges of the job to remove burrs and unevenness on the edge to get a sheet size of 50x2mm.

Cleaning and setting job piece

Remove rust if any using a wire brush and emery paper.

Do not rub with heavy pressure on the wire brush.

Use the emery paper rolled on a piece of wood while cleaning.

Remove paint, oil or grease by dipping the M.S. sheet in a solvent of dilute hydrochloric acid.

Draw lines parallel to the longer edge of the sheet at 10mm from one edge and punch along the lines to serve as a guide. Fig 1

Keep the job on the work table on a fire brick (Fig 2) to reduce the heat conduction and to position the job flat.

Use welding goggles.

Hold the blowpipe and flame in correct position (angle) for proper fusion.

Fig 1

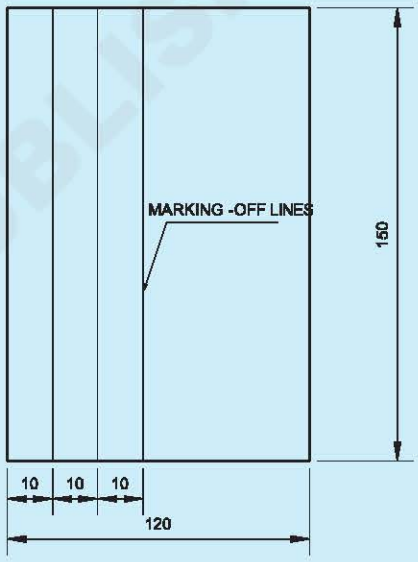
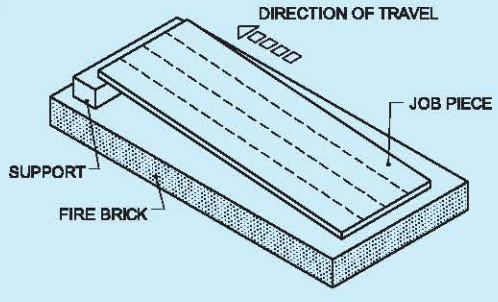


Fig 2



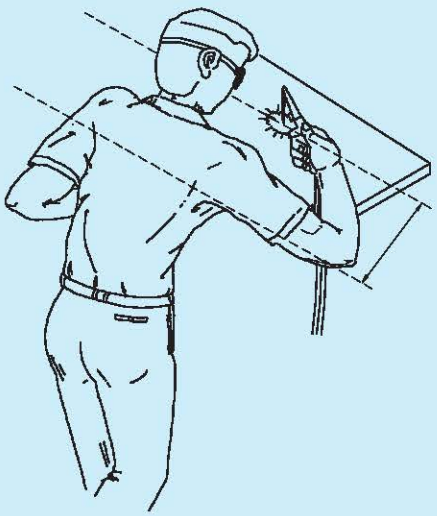
Position the blowpipe in such a way that:

– the punched lines of the sheet is parallel to the operator (Fig 3)

– there is less fatigue to the hand of the operator

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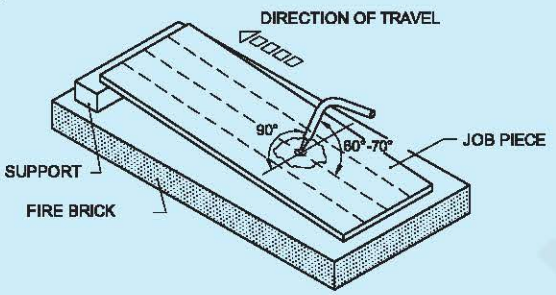
Fig 3



WI.20N1109H3

– The angle of the nozzle with the welding line is between 60° - 70°. The angle between the nozzle and the job surface should be 90°. (Fig 4)

Fig 4



WI.20N1109H4

Fuse the metal to form a small puddle of molten pool on the job surface at the right end.

Making fusion run with filler rod: During gas welding, most of the joints require filler metal to obtain proper size of weld and to get a strong joint. So while the flame melts the base metal, it also melts the filler rod to fill the groove or depression in the joint.

The feeding of filler metal in molten pool requires special skills.

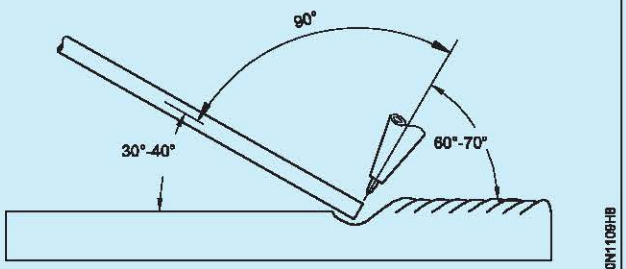
The heat input by the flame depends on the volume of acetylene and oxygen gas burnt. Different size nozzles will give different volume of gases and heat required to melt the metal depends on the thickness of metal to be welded. So select nozzles based on thickness of base metal to be welded.

For 3.0mm thick MS sheet select No. 5 nozzle and fix it to the blow pipe.

Blowpipe angle 60° - 70° with weld line (towards right). Filler rod angle 30°- 40° with weld line (towards left). (Fig 5)

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.

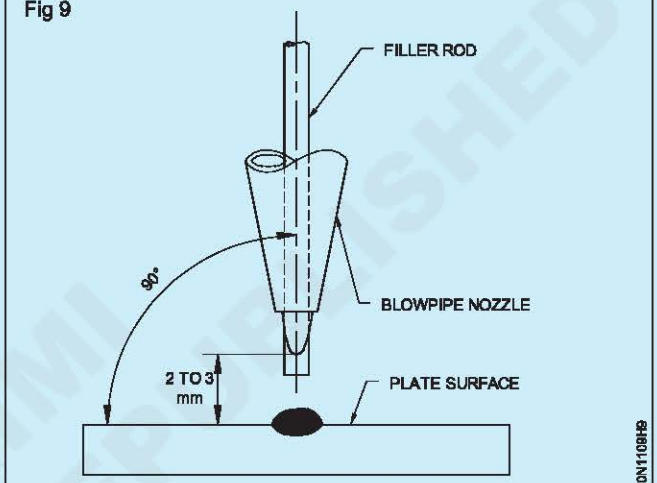
Fig 8



WI.20N1109H8

Keep the blowpipe and filler rod at 90° to the plate surface, so that the metal melts equally on both sides of the inner core of the flame. (Fig 6)

Fig 9



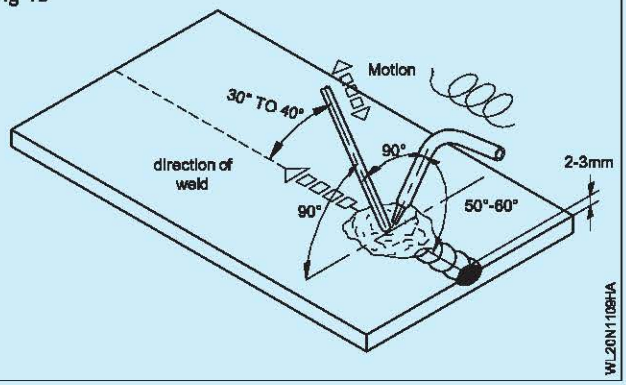
WI.20N1109H8

Fuse the metal surface, maintain the molten pool and add filler metal with proper motion.

For the blowpipe, a slight circular motion is required and for the filler rod, a piston like motion (Fig 7) (up and down) is required.

Maintain the flame cone distance to metal surface 2-3 mm.

Fig 10

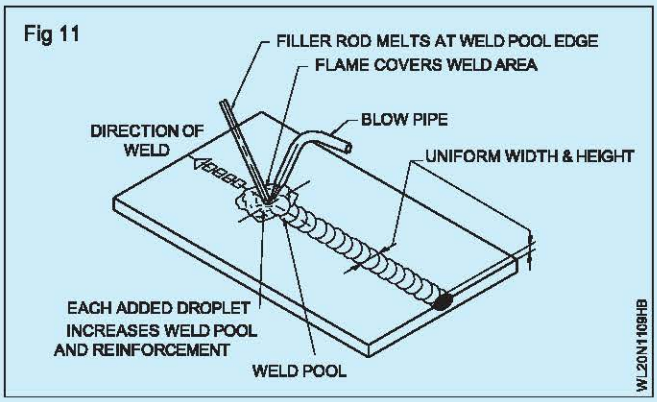


WI.20N1109HA

Move the blowpipe and filler rod in leftward direction, along the punch-marked straight line, to progress the weld. (Fig 8)

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Fig 11



Add filler rod in the weld pool to get 0.5 to 1 mm weld reinforcement above the sheet surface.

Maintain constant speed, angles and motion during welding for the blowpipe and the filler rod.

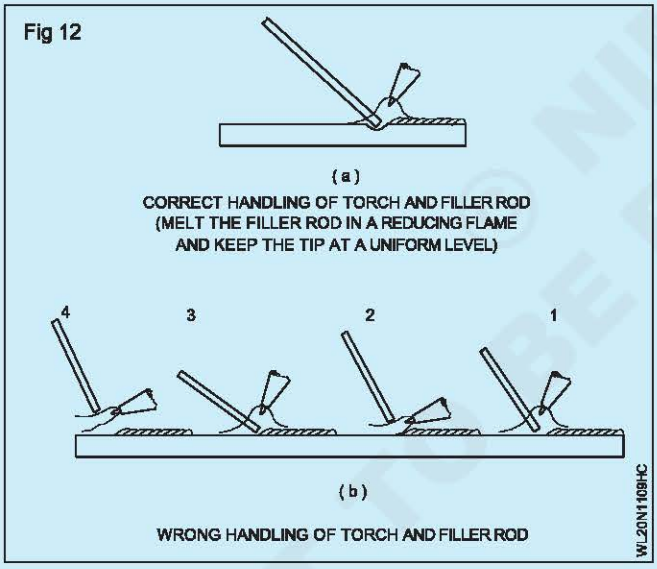
Keep the end of the filler rod within the outer envelope of the flame to avoid its oxidation.

Restarting and stopping of weld

Restarting

Hold the blowpipe nozzle at 80° angle with the cone pointing on the last 3 mm of weld bead deposited i.e. the crater. (Fig 12)

Fig 12



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 end to control burn through.

Build up the crater by adding enough filler metal, by dropping a few drops of molten metal at the crater.

Remove the flame slowly but cover the weld pool with the end of the flame's outer envelope to protect it from atmosphere.

Remove the filler rod end from the weld zone before the weld pool solidifies.

Inspection of the deposited run

Look for the following on the deposited bead.

Depression at various points on the bead. (This is due to variation in speed of travel of the blowpipe; improper feeding of the filler rod; wrong restarting; splashing of molten pool due to inner core of flame touching the molten metal.)

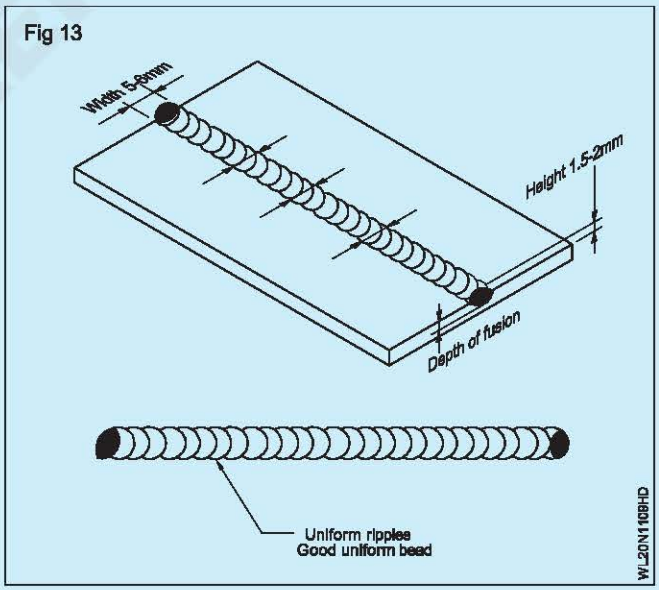
Undercut at the toes of the bead. (This is due to excessive pressure of gases and setting harsh flame; improper manipulation of the blowpipe; improper feeding of the filler rod.)

Concave bead surface. (This is due to harsh flame and excessive pressure of gases; inadequate feed of filler rod.

Porosity. (This is due to improper cleaning of the sheets; rusted filler rod.)

The correct bead is shown in Fig 13.

Fig 13

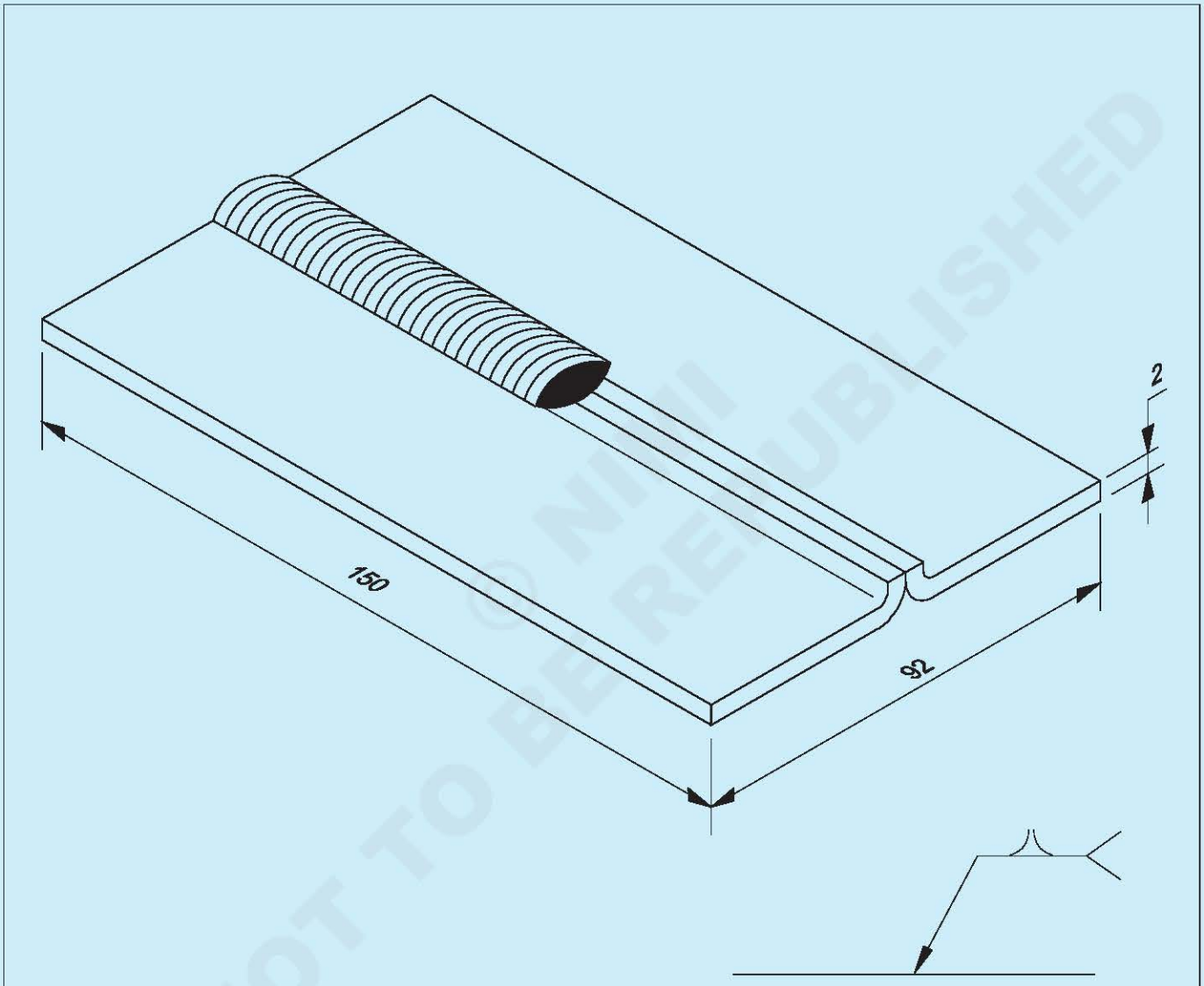


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Edge joint on MS sheet 2mm thick in flat position without filler rod (OAW-03)

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

- **prepare the job as per drawing**
- **bend the edges of the plate as per drawing**
- **set the job as a edge joint and tack weld**
- **weld the joint by fusion method.**



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2	ISST 50 x 2 - 150		Fe 310 - W			1.1.10
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**EDGE JOINT ON M.S.SHEET 2mm IN FLAT POSITION WITHOUT FILLER ROD**				TOLERANCE ±1	TIME
					WL20N1110E1	

Job Sequence

- Prepare the job pieces as per drawing.
- File the edges of square and ensure through cleaning of the edges.
- Bend the edges of the plates to be joined at 90° to the surface.

The length of the bent portion should be twice of the thickness of the plate.

- Set the gas welding plant, fix nozzle No. 7 and set the gas pressure of 0.15 kg/cm^2 for both gases.
- Set neutral flame.
- Clean the tacks and set the job on the welding table in a flat position, over fire brick supports.
- Start the weld at right end of the job.
- Keep the blowpipe at 60° - 70°.
- Fuse the edges uniformly and proceed towards left.

Fuse the bent edges up to the entire surface of the plate.

- Stop at the left end, fill the crater and complete the weld.
- Extinguish the flame, cool the nozzle in water.
- Clean the welded joint and inspect for
  - Uniform width and height of bead.
  - Uniform ripples.
- Edge plate melted off

Skill Sequence

Edge joining on MS plate

Objectives: This shall help you to
- **make bend the edges of the plates.**

Preparation: Prepare the job pieces of size 150×50×2mm = 2Nos by shearing and then filing.

Setting and bending:

- Bend the edges of the plates.
- Set the prepared job pieces on the welding table and tack at both ends.
- Length of the tack weld is 6 mm approximately.
- Check the alignment after tacking.

Welding

- Start the weld at the right end of the joint.
- Maintain uniform travel speed and feed to the flame.
- Clean the deposited bead using wire brush.

Use all the safety apparels and gas welding goggles.

Inspection

Inspect the quality of weld by

- Checking the finish of the job.
- Checking the uniformity of width and height of the weld bead in size.
- Checking the uniformity of ripples, fusion and complete penetration.
- Checking that the weld is free from faults such as porosity, undercut, lack of fusion etc.
- Blow wolks.
- Edge plate melted off.

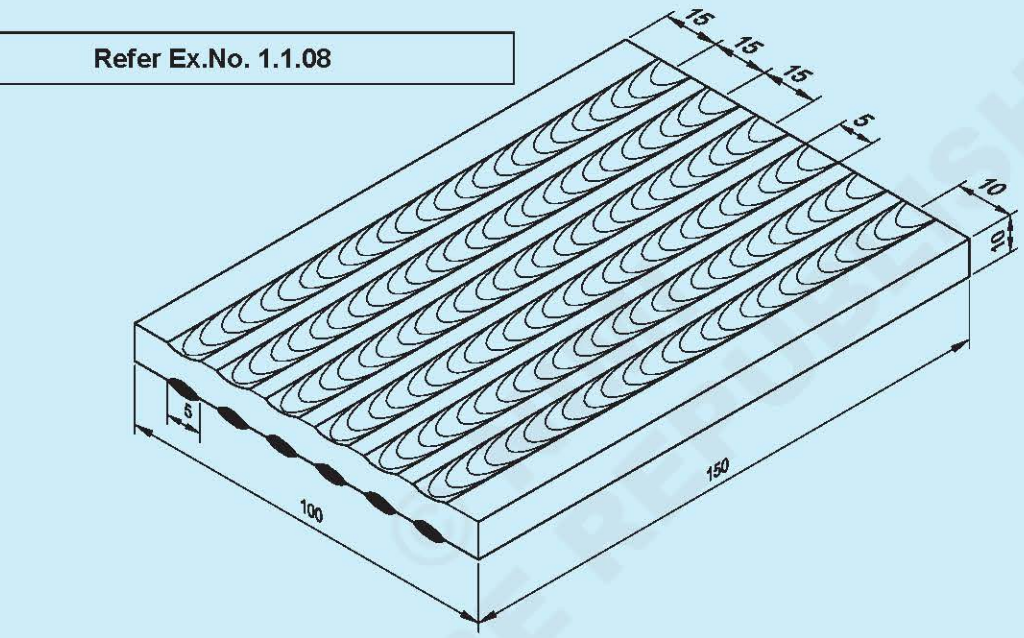
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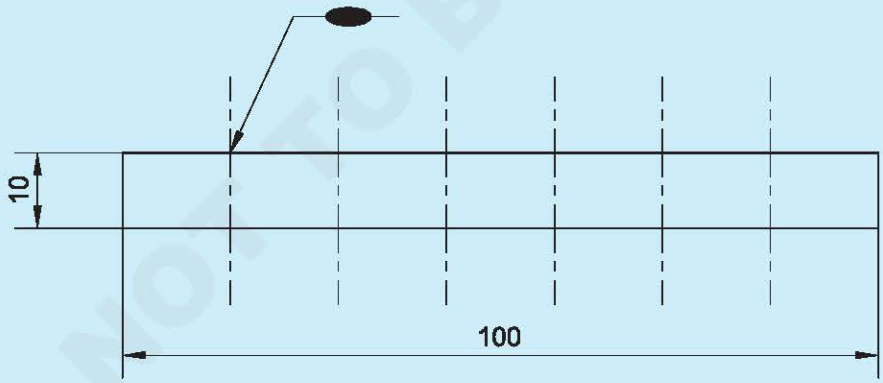
Straight line beads on MS plate 10mm thick in flat position (SMAW - 02)

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

- **prepare and set the job as per drawing**
- **select the electrode, current and polarity**
- **deposit uniform straight bead in flat position**
- **maintain constant arc length, electrode angle and travel speed**
- **clean and inspect the job.**

Refer Ex.No. 1.1.08





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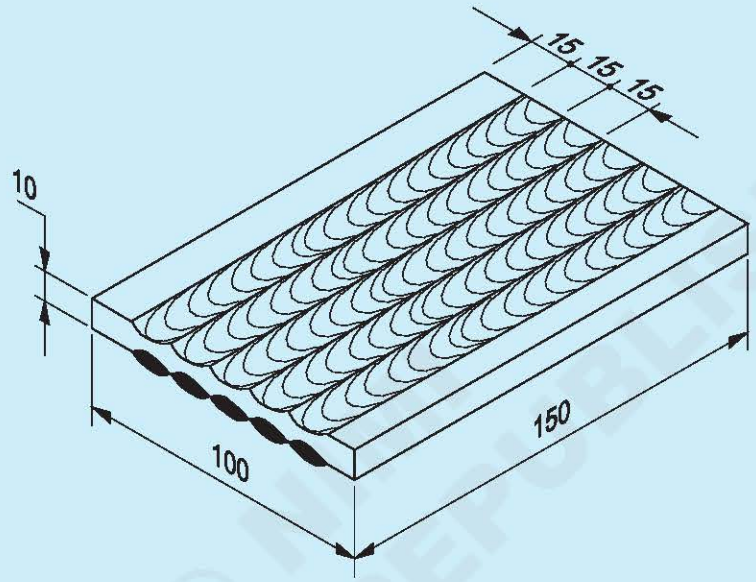
1	100 ISF 10 - 150		Fe 310 - W			1.1.11
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

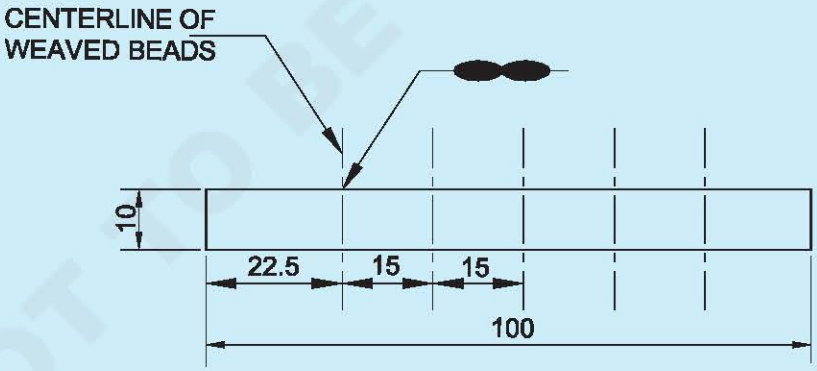
SCALE NTS	STRAIGHT LINE BEADS ON M.S.PLATE 10mm THICK IN FLAT POSITION (SMAW-02)	TOLERANCE ±1	TIME 10 Hrs
		CODE NO. WLN1111E1	

Weaved beads on MS plate 10mm thick in flat position (SMAW-03)

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

- **prepare the job as per drawing**
- **select and set the electrode, current, polarity**
- **deposit uniform beads by weaving in flat position**
- **maintain the required arc length, electrode travel speed.**





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1	100 ISF 10 - 150		Fe 310 - W			1.1.12
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	WEAVED BEADS ON M.S PLATE 10mm THICK IN FLAT POSITION.				TOLERANCE ±1	TIME
					CODE NO. WL20N1112E1	

Job Sequence

- Prepare the job to size as per the given drawing.
- Ensure the job piece is free from oil, grease, paint, dirt etc.
- Clean the job surface with a steel wire brush and by file the edges.
- Mark parallel lines on the job surface as per drawing for depositing weave beads and punch.
- Set the work piece (job) on the welding table in a flat position.

Wear protective clothing (safety apparels).

- Inspect the welding screen glasses for spatters and for suitable shade number.
- Select 4mm ø medium coated M.S. electrode. (BIS Code:ER4211)
- Set the welding current between 150 - 160 amps.
- Observe the electrode burning rate on a scrap piece and re-adjust the current, if necessary.
- Deposit the weaved beads on the work piece between the punched lines from one end to the other.
- Restart the weld whenever the arc is put off or when changing electrode or otherwise.
- Stop weld in the end and fill up the crater.
- Deslag the weld bead using a chipping hammer and clean with a steel wire brush.

  Use chipping goggles and tongs during Deslagging.
- Inspect the deposited weaved beads for:
  - uniform width and height
  - straightness of beads
  - uniform ripples
  - overlap on sides of weld
  - external weld defects like undercut, porosity, slag inclusion etc.
  - unfilled crater
  - restarting defects.

Skill Sequence

Weaved beads on MS plat 10mm thick

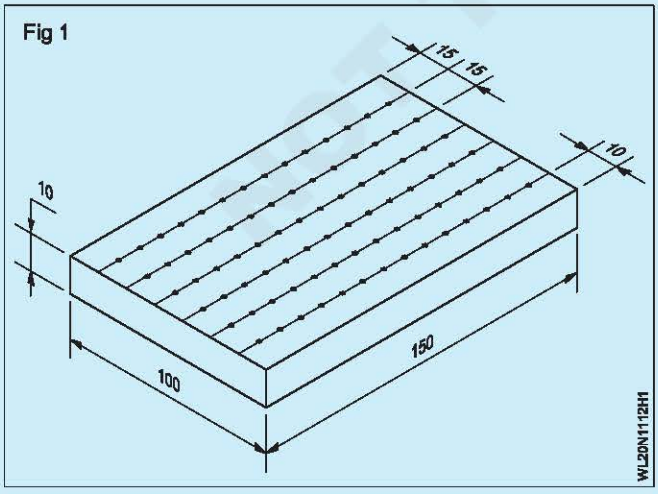
Objectives: This shall help you to
- **maintain the required arc length, electrode travel speed**
- **clean and inspect the weld defects.**

Wider or weaved beads are required while welding deep groove joints and multi-pass fillet welds used while welding thicker plates and pipes.

Deposition of weaved beads in flat position

Prepare M.S. plate piece 150×100×10mm with punched lines for laying weaved beads. (Fig 1)

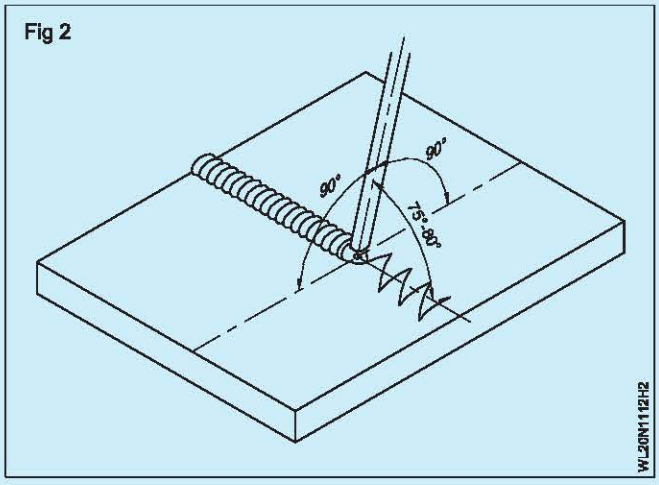
Fig 1



Ensure 150 - 160 amps current setting for a 4.00 mm ø medium coated M.S. electrode. For selecting the current to be used for different types and sizes of electrodes, refer the electrode packet on which the details are given.

Position the electrode with the weld line at an angle of 75° - 80°. Fig 2.

Fig 2



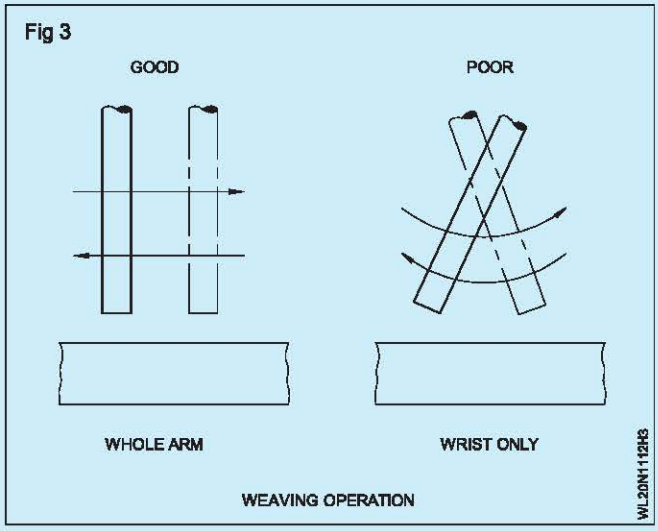
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Position the electrode with the adjoining plate surface at an angle of 90° giving side-to-side weaving motion using the arm movement. Avoid using wrist movement for electrode weaving.

Deposit the weaved beads between the punched lines by:

Positioning the electrode correctly (as shown in the Fig 2)

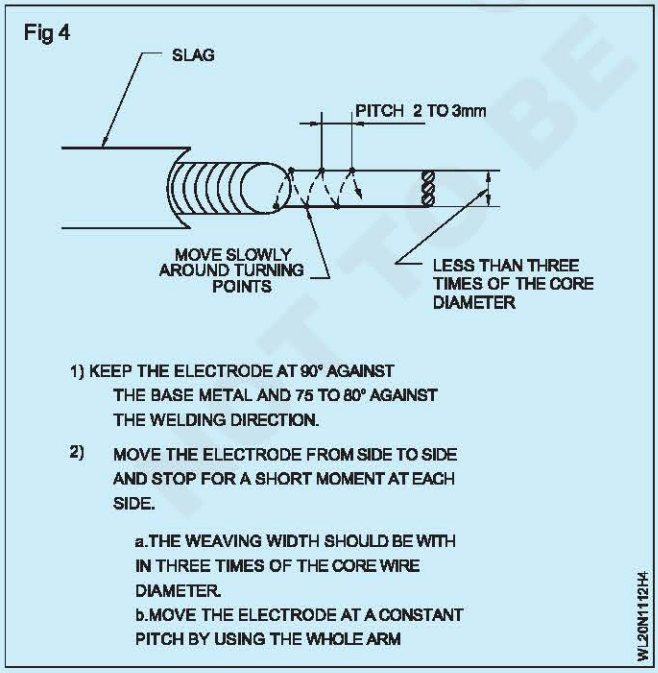
Weaving the electrode side-to-side. (Fig 3)



Restrict the weaving motion to three times the electrode diameter i.e. 10 for 4mmø electrode.

Advance the bead on each weave by not more than 2 to 3 mm, so that the light, thin, molten slag will always be kept away from the molten pool of metal. Fig 4.

Advancing the bead too far ahead will result in slag inclusion and poor appearance.



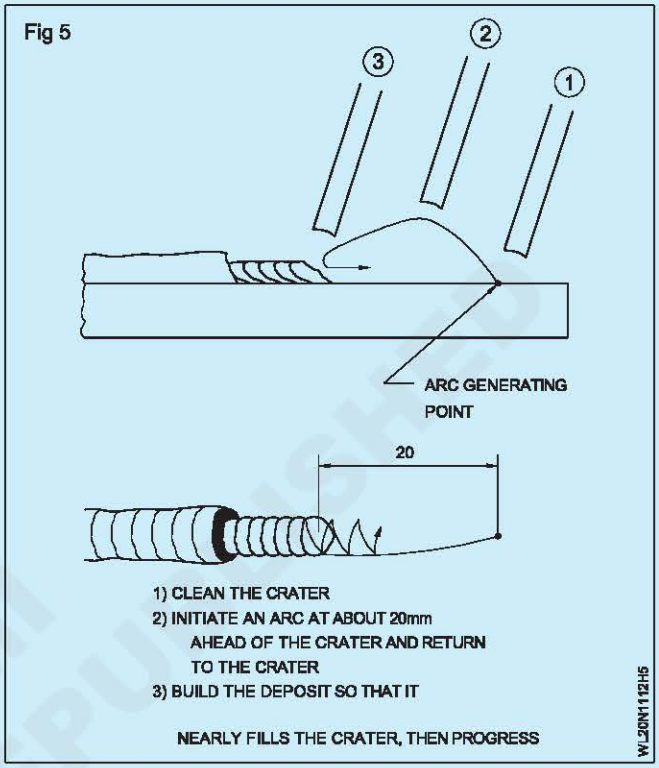
Restarting of bead

To ensure a good restart, proper fusion and fill up at the crater, proceed as follows. Remove the slag about 10-15 mm from the end of the crater.

Restart with a long arc at the forward edge of the crater. (Fig 5)

Move the arc slowly across the crater reducing the arc length and fill the crater.

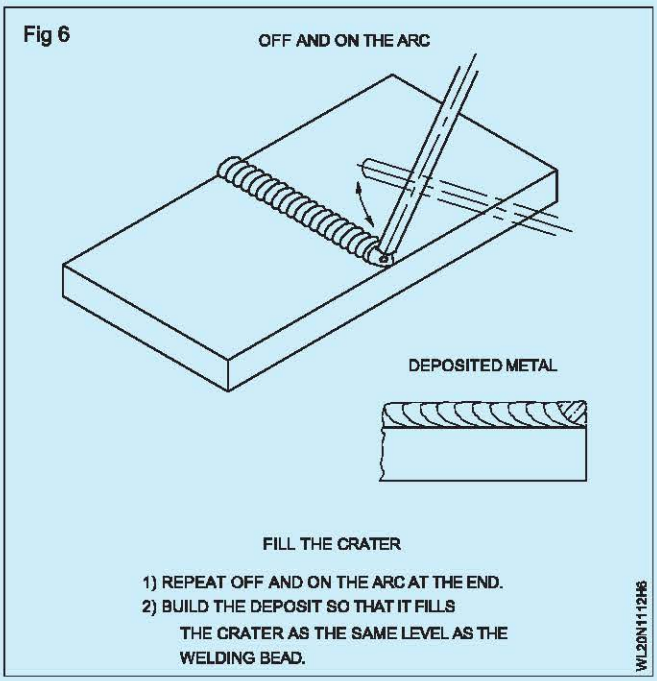
Start forward travel at the normal rate with medium arc length.



Ending the bead

At the end of each weld bead fill up the crater as follows.

Stop the forward movement of the electrode at the end of the weld. (Fig 6)



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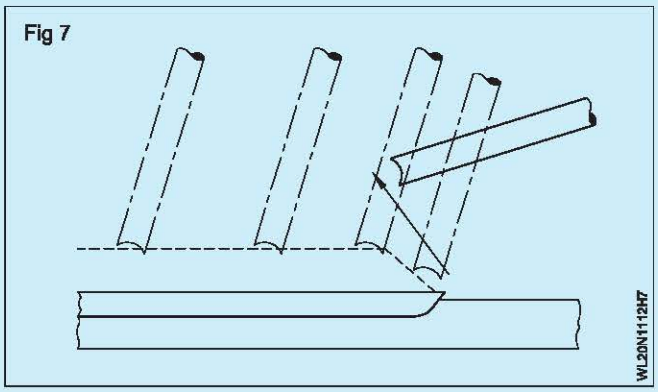
Change the angle of the electrode.

Move back along the weld about 15-20 mm.

Hold for 2 to 3 seconds to fill the crater.

Break the arc quickly. (Fig 7)

Fig 7

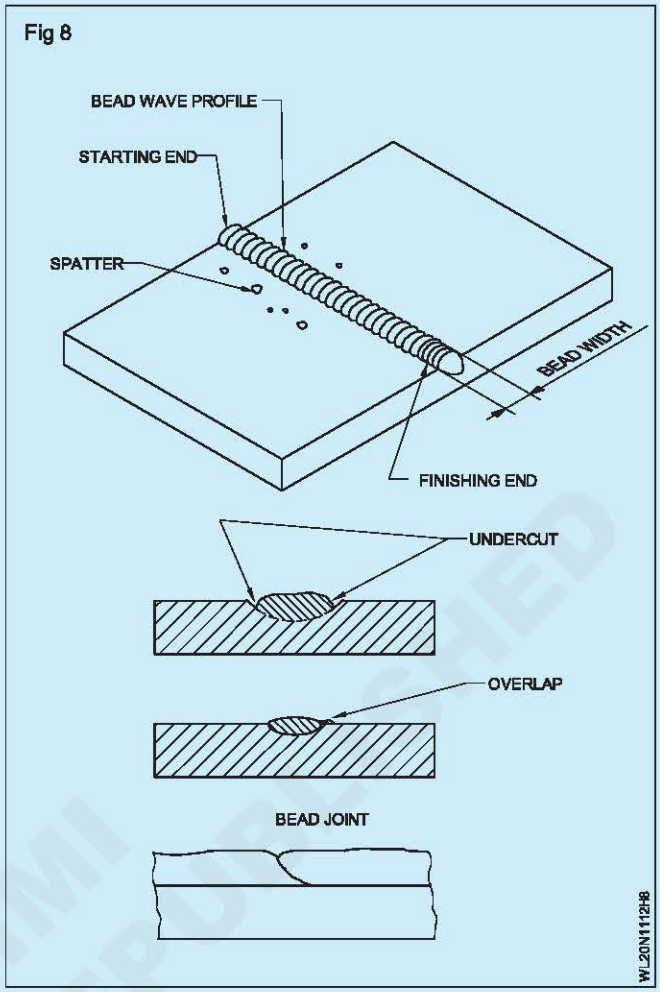


Inspect the beads.

Check for

– Bead form (width, reinforcement and wave profile). Fig 8
– Undercut and overlap porosity, slag inclusion and finish. Fig 8

Fig 8

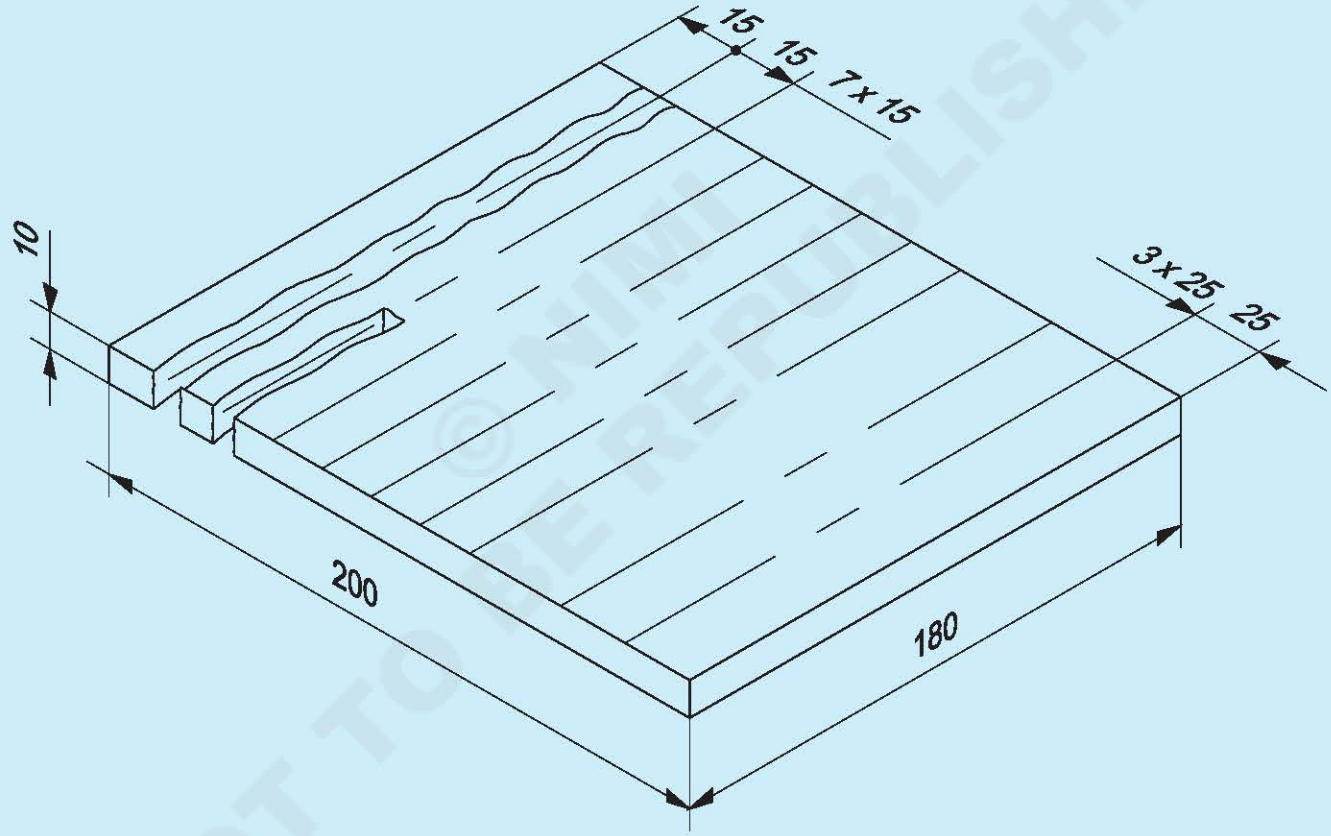


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Setting up of Oxy - Acetylene flame and make straight cuts by free hand

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

- **set oxy-acetylene plant for gas cutting**
- **set the work piece for a straight cutting**
- **set the cutting flame**
- **make straight line cutting**
- **clean and inspect the job.**



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1	100 ISF 10x200mm	-	Fe310-W	-	-	1.1.13
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	SETTING UP OF OXY - ACETYLENE PLANT AND STRAIGHT CUTTING BY FREE HAND (OAGC-01)	DEVIATIONS	TIME
		CODE NO. WL20N1113E1	

Job Sequence

- Wear complete safety apparel.
- Set the gas welding plant with a cutting blowpipe.
- Attach the correct nozzle according to the thickness of the metal.
- Adjust the gas pressure of acetylene and cutting oxygen according to the thickness of the metal and the cutting nozzle.
- Clean the surface to be cut.
- Punch a straight line.
- Adjust proper cutting flame setting.
- Hold the cutting blowpipe at 90^0 to the cut line and plate surface.
- Hold at one end of the plate on the punch line up to cherry red heat.

Keep a distance of about 5mm between the work piece and the nozzle.

- Release the cutting oxygen and observe the cutting action.
- Move the cutting blowpipe towards the other end, following the procedure line.

Maintain a correct speed and distance of the nozzle.

- Close the cutting oxygen and shut off the flame on the completion of the cut.
- Clean the cut and inspect for its accuracy without defects.
- Repeat the exercise till a good and smooth cut is achieved.

Skill Sequence

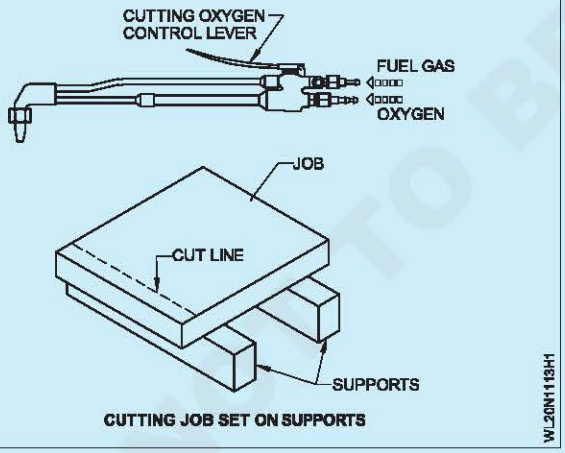
Straight cutting along by hand

Objectives: This shall help you to
- **observe safety precautions**
- **select the cutting nozzle and gas pressure.**

Setting the gas cutting plant: Set the oxy-acetylene plant and connect the cutting blowpipe.

Setting the job for cutting (Fig 1)

Fig 1



CUTTING JOB SET ON SUPPORTS

Set the job for cutting on a rigid surface.

Provide overhang so that the parting piece is free to fall.

Ensure the underside of the cut line is free from any obstruction.

Wear safety apparel while gas cutting.

Adjusting the cutting flame

Select the cutting nozzle and set the gas pressure as per the cutting job thickness. (Table 1)

Set the cutting nozzle in the blowpipe correctly. (Fig 2)

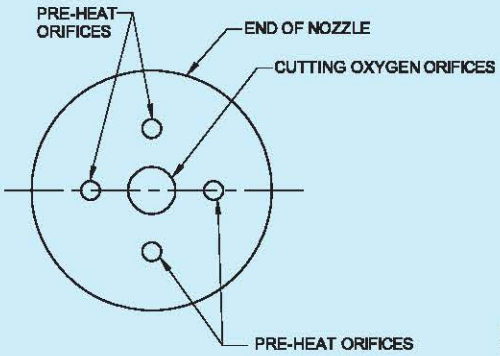
TABLE 1

Data for cutting

Diameter of cutting oxygen orifice nozzle	Thickness of steel plate	Cutting oxygen Pressure
(1) mm	(2) mm	(3) kg/cm^2
0.8	3-6	1.0-1.4
1.2	6-19	1.4-2.1
1.6	19-100	2.1-4.2
2.0	100-150	4.2-4.6
2.4	150-200	4.6-4.9
2.8	200-250	4.9-5.5
3.2	250-300	5.5-5.6

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Fig 2

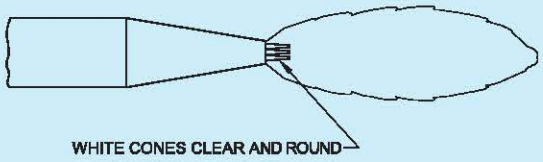


HOLES ON THE CUTTING BLOWPIPE NOZZLE

WL20N1113H2

Adjust the neutral flame for preheating. (Fig 3)

Fig 3



CORRECT FLAME ADJUSTMENT FOR CUTTING

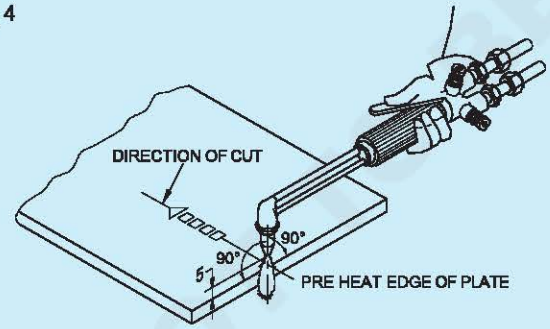
WL20N1113H3

Ensure that the flame adjustment is not disturbed while operating the control lever for cutting oxygen.

Straight cutting

Hold the cutting blowpipe at 90^0 with the plate surface, and cut along the line (Fig 4)

Fig 4



STARTING OF CUT

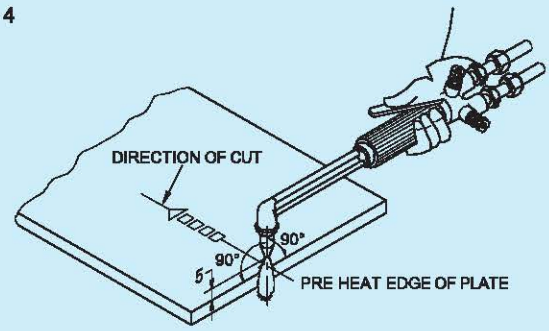
WL20N1113H4

Preheat the starting point to red heat. (Fig 4)

Keep the distance between the work piece and the nozzle about 5mm to avoid backfire. (Fig4)

Release the extra oxygen, observe the cutting action and start travelling along the punched line at a uniform speed. (Fig 5)

Fig 4



STARTING OF CUT

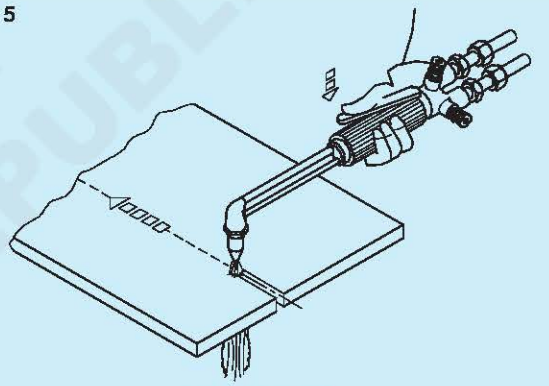
WL20N1113H4

While gas cutting ensure

Straight travel of the cutting blowpipe without side-to-side movement and correct nozzle position with the plate surface till the cutting oxygen valve is fully open.

If possible, fix the straight edge to the plate, and also the spade support to ensure a straight cut (Fig 6) and to maintain correct nozzle distance.

Fig 5

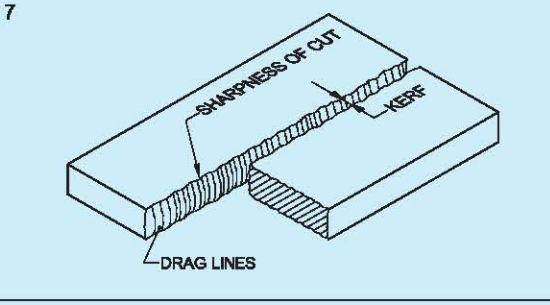


CUT IN PROGRESS

WL20N1113H5

Inspection of gas cut (Fig 7)

Fig 7



WL20N1113H7

Clean the gas cut with a chipping hammer, chisel and wire bunch.

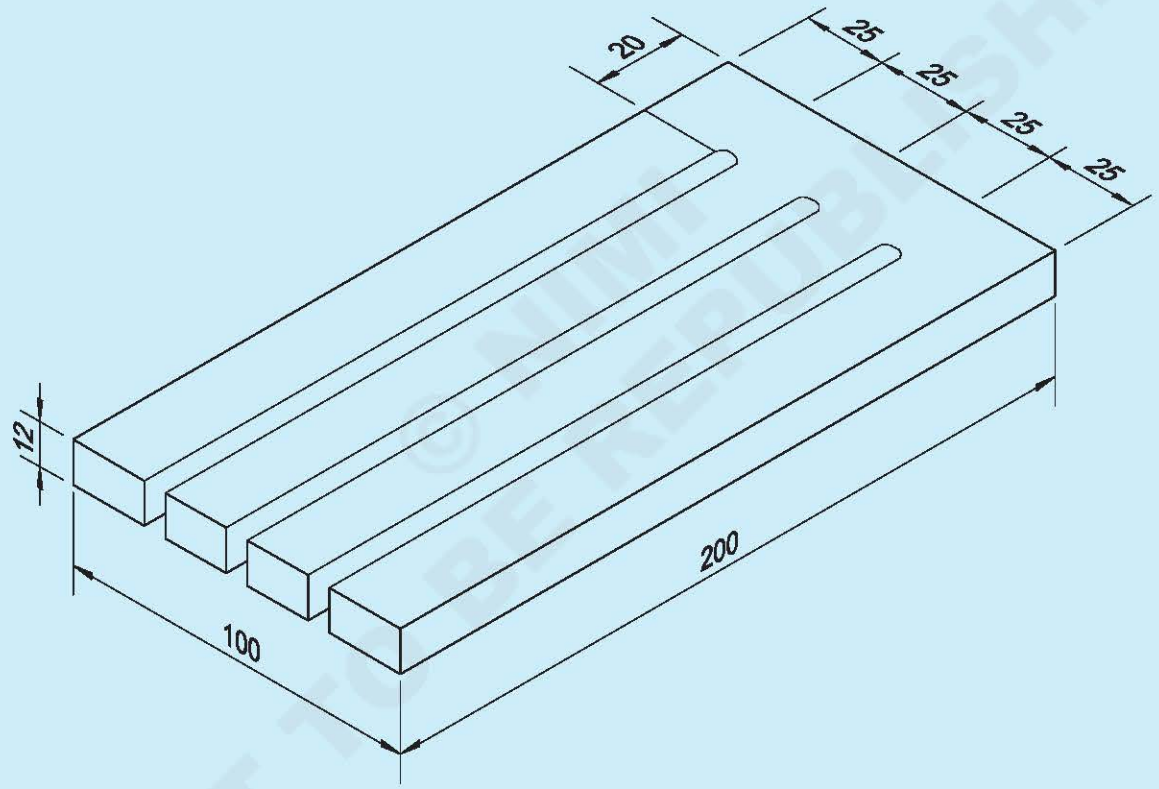
Inspect for uniform

- Smooth cut or drag lines
- Straightness of cut
- Sharpness of cut
- Width of cut.

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Perform marking and straight line cutting of MS plate 10mm thick by gas accuracy within ± 2mm (OAGL - 02)

Objectives: At the end of this exercise you shall be able to
- **set the work pieces for a straight cutting**
- **set the gas cutting flame**
- **clean and inspect the cutting defects**
- **made a straight line by hand.**



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01	100 ISF 10-200	-	Fe310-W	-	-	1.1.14
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:2	**PERFORM MARKING AND STRAIGHT LINE CUTTING OF M.S. PLATE 10mmTHICKNESS BY GAS ACCURACY WITH IN ±2mm (OAGC-02)**	DEVIATIONS	TIME
		CODE NO. WL20N1114E1	

Job Sequence

Making straight cuts

- Wear all safety clothing.
- Set the gas welding plant with a cutting blowpipe.
- Fit the correct cutting nozzle according to the thickness of the metal to be cut (for M.S. plate 10mm thickness use 1.2mm dia. orifice cutting nozzle)
- Adjust both oxygen and acetylene gas pressure according to the cutting nozzle size. (Oxygen 1.6 kg/sq.cm and acetylene 0.15 kg/sq.cm)

While adjusting the pressure, keep the cutting blowpipe valves open.

- Wear the gas welding goggles.
- Set the neutral flame.
- Take 200×100×10 thick plate, clean, mark and punch the straight lines on the plate 25mm apart.
- Hold the blowpipe at an angle of 90° between the line of cut and the cutting nozzle axis and between the nozzle and the surface of the plate.
- Heat one end of the punched line up to cherry red heat condition.
- Keep the distance between the work piece and the tip of the nozzle about 5mm.
- Place the preheat cone approximate 1.6mm above the plate.
- Move the flame in circle a little larger than the tip size. When metal is heated to Cherry red, move the tip to the edge of the plate.
- Operate the cutting oxygen lever immediately and move the torch slowly along cutting direction.
- Maintain correct torch speed and distance between the plate surface and the nozzle up to the end of the cut.
- If long plates are to be cut, to get a good straight gas cut surface, clamp a straight edged flat parallel to the line of cut and use a spade guide attached to the cutting torch. Move the torch uniformly along the clamped flat and pressing the spade guide against the flat.
- On completion of the cut release the cutting oxygen lever and shut off the flame.
- Clean the cut surface by wire brush after chipping off any slag sticking to the cut edge.

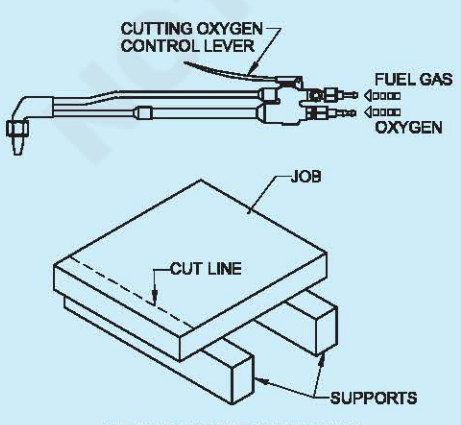
Skill Sequence

Gas cutting

Objectives: This shall help you to
- **observe safety while cutting with gas**
- **make a straight line cutting on a job.**

Setting the gas cutting plant: Set the oxy-acetylene gas cutting plant in the same way as was done for welding and connect the cutting blowpipe in the place of the welding blowpipe. (Fig 1) Also change the oxygen welding regulator with oxygen cutting regulator.

Fig 1



CUTTING JOB SET ON SUPPORTS

Setting the job for straight line cutting (Fig 2): Mark and punch 7 straight lines on the plate 15 mm apart for a straight line cut and 3 lines 25mm apart for bevel cutting on other edge.

Set the job on the cutting table so that the parting piece is free to fall.

Ensure that the underside of the cutting line is clear and no combustible materials are lying nearby.

Adjusting cutting flame: Select the cutting nozzle and set the gas pressure as per the cutting job thickness.

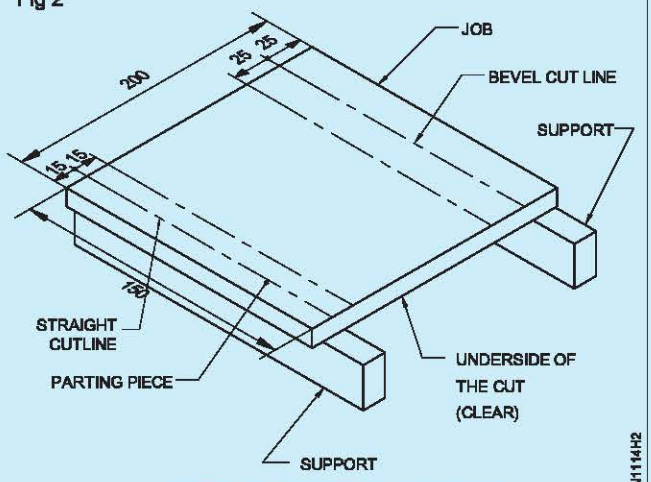
The bevel thickness will be more for bevel cut, when compared with a square cut for same thickness.

Acetylene pressure should be 0.15 kg/cm^2 for all thickness of plates.

Select ø 1.2 mm (orifice) cutting nozzle for cutting a 10mm thick plate.

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Fig 2



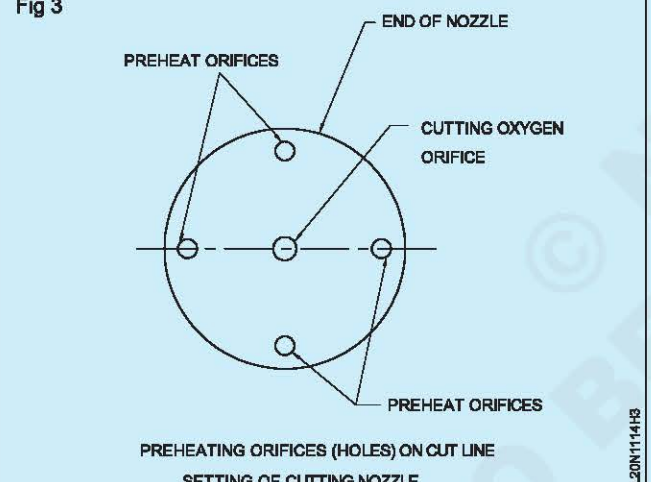
CUTTING JOB SET ON SUPPORTS

Set 1.6 kg/sq.cm pressure for the cutting oxygen and 0.15 kg/sq.cm pressure for the acetylene gas.

Ensure safety apparel is worn.

Fix the cutting nozzle into the cutting blowpipe correctly. (Fig 3)

Fig 3



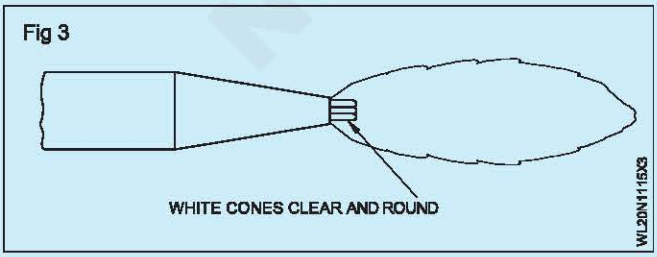
PREHEATING ORIFICES (HOLES) ON CUT LINE
SETTING OF CUTTING NOZZLE

Check for leakage in the blowpipe connections of oxygen and acetylene gas lines.

Adjust the neutral flame for preheating. (Fig 4)

Ensure that the flame adjustment is not disturbed while operating the cutting oxygen lever.

Fig 3

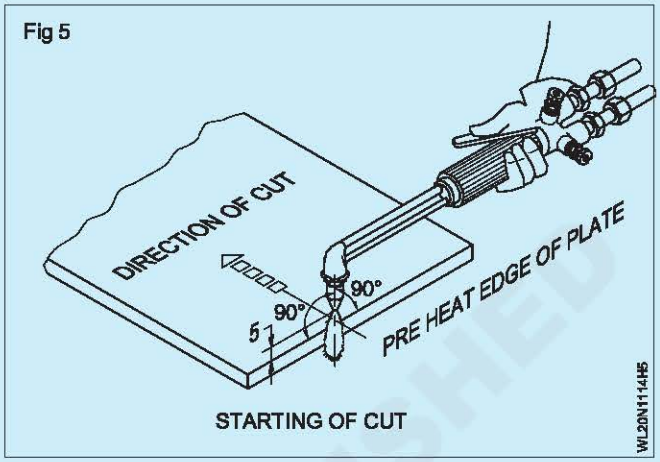


Straight line cutting: Keep the hand cutting blowpipe at 90° angle with the plate surface and start cutting a straight line. (Fig 5)

Preheat the starting point to red heat before pressing the cutting oxygen lever. (Fig 5)

Keep the distance between the work piece and the nozzle about 5 mm to avoid backfire. (Fig 5)

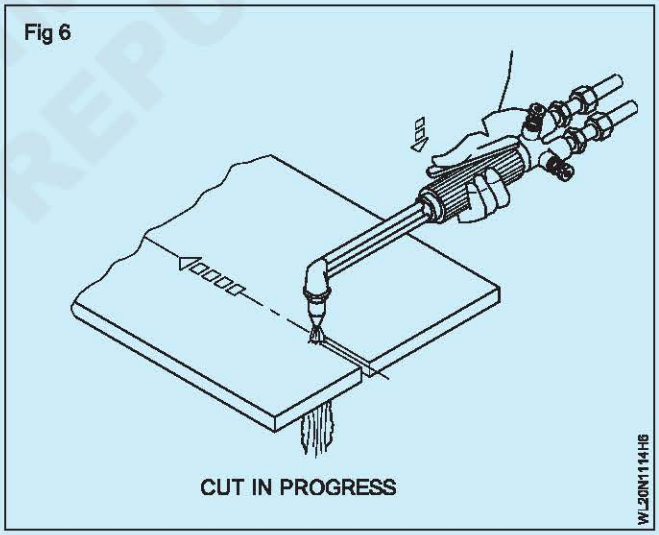
Fig 5



STARTING OF CUT

Release the cutting oxygen by pressing the cutting oxygen control lever and start the cutting action and move the blowpipe along the punched line with uniform speed. (Fig 6)

Fig 6



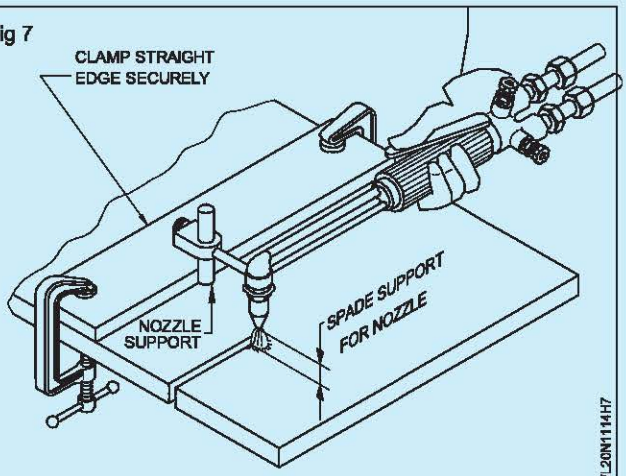
CUT IN PROGRESS

Ensure straight travel without any side-to-side movement.

The nozzle angle is 90° with the plate surface till the completion of cut.

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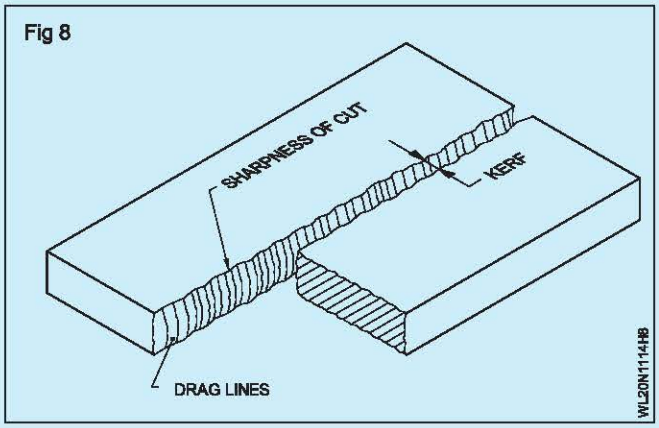
Fig 7



Open the cutting oxygen valve fully.

If possible fix a straight edge or template to the plate and fix a support to the cutting nozzle so as to ensure constant distance between the tip of the nozzle and the plate surface and maintain a uniform straight cut. (Fig 7)

Fig 8



Inspect the cutting for

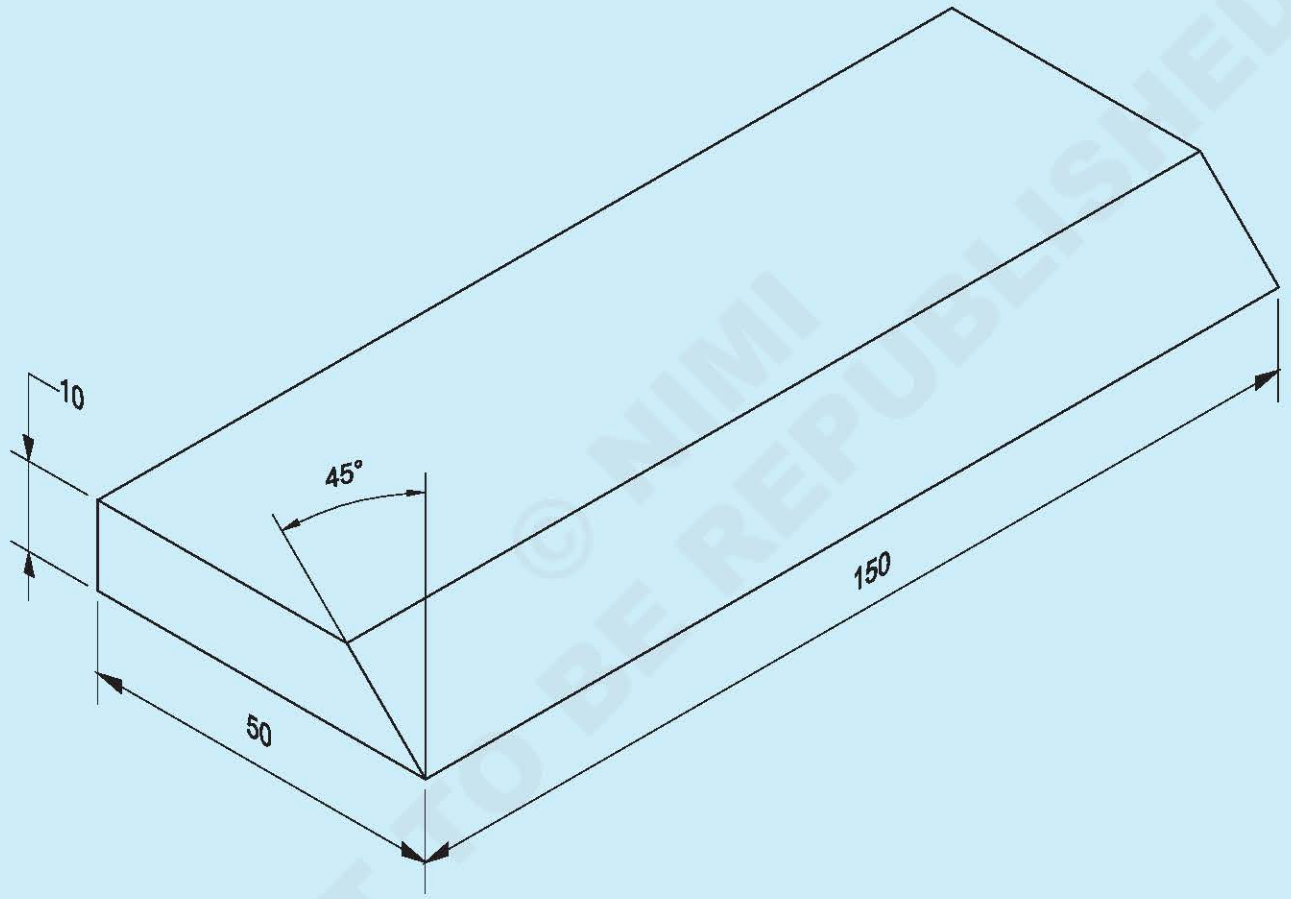
- uniform and smooth cut or drag line
- straightness, sharpness
- width of the cut (Kerf) Fig 8

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Beveling of MS plates 10mm thick, cutting regular geometrical shapes irregular shapes chamfers by gas cutting (OAGC - 03)

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

- **set the work piece as per drawing**
- **cut bevel regular geometrical shape and irregular shape and chamfer**
- **clean the job.**



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	50 ISF 10-100					
2	100 ISF 10-150	-	Fe310-W	-	-	1.1.15
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : NTS	**BEVELING OF M.S PLATE 10mm THICK CUTTING REGULAR GEOMETRICAL SHAPES AND IRRUGULAR SHAPES CUTTING CHAMPERS BY GAS CUTTING OAGC-03**	DEVIATIONS	TIME
		CODE NO. WL20N1115E1	

Job Sequence

- Wear safety apparel.
- Clean the surface to be cut.
- Set the gas welding plant and fix the cutting blowpipe.

Ensure the cutting nozzle is according to the thickness of the metal.

- Adjust the gas pressure of acetylene and the cutting oxygen.

Ensure the pressure setting as per the metal thickness and size of the cutting nozzle.

- Mark and punch the plate at the required bevel angle.
- Adjust a proper cutting flame.
- Hold the cutting blowpipe at the proper bevel angle to be cut.
- Heat at one end of the plate on the punch line up to cherry red hot.
- Release the cutting oxygen, and observe the cutting action.
- Move the cutting blowpipe towards the other end, following the punched line slowly and steadily at the required angle.

Maintain a correct speed and distance of the nozzle.

- Close the cutting oxygen and extinguish the flame on the completion of the cut.
- Clean the cut, and inspect for its accuracy.

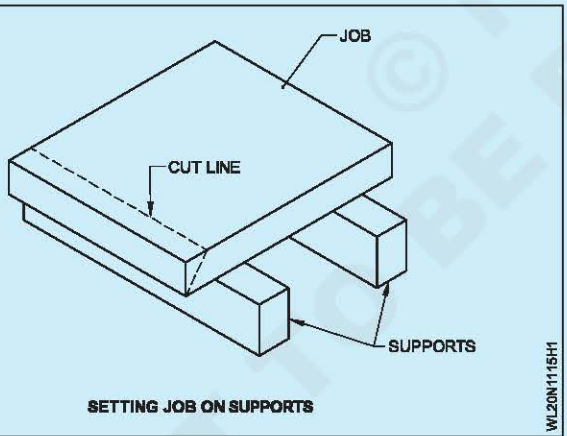
Skill Sequence

Bevel cutting by hand (Oxy-acetylene)

Objectives: This shall help you to
- **cut bevel regular geometrical shape and irregular shape and chamfer**
- **clean inspect and identify the job.**

Setting the job (Fig 1)

Fig 1



SETTING JOB ON SUPPORTS

Set the job on a rigid table.

Ensure the underside of the cut line is clear.

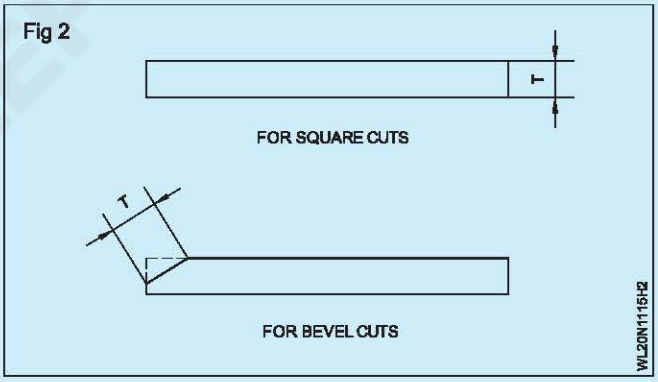
Adjustment of the cutting flame.

Select a cutting nozzle as per the length of the bevel. (Fig2)

Set the cutting nozzle in the blowpipe and adjust the neutral flame for pre-heating.

Ensure that the flame adjustment is not disturbed while operating the cutting oxygen lever.

Fig 2



Bevel cutting

Hold the cutting blowpipe (nozzle) at the required bevel angle. (Fig 3)

Preheat the starting point to a cherry red color.

Distance between the work piece and the nozzle tip should be about 5mm to avoid backfire. (Fig 3)

Release extra oxygen, observe the cutting action and start travelling along the punched line with a uniform speed (Fig 4) and steady hand.

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Fig 3

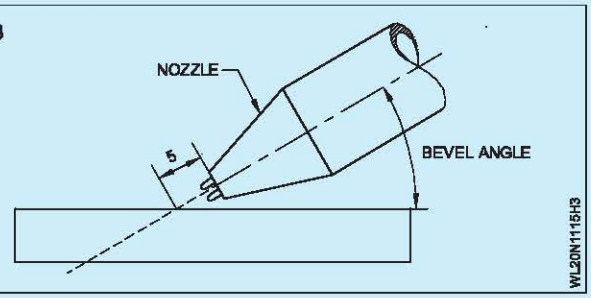
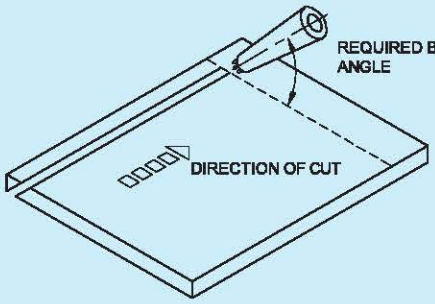


Fig 4



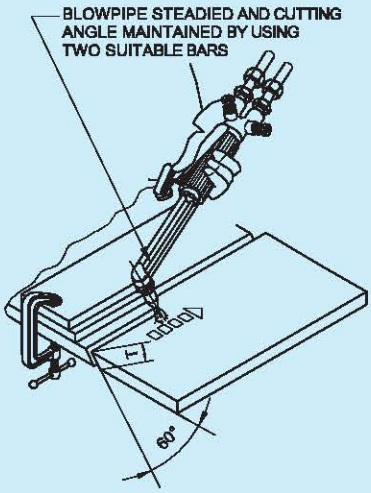
The cutting speed should be less than required for the straight cut for the same thickness.

If possible, fix suitable straight bars to the cutting job to ensure a straight cut and angle maintenance. (Fig 5)

Inspection of bevel cut

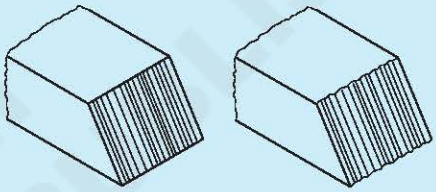
Clean the cut and inspect the cutting quality

Fig 5



A good quality cut is indicated by a straight top edge and extremely smooth-cut face. (Fig 6a) Poor quality gouging is a common defect in gas cutting. (Fig 6b) This is caused by excess speed or too mild a heating flame.

Fig 6



TASK 2:

- Clean the surface of raw material 100 ISF100 - 10mm.
- Mark the center line of the job, and punch as per drawing
- Scribe the circle of diameter 100 mm, using divider (Fig 1).
- Scribe the arc with center A of radius 50 mm (Fig 1) cutting the circle, repeat with center B to scribe the arc as shown in Fig 1.
- Scribe the lines to join AC, CE, EB, BF, DF and DA as in Fig 2, using straight edge and scribes to farm hexagon.

Fig 1

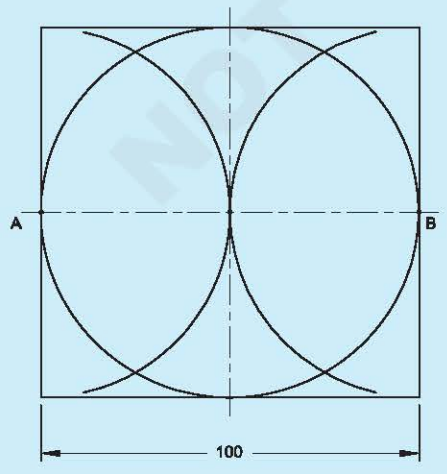
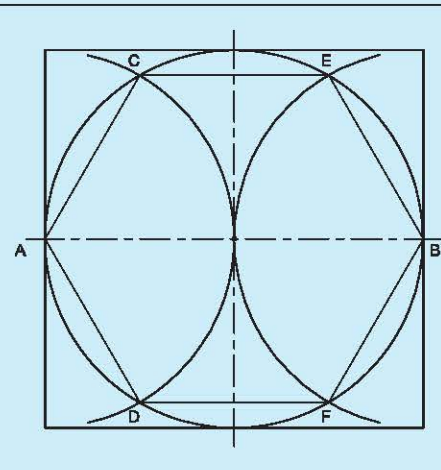


Fig 2



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- Punch witness marks to complete the hexagon shape.
- Mark the triangle with in the hexagon as per the dimension shown in the drawing, and punch witness marks to complete the triangle.
- Drill a hole of ø6mm on center mark.
- Set the oxy-acetylene plant and cutting blowpipe for gas welting the geometrical profiles.
- Attach suitable nozzle for gas cutting, according to thickness metal to be cut.
- Adjust the gas measure of acetylene and cutting oxygen, according to the thickness of metal to be cut.
- Adjust proper cutting flame, and hold the cutting blowpipe at 90° (Refer skill sequence on 1.1.15).
- Start the gas welting from drilled hole to triangle line marked.
- Cut the profile on marked line to complete the triangle.
- Start the cutting from the edge of plate to the marked line of hexagon as required.

Maintain correct speed and distance of nozzle while cutting.

- Close cutting oxygen and extinguish the flame on completion of cut.
- Clean the cut, after one job is cooled.
- Inspect the surface cut for uniformity.

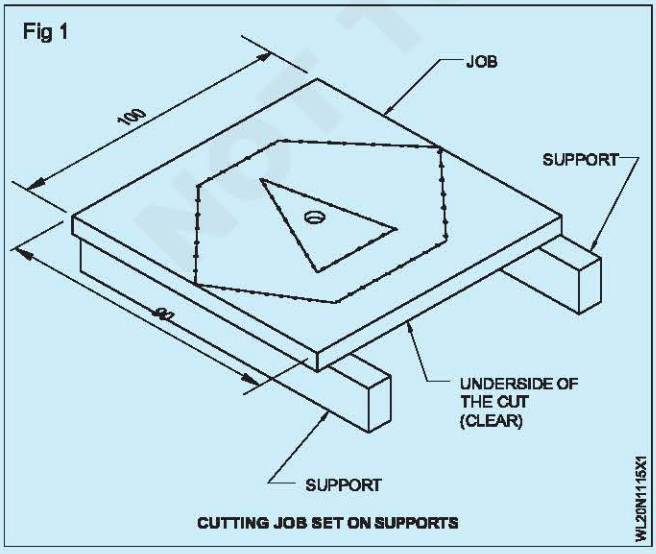
TASK 3

- Clean the surface of metal to be cut.
- Mark and punch as per the profile shown in the drawing.
- Set the gas cutting plant with a cutting blow pipe.
- Attach the correct cutting nozzle according to thickness of the metal.
- Adjust the gas measure for the cutting.
- Adjust a proper cutting flame and has the blowpipe in proper position.
- Heat the metal surface at the starting point to bright red hot.
- Move the cutting blow pipe towards the other end following the punched line slowly and steadily.
- Maintain a correct speed and distance of the nozzle while cutting.
- Close the cutting oxygen and extinguish the flame an completion of the cut.
- Clean the cut, and inspect for its accuracy.

Straight the gas cutting plant

Objectives: This shall help you to
- **cut the triangular and hexagonal shape.**

Setting the job for straight line cutting of Triangular shape (Fig 1): Mark and punch straight lines on the plate.



Set the job on the cutting table so that the parting piece is free to fall.

Ensure that the underside of the cutting line is clear and no combustible materials are lying nearby.

Adjusting cutting flame: Select the cutting nozzle and set the gas pressure as per the cutting job thickness. (Table 1)

Acetylene pressure should be 0.15 kgf/cm^2 for all thickness of plates.

Select 0.8 mm ø cutting oxygen (orifice) nozzle for cutting a 6 mm thick plate.

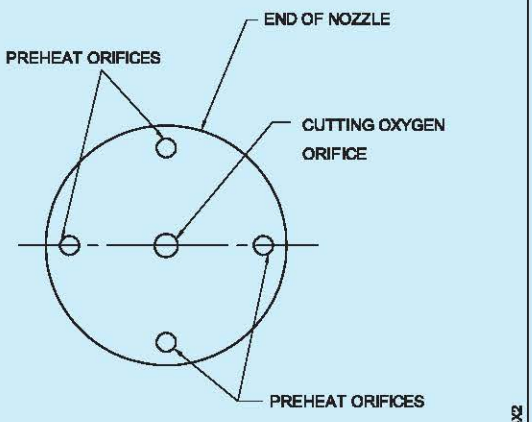
Set 1.4 kg/sq.cm pressure for the cutting oxygen and 0.13 kg/sq.cm pressure for the acetylene gas.

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Ensure safety apparel is worn.

Fix the cutting nozzle into the cutting blowpipe correctly. (Fig 2)

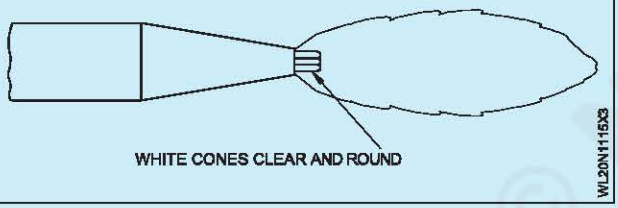
Fig 2



Check for leakage in the blowpipe connections of oxygen and acetylene gas lines.

Adjust the neutral flame for preheating. (Fig 3)

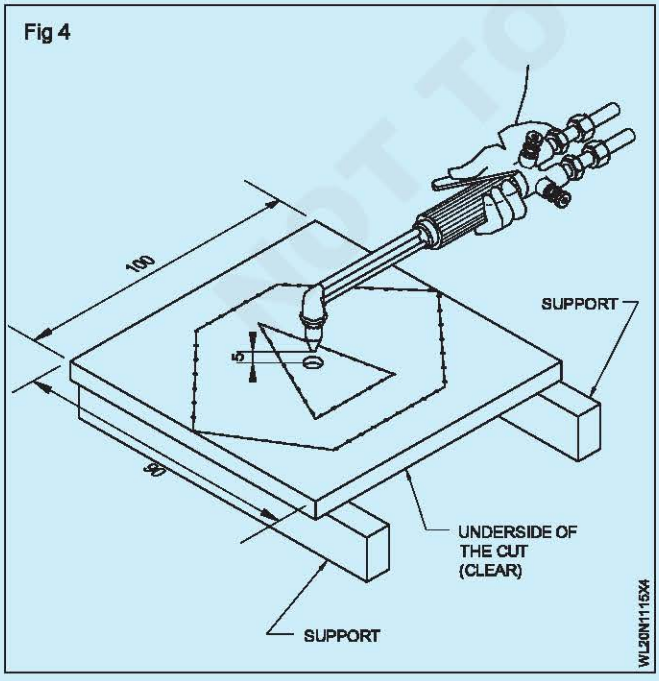
Fig 3



Ensure that the flame adjustment is not disturbed while operating the cutting oxygen lever.

Straight line cutting: Keep the hand cutting blowpipe at 90° angle with the plate surface and start cutting a straight line. (Fig 4)

Fig 4

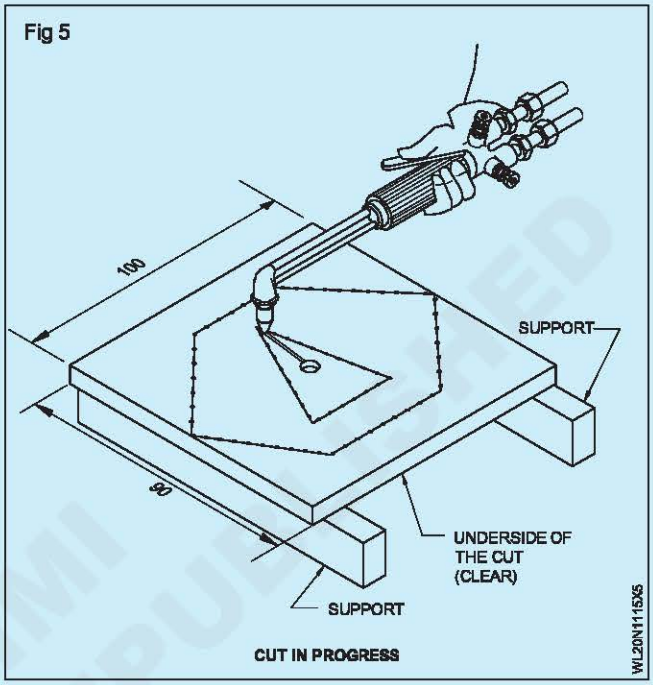


Preheat the starting point to red heat before pressing the cutting oxygen lever. (Fig 4)

Keep the distance between the work piece and the nozzle about 5 mm to avoid backfire. (Fig 4)

Release the cutting oxygen by pressing the cutting oxygen control lever and start the cutting action and move the blowpipe along the punched line with uniform speed. (Fig 5)

Fig 5



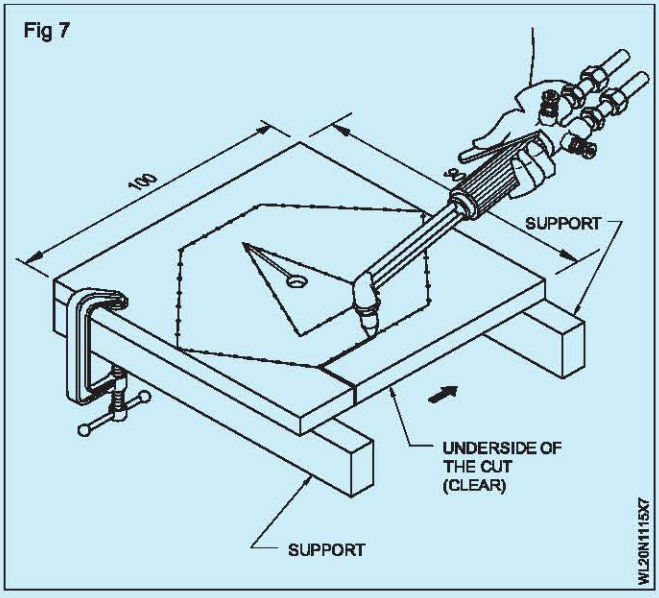
Ensure straight travel without any side-to-side movement.

The nozzle angle is 90° with the plate surface till the completion of cut.

Open the cutting oxygen valve fully.

If possible fix a straight edge or template to the plate and fix a support to the cutting nozzle so as to ensure constant distance between the tip of the nozzle and the plate surface and maintain a uniform straight cut. (Fig 6)

Fig 7



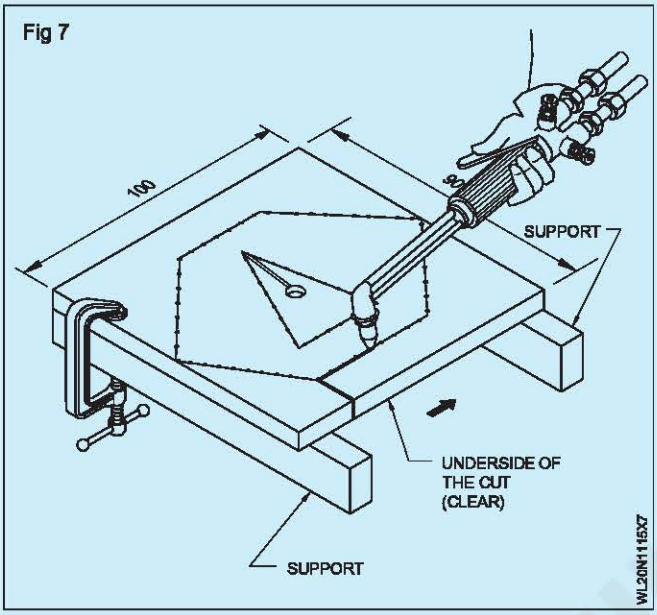
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- Complete to cut the shown in of interned for angle along the punched times.

Hexagon cutting

- Set the job as shown in Fig 7.
- Hold the cutting flow pipe (nozzle) at required angle is 90°.
- Cut the hexagon along the punched lines.

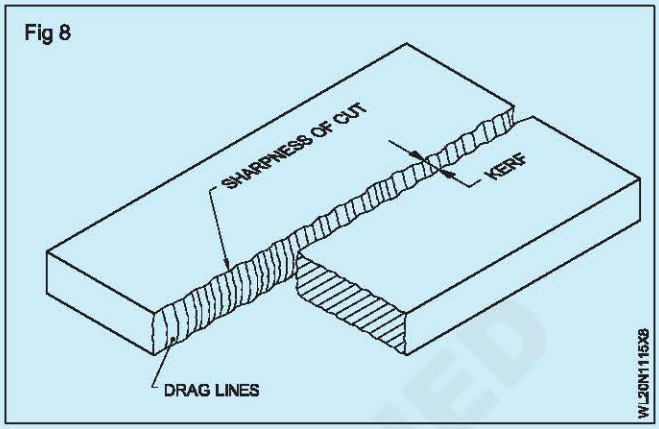
Fig 7



Inspect the cutting for

– uniform and smooth cut or drag line
– straightness, sharpness
– width of the cut (Kerf) Fig 8

Fig 8

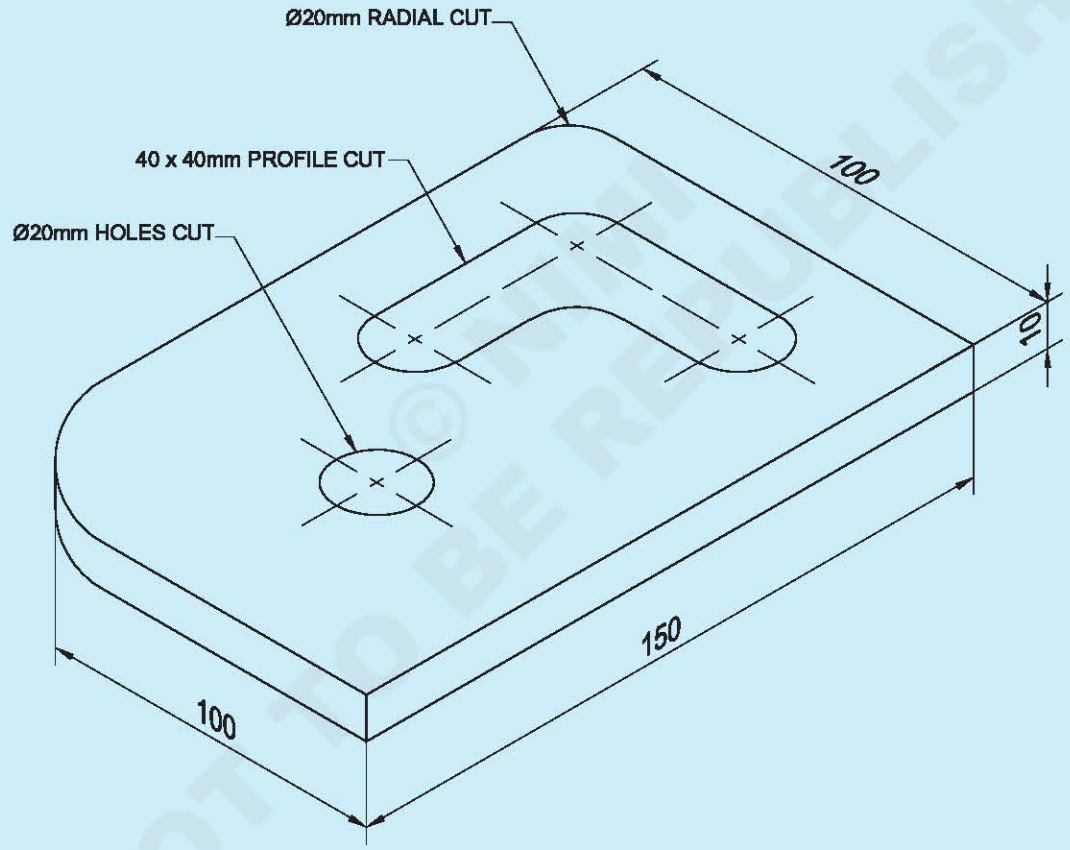


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Marking and perform radial cuts, cutting out holes using oxy-acetylene gas cutting (OAGC) - 04

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

- **set the gas cutting machine**
- **select the nozzle No. and oxygen pressure**
- **operate and make a holes and radial cuts as per drawing**
- **cleaning the job.**



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1	100 ISF 10 - 150		Fe310 - W			1.1.16
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**MARKING AND PERFORM RADIAL CUTS ,CUTTING OUT HOLES USING OXY-ACETYLENE GAS CUTTING (OAGC-04)**	LINEAR TOLERANCE ±1 ANGULAR TOLERANCE ±1°	TIME
		CODE NO. WL20N1116E1	

Job Sequence

- Set the cutting machine and connect the oxygen and acetylene cylinders, regulators to the hoses of the machine and fix a suitable cutting nozzle.
- Clean the surface of the metal plate to be cut.
- Select and fix the nozzle as per the thickness of the plate to be cut.
- Set the required pressure of oxygen and acetylene according to the size of the nozzle.
- Adjust the nozzle to a height such that the inner cone of the preheating flame is 5 mm from the surface of the metal to be cut.
- Ignite and set the neutral flame.
- Allow for sufficient preheating, and then switch 'on' the jet of oxygen.
- Use tongs while handling the gas cut job.
- Ensure that the molten slag diving cutting and solidified hot slag chipped after cutting fall into a collecting through kept below the table.
- Clean the cutting edges from slag and inspect the cut for gas cutting defects.

Skill Sequence

Marking radial cuts and holes

Objectives: This shall help you to
- **marking radial cuts and holes.**

Setting the gas cutting plant.

Setting the job to radial cut and cutting out holes.

Select nozzle size and gas pressure (O_2 & C_2H_2)

1 Uniform and smooth cut or drag the curved edge.

2 Width of the curved (kerf)

3 Ensure the curved out of circle is smooth

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Marking and perform radial cuts, cutting out holes using oxy-acetylene gas cutting (OAGC) - 04

Objectives: At the end of this exercise you shall be able to
- **identify the cutting defects in gas welding**
- **record the cause and effects of gas cutting defects.**

Fig 1

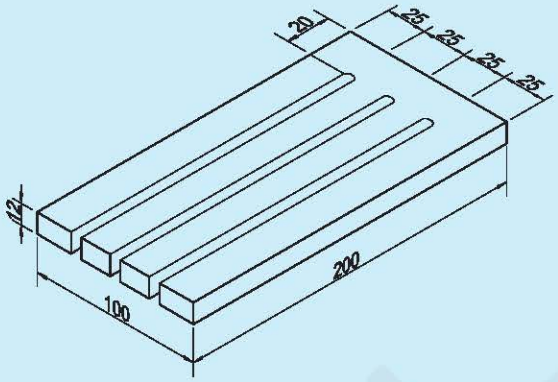


Fig 2

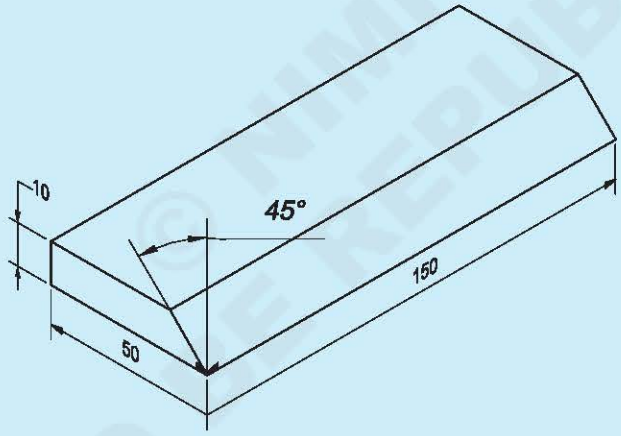
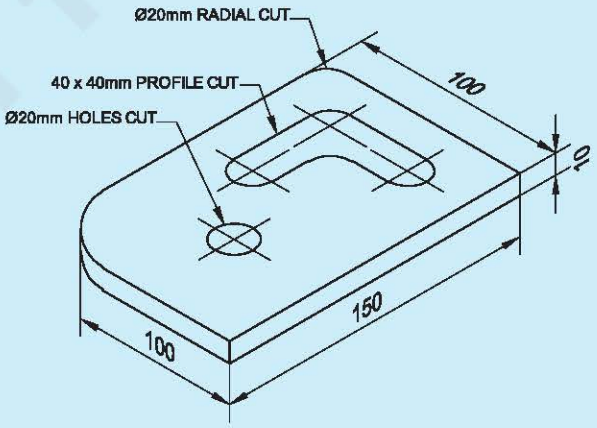


Fig 3



WL20N1117E1

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Job Sequence

- Observe the defects shown in drawing.
- Record the defects name and cause and effects for the defects in table 1.
- Get it checked by the instructor, training officer.

TABLE 1

Name of the Ex.No	Appearance of cut	Remedies
1		
2		
3		
4		
5		
6		

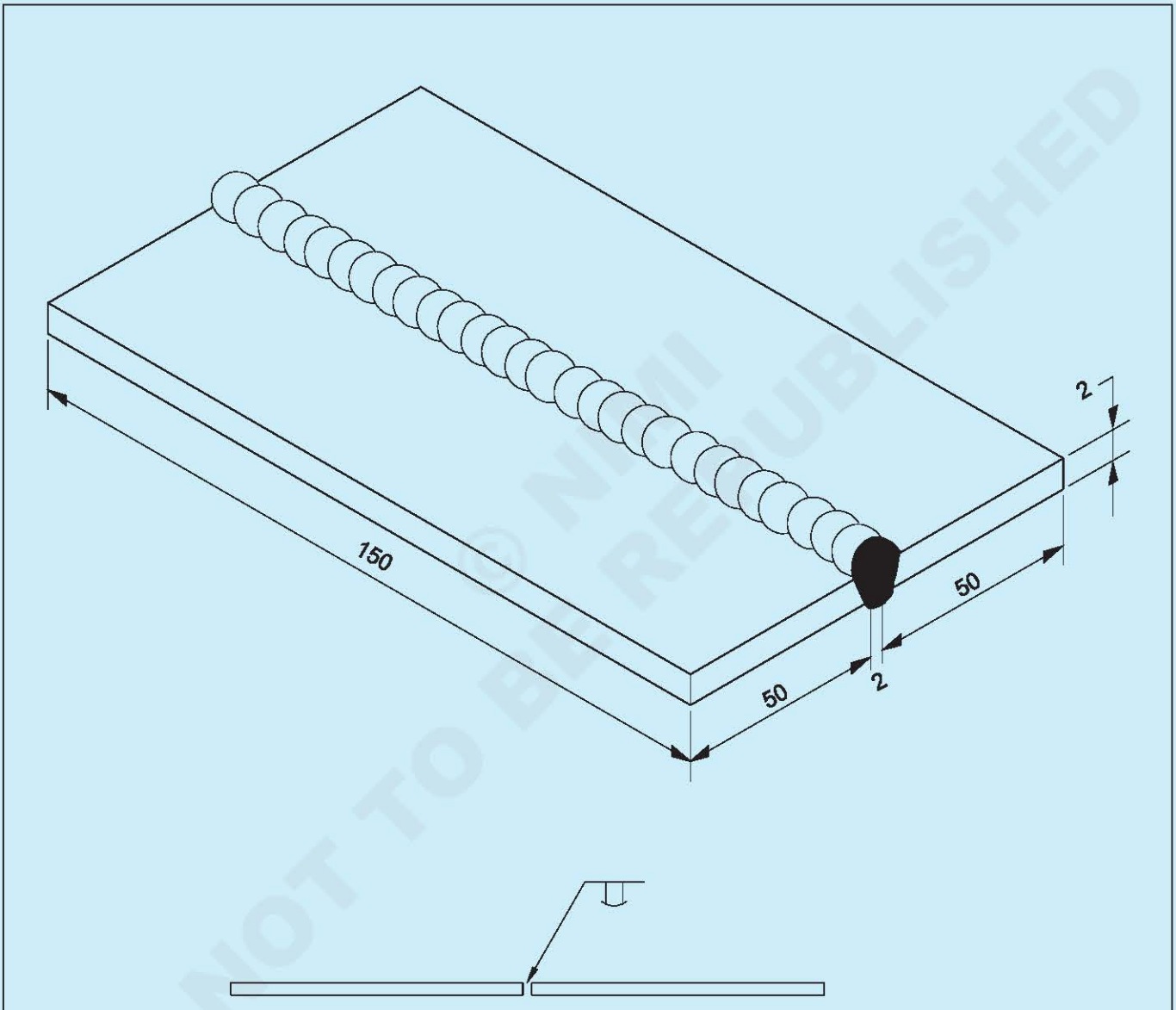
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Square butt joint on MS sheet 2 mm thick in flat position (1G) (OAW-04)

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

- **prepare the job as per drawing**
- **file the edges of the plate to square**
- **weld the square butt joint in flat position**
- **clean and inspect the job**
- **set the job with proper root gap and tack weld.**

Scan the QR Code to view the video for this exercise



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2	ISST 50 x 2 - 150		Fe 310 - W			1.2.18
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
					CODE NO. WL20N1218E1	

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
- **make a square butt joint by key hole method**

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)

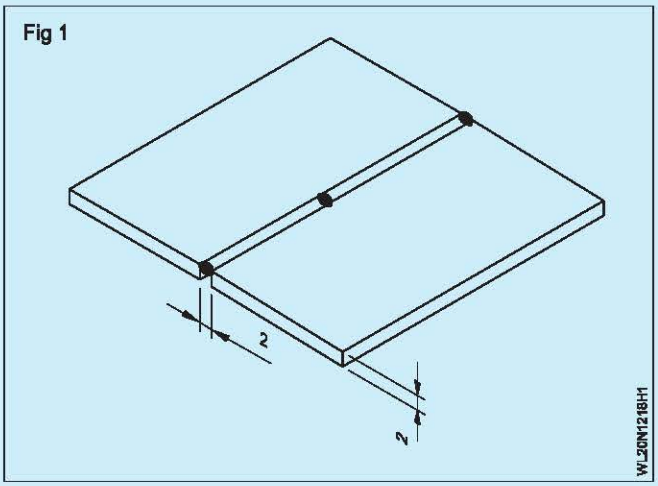
The root gap is increasing from right end to the left end because the gap will get closed as the weld proceeds towards the left end, due to expansion of the base metal.

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

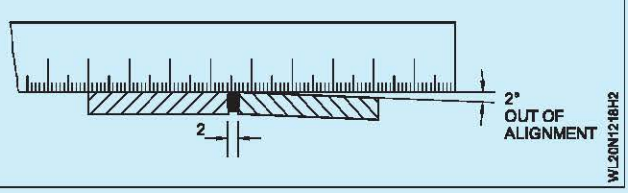


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Tack welds should be on the back side of the joint to be welded and in line with the joint.

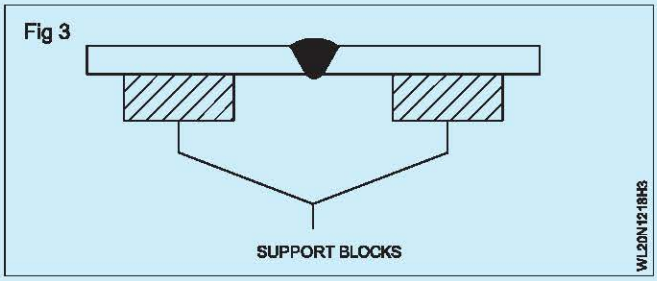
Check the alignment after tacking, and reset, if the sheets are out of alignment. (Fig 2)

Fig 2



Welding: Keep free space under the joint for complete penetration. (Fig 3)

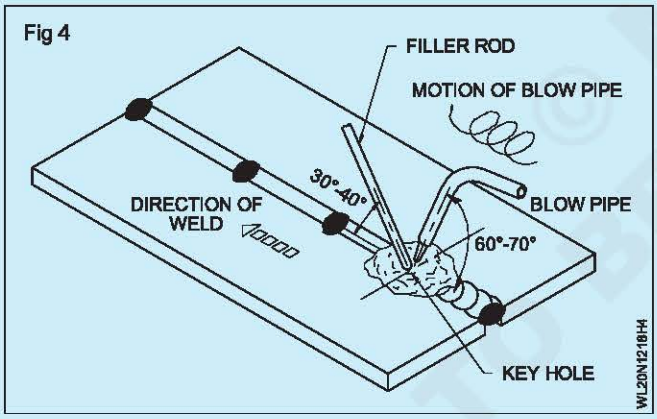
Fig 3



Start the weld at the right end of the joint. (Fig 4)

Weld a well fused uniform bead with complete penetration using leftward technique. (Fig 4)

Fig 4



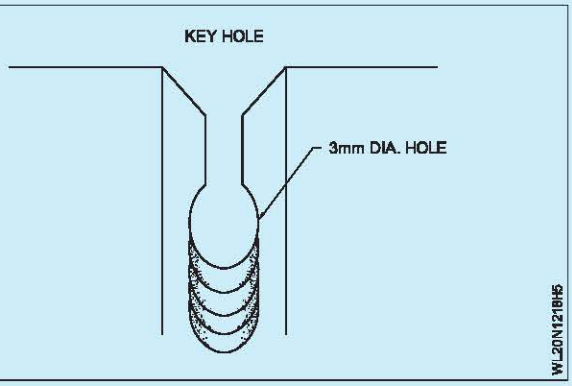
Manipulate the blowpipe to maintain necessary motion to the blow pipe and the filler rod and the recommended angle of blowpipe and the filler rod.

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.

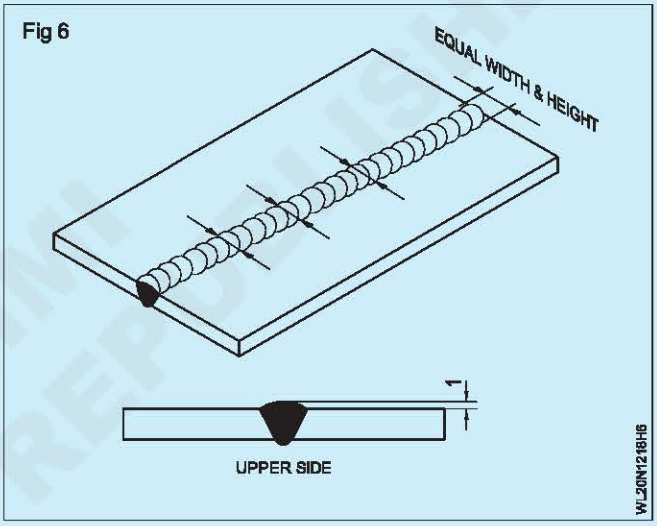
Fig 5



Inspect the quality of weld by:

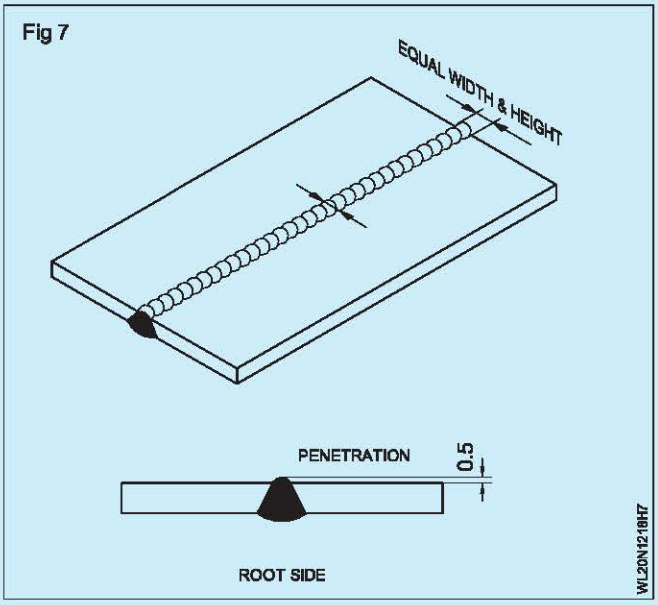
- checking the finish of the job
- checking the alignment (remove distortion if required)
- checking the uniformity of width and height of the weld bead in size (Fig 6)

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



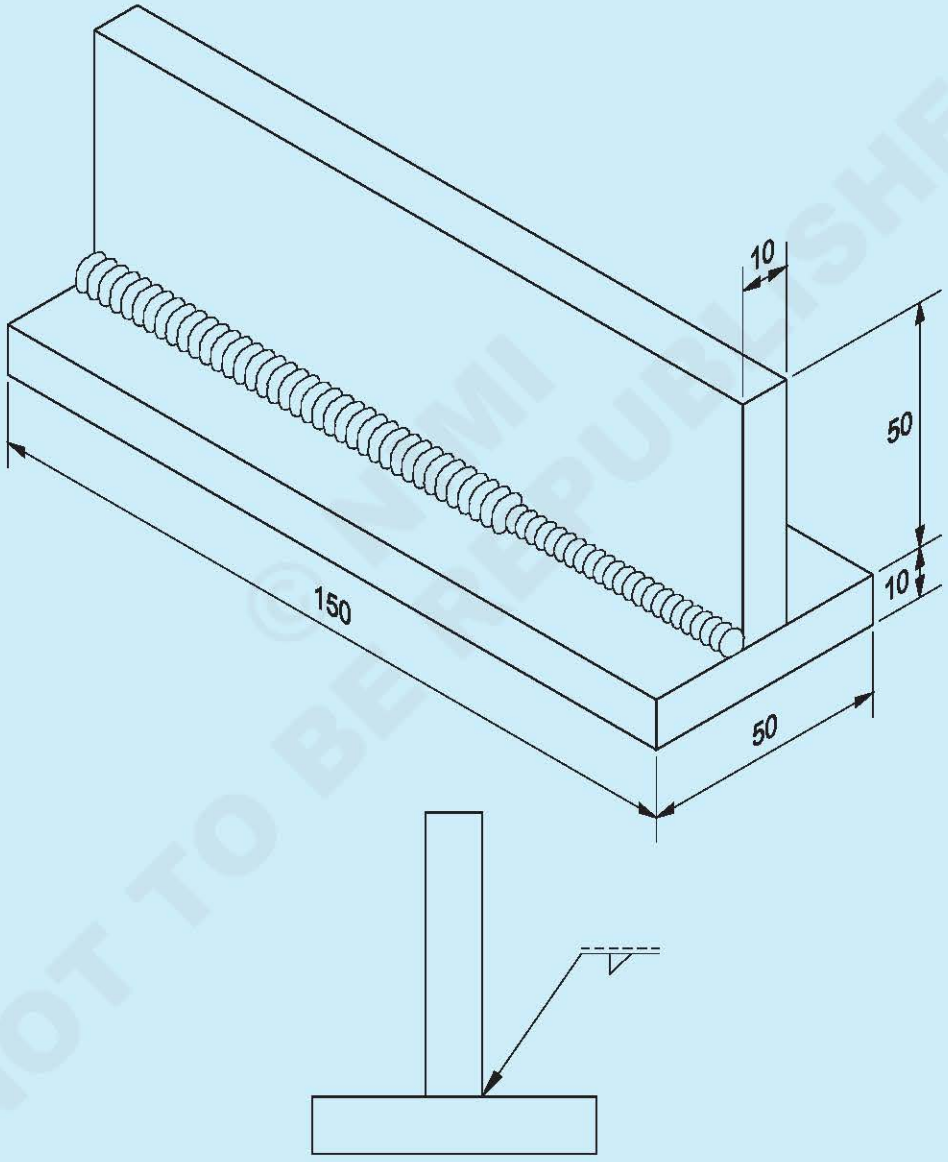
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Fillet "T" joint on MS plate 10mm thick in flat position (1F)-(SMAW-04)

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

- **prepare the job ad per drawing**
- **set the job in flat position**
- **deposit root and covering run**
- **clean and inspect surface defects.**

Scan the QR Code to view the video for this exercise



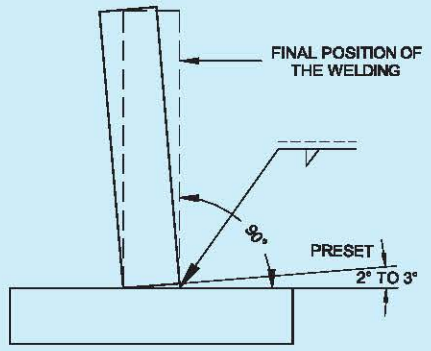
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2	50 ISF 10 - 150	-	Fe 310 - W	-	-	1.2.19
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	FILLET "T" JOINT ON M.S PLATE 10mm THICK IN FLAT POSITION.(1F) - (SMAW-04)				TOLERANCE ±1	TIME
					CODE NO. WL20N1219E1	

Job Sequence

- Cut the plate by gas cutting/hacksaw cutting as per drawing.
- File the edges square.
- Clean the joining edges and surface of the plates.
- Wear protective clothing.
- Set the pieces in the form of Tee as per drawing and Tack-weld on both ends.
- Preset the pieces to have 92° to 93° angle between the plate surfaces. (Fig 1) i.e. give a distortion allowance of 2 to 3°.
- Set the Tee joint in a flat position.
- Connect the electrode cable to the negative terminal, if a DC machine is used.
- Deposit root run using a 3.15mm dia. medium coated M.S. electrode and 110 amps welding current.
- Ensure uniform root penetration and an electrode angle of 45° between the plates and 80° with the weld line.
- Wear chipping goggles.
- Remove the slag from the root run with a chipping hammer and clean with a wire brush.

Fig 1



- Deposit covering run with a weave motion using a 4mm dia. medium coated M.S. electrode and 160 amps welding current.
- Remove the slag from the final bead and clean the weld.
- Use weld gauge for checking the leg size of the weld. get the required 10mm leg length in 2 runs of weld deposit then deposit a third run using the same technique adopted for the second run.
- Inspect the Tee fillet weld for defects.

Skill Sequence

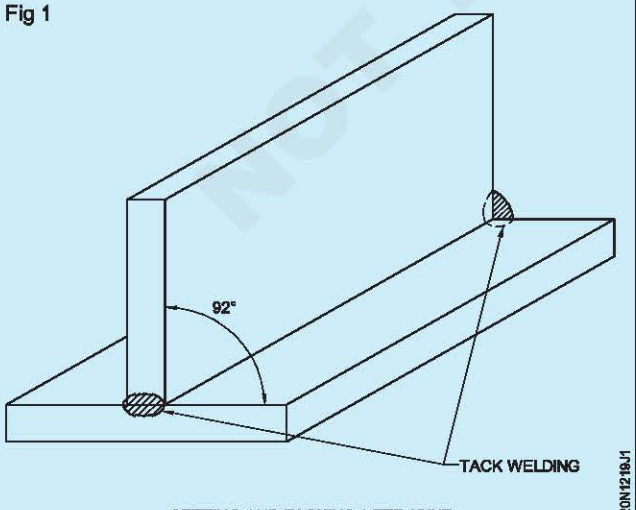
Fillet 'T' joint in flat position (1F)

Objective: This shall help you to
- **prepare and make 'T' joint in flat position.**

Setting and tacking of a Tee joint (Fig 1)

Set the pieces in alignment forming 92° between the plates Fig 1. This presetting to 92° is done to compensate the effect of shrinkage forces when weld deposit cools down.

Fig 1



SETTING AND TACKING A TEE JOINT

Tack-weld the pieces at both ends of the Tee joint by using a 3.15mm dia. medium coated M.S. electrode and 110/ 120 amps welding current.

Ensure the tacks are well fused at the root.

Check the alignment of the Tee joint after tacking.

Welding a tee fillet joint

Use a channel to place the joint in a flat position. (Fig 2)

The electrode angle of 45° will help to fuse both plates equally and the 80° angle will help to get a good root penetration.

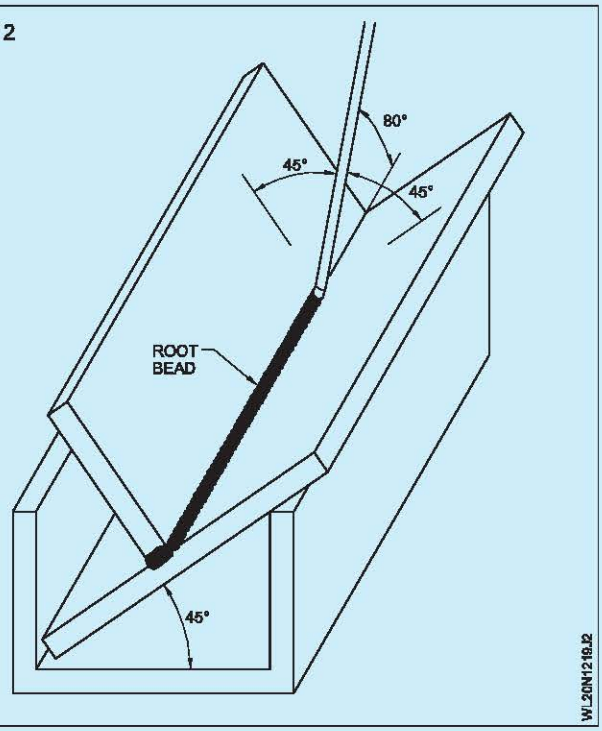
Proceed along the welding line with uniform travel speed and short arc to get uniform fusion and root penetration.

The slag has to be removed thoroughly from the root run so that the slag inclusion defect can be avoided in the next run.

Use a slightly side-to-side weaving motion. (Fig 3) The width of weave should give a leg size of 10mm.

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Fig 2

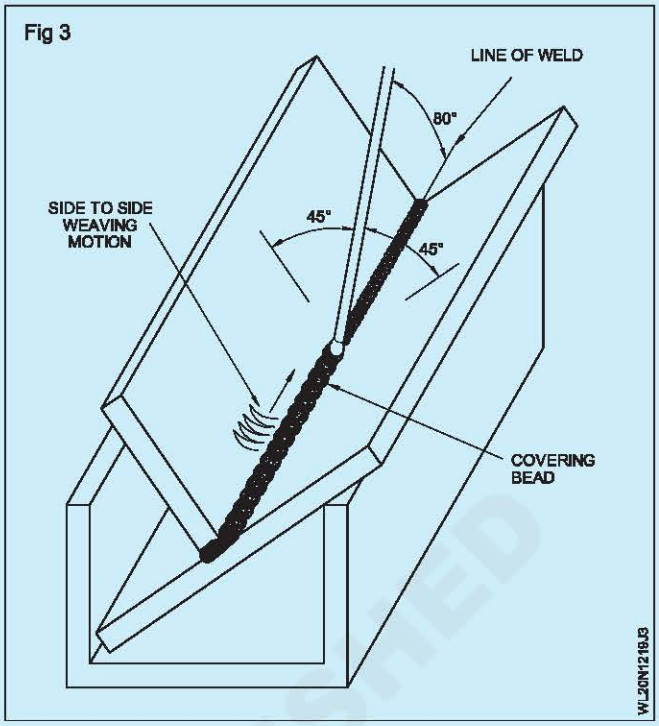


Maintain the same electrode angle as in the root bead.

If the leg size is less than 10mm then deposit a third run using the same technique used for the second run.

Clean the final covering bead thoroughly.

Fig 3



Stop the electrode weaving for a moment at the toes of the weld to avoid undercut. Fill the crater at the end of the bead.

Inspection of fillet weld

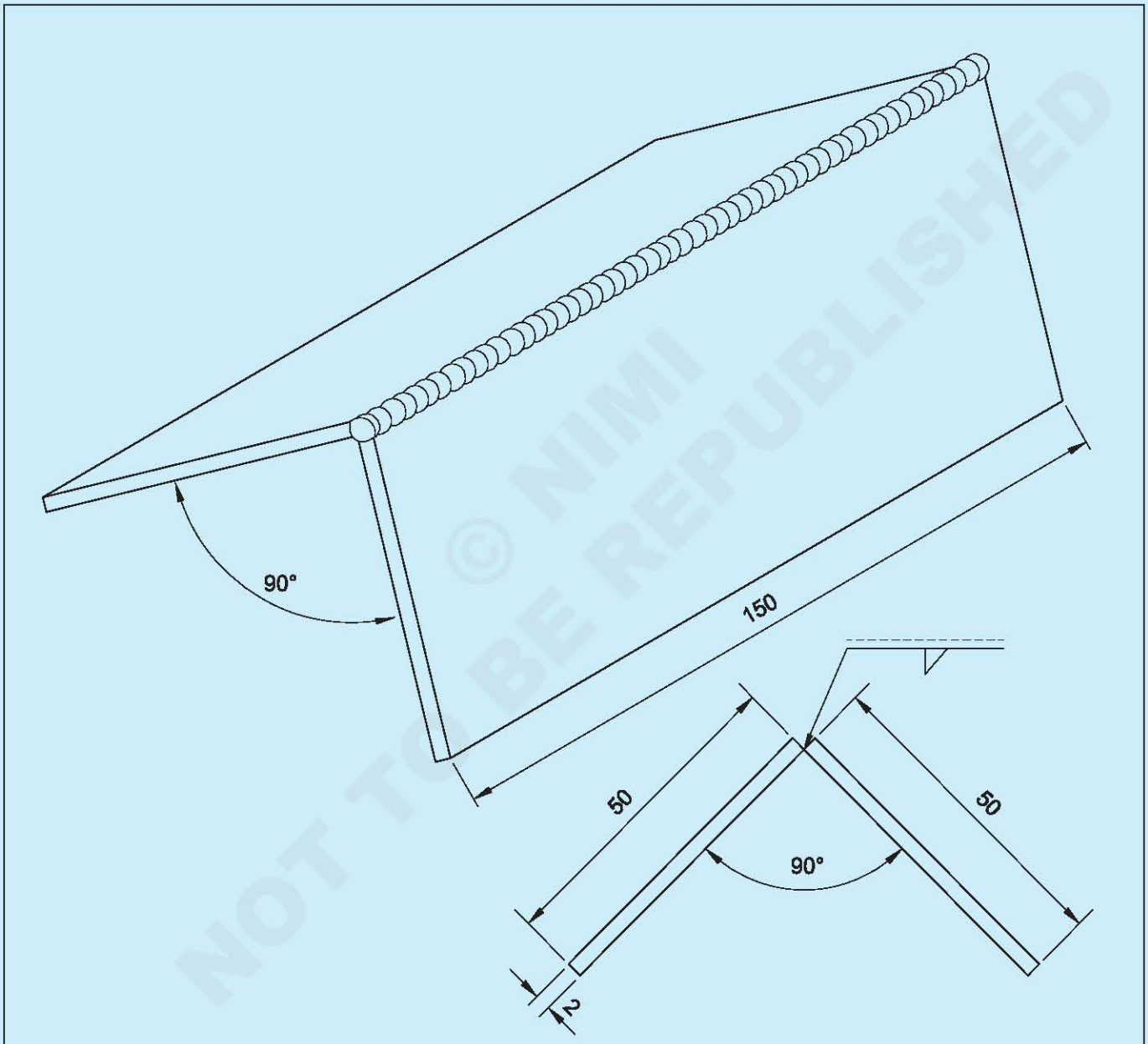
Inspect the fillet welds for defects, correct shape and size of fillet and equal leg length on either side of the weld.

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Open corner joint on M.S. sheet 2 mm thick in flat position (1F) - (OAW-05)

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

- **prepare the job as per drawing**
- **state the proper root gap and tack weld**
- **select proper filler rod and nozzles and set neutral flame**
- **weld the job using leftward technique**
- **clean and inspect weld defects.**



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2	ISST 50 x 2 - 150	-	Fe 310 - W	-	-	1.2.20
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	OPEN CORNER JOINT ON M.S. SHEET 2mm THICK IN FLAT POSITION (1F) - (OAW-05)	TOLERANCE ±0.5	TIME
		CODE NO. WL20N1220E1	

Job Sequence

- Prepare the edges of the sheets to be joined by filling.
- Set the sheets as outside corner joint by keeping at 90° angle between the members with a uniform root gap of 1.5mm between the edges.
- Fix nozzle No. 5 and adjust the gas pressure to 0.15kg/ sq.cm. for both gases.
- Select C.C.M.S. filler rod 1.6 mm dia.
- Wear all safety clothing and use the gas welding goggle.
- Set natural flame, tack at both ends of the joint and at the center by fusing the edges adding filler rod.
- Check the correct alignment of the joint pieces with a try square, clean the tacks, and reset if needed.

Use tongs for holding hot pieces.

- Keep the tacked joint on the welding table in a flat position.
- Hold the blowpipe and filler rod at an angle of 60° to 70° and 30° to 40° respectively with the weld line, start welding from the right hand edge of the joint, move towards the left hand side using the leftward technique.
- Keep the flame at the root of the joint, fuse both the edges uniformly, then dip the filler rod in the molten pool, like a 'piston like' motion, steadily move and give slight circular motion to the blowpipe.

Maintain 1 to 1.5 mm distance between the flame cone and the molten pool to avoid backfire, and to obtain good fusion of the root, use the key-hole technique.

Add filler metal at the top edge of the molten pool as required to build up the weld.

Synchronize the rate of travel and addition of filler metal to obtain a slightly convex bead with proper root penetration.

- Stop welding at the left hand edge of the joint, after filling up the crater.
- Extinguish the flame, cool the nozzle and keep the blowpipe at a safe place.
- Clean the welded joint and inspect for:
  - uniform ripples with slightly convex bead with correct throat thickness.
  - uniform width and height of bead
  - uniform penetration of bead on the reverse side of the joint near the root (indication of root fusion).

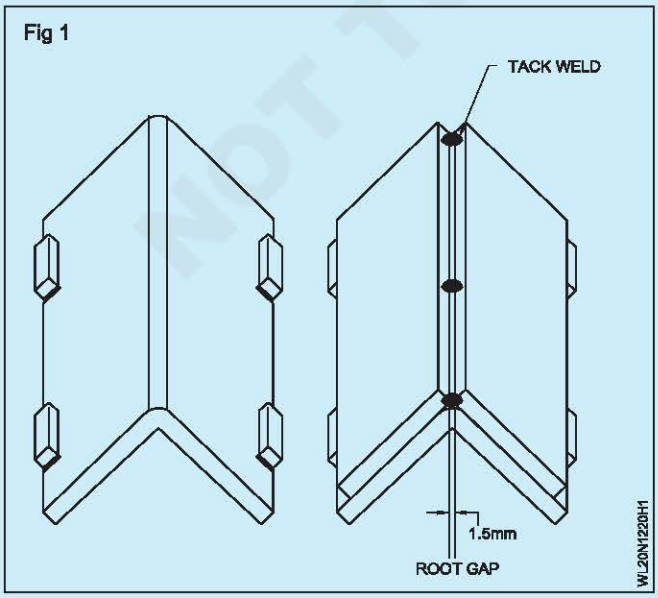
Skill Sequence

Open corner joint in flat position

Objectives: This shall help you to
- **prepare and weld open corner joint.**

Set the job pieces prepared with square edges in correct position using angle iron support. (Fig 1)

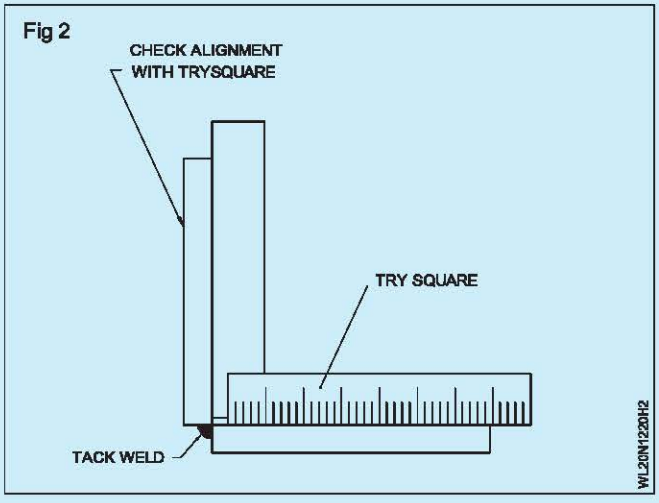
Fig 1



Tack-weld the pieces at correct intervals in correct sequence, with 1.5 mm root gap.

Check the alignment of the tacked pieces and reset, if required. Use a try square. (Fig 2)

Fig 2



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Fusion welding on open corner joint

Make uniform bead with correct penetration by:

– holding the blowpipe and filler rod in correct position (Figs 3 and 4)

Fig 3

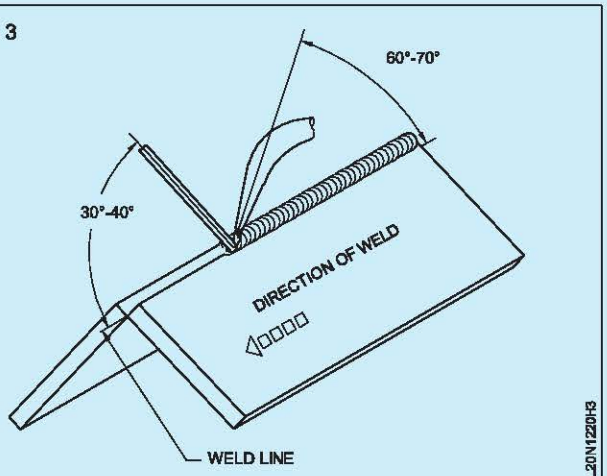
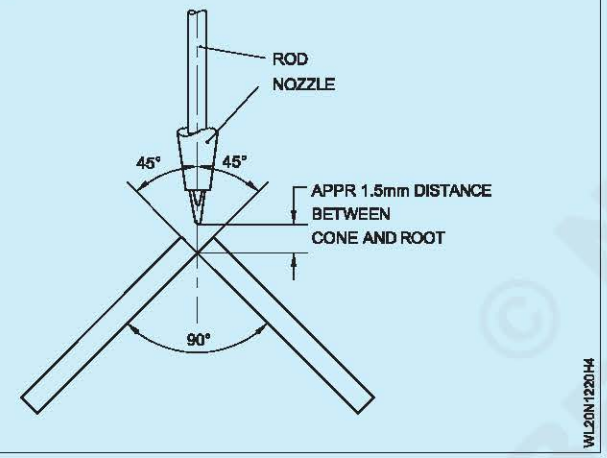


Fig 4



– maintaining uniform travelling speed

– fusing the edges with the keyhole formation to get full penetration. (Fig 5)

– ensuring the top edges of the sheets do not melt excessively.

Inspect the open corner welded joint for:

– 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 6)

Fig 5

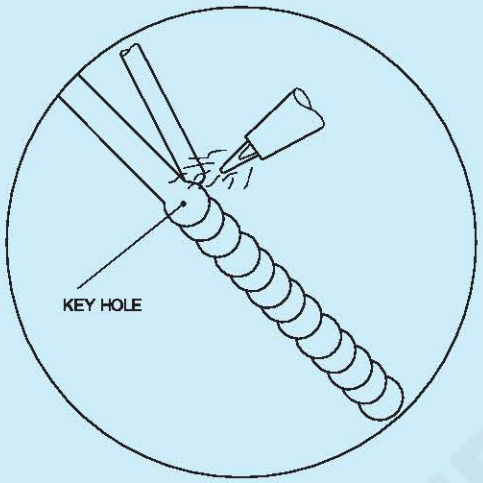
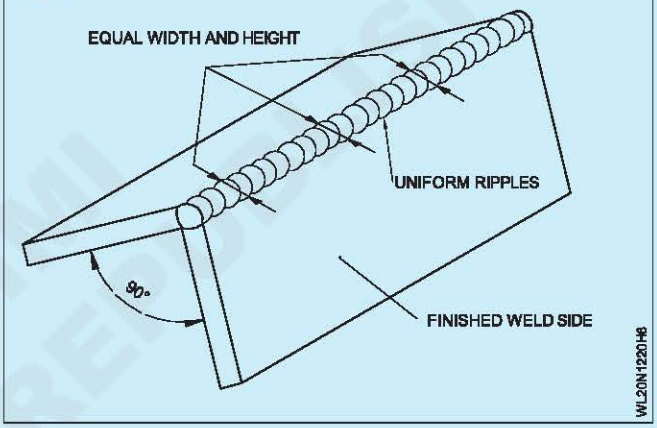
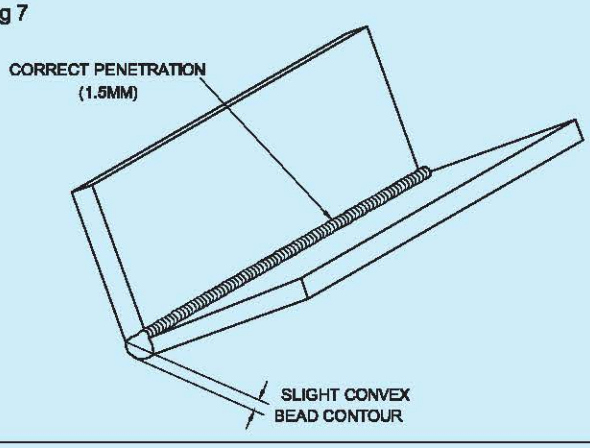


Fig 6



– slight convex bead with weld penetration at the root of the joint. (Fig 7)

Fig 7



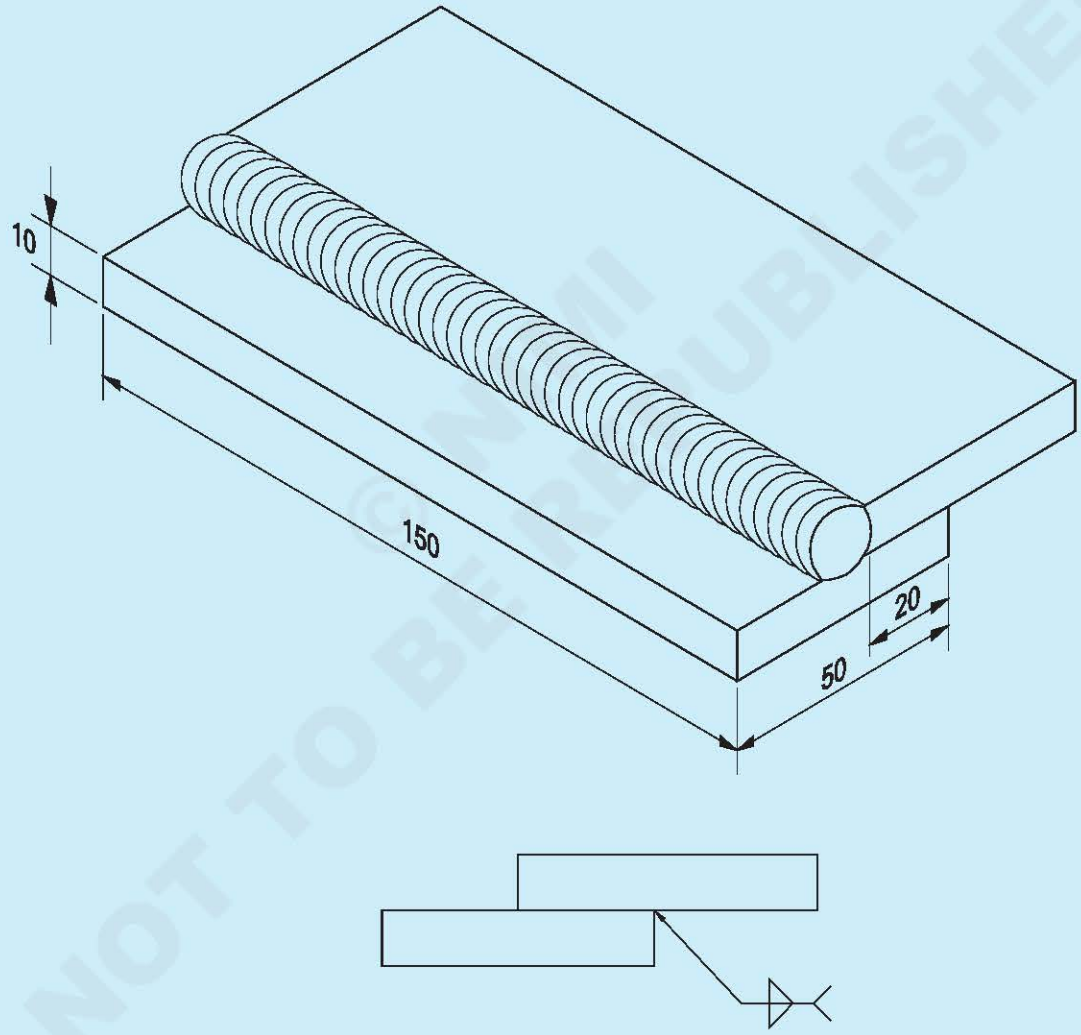
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Fillet lap joint on MS plate 10mm thick in flat position (1F)-(SMAW-05)

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

- **prepare plate pieces by gas cutting**
- **set plates as a lap joint and tack weld at both ends**
- **place the lap joint in a flat position**
- **deposit the final and covering run**
- **clean and inspect the job surface defects.**

Scan the QR Code to view the video for this exercise



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2	50 ISF 10 - 150		Fe 310 - W			1.2.21
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**FILLET LAP JOINT ON M.S PLATE 10mm THICK IN FLAT POSITION (1F)-(SMAW-05)**				TOLERANCE ±1	TIME
					WL20N1221E1	

Job Sequence

- Cut the plate pieces by gas cutting as per drawing.
- File the gas-cut edges to square.
- Remove the grinding burrs and clean the surfaces by wire brush.
- Set the pieces in the form of a lap joint as per drawing.
- Select DCEN polarity, in case of a DC machine.

Wear protective clothing.

- Tack-weld on both ends.
- Set the lap joint in a flat position.
- Deposit root run by using a 3.15mm dia. medium coated M.S. electrode with 100-110 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 final covering run with a weave motion using a 4.00 mm dia. medium coated M.S. electrode with 150-160 amps welding current.

Prevent the upper edge of the plate from melting off.

- Remove the slag from the final weld and clean thoroughly.

Use a weld gauge to check the fillet size.

- Inspect the lap fillet weld for surface defects and size.

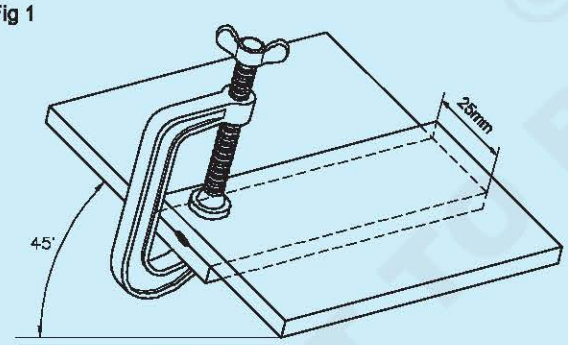
Skill Sequence

Lap fillet joint in flat position

Objective: This shall help you to
- **prepare and weld lap fillet joint in flat position.**

Setting and tacking the lap joint (Fig 1)

Fig 1



SETTING TACKING A LAP JOINT.

WL20N1221H1

Set the lap joint with an overlap of 25mm.

The overlap may vary based on the plate thickness.

Tack-weld on both ends. (Fig 1) Ensure the 2 lapping surfaces are perfectly cleaned and they contact each other properly. Use a 3.15mmø MS electrode with 120amp current for tacking.

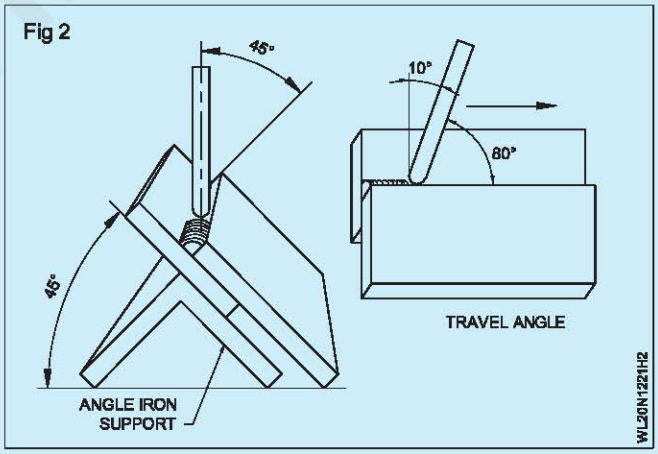
Set the joint in a flat position using angle iron (Fig 2).

Welding the lap fillet joint in flat position

Deposit root run with a 3.15mmø medium coated MS electrode with 100-110 amp. current.

Maintain 80° angle to the line of the weld and 45° between the weld faces. (Fig 2)

Fig 2



WL20N1221H2

Maintain a short arc to get uniform fusion and root penetration.

Avoid side-to-side movement of the electrode.

Deslag and clean the root bead thoroughly.

Deposit the final covering run with a 4mmø medium coated MS electrode and 160amp current.

Give side-to-side movement to the electrode not more than 2.5 times its dia.

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Use the same electrode angle as was used for the root bead.

Prevent the upper edge of the plate from melting off by not allowing the arc to concentrate more on the upper edge.

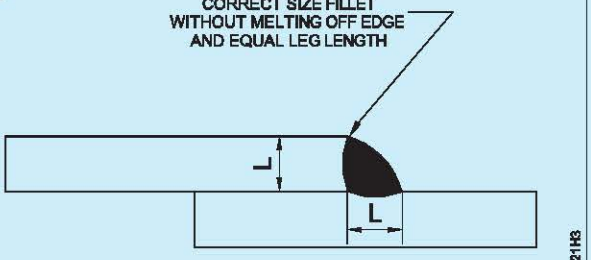
Remove the slag with a chipping hammer.

Clean the weld with a steel wire brush.

Inspect the lap fillet weld (Fig 3) 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



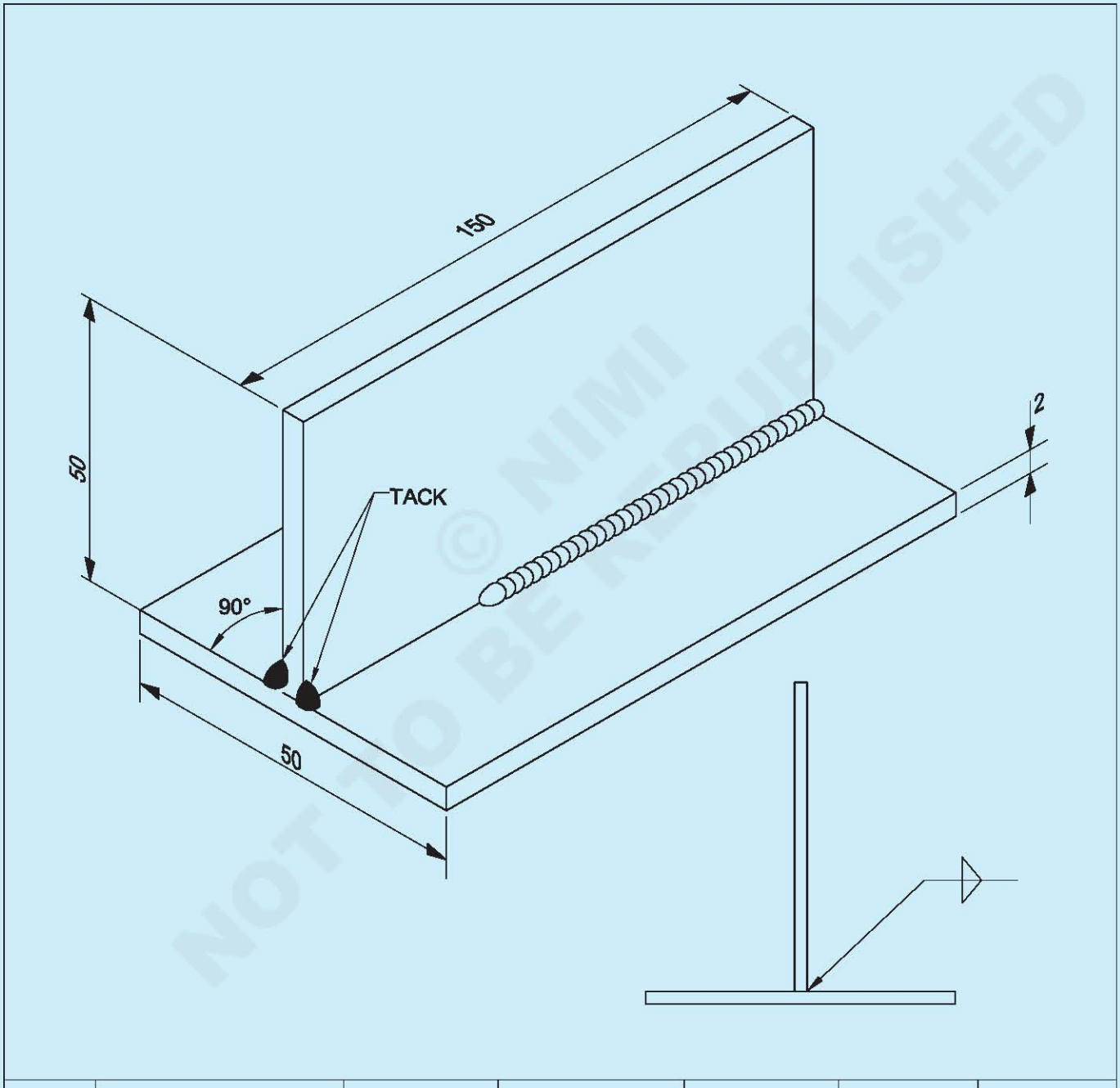
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Fillet 'T' joint on M.S. sheet 2mm thick in flat position (1F)-(OAW-06)

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

- **prepare the job as per drawing**
- **set and tack weld the job**
- **select filler rod and nozzle size**
- **weld the job in flat position**
- **clean and inspect the weldments for defects.**

Scan the QR Code to view the video for this exercise



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2	ISST 50 x 2 - 150		Fe 310 - W			1.2.22
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**FILLET "T" JOINT ON M.S. SHEET 2mm THICK IN FLAT POSITION (1F)-(OAW-06)**				TOLERANCE ±0.5	TIME
					CODE NO. WL20N1222E1	

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.
- Check perpendicularity using try square after back weld.
- 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 weld tee joint in flat position.**

'T' fillet joints are used extensively in industry i.e., fabrication 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

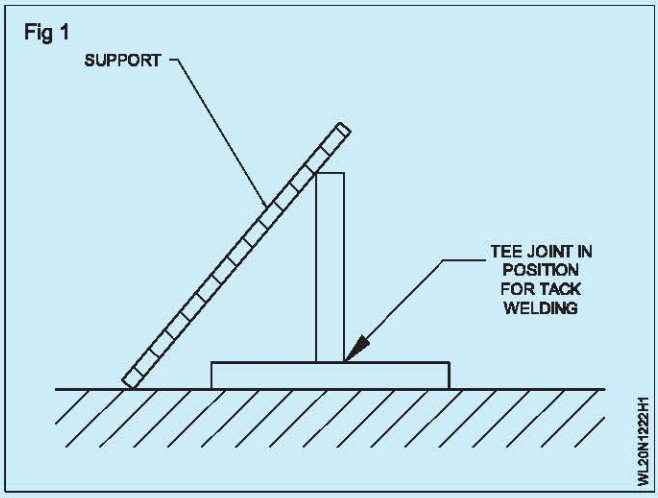
Place the pieces on the welding table as 'T' joint.

Hold the pieces in position using support. (Fig 1)

Ensure the vertical piece is perpendicular to the horizontal piece without gap of the joint.

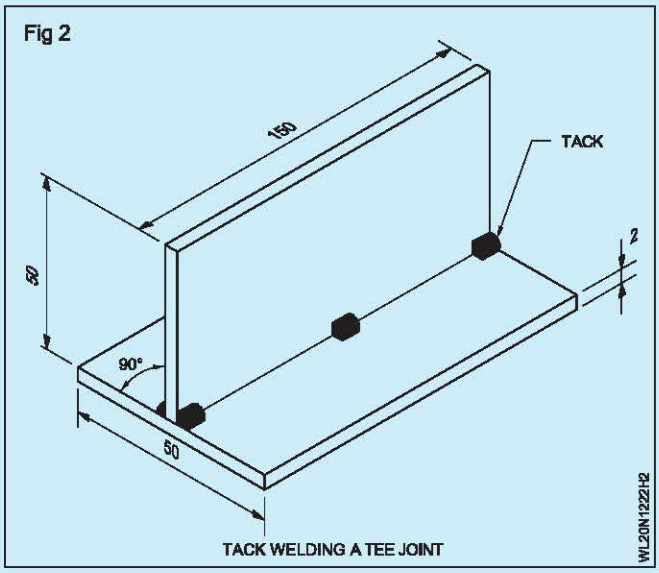
Check with a try square for perpendicularity.

Fig 1



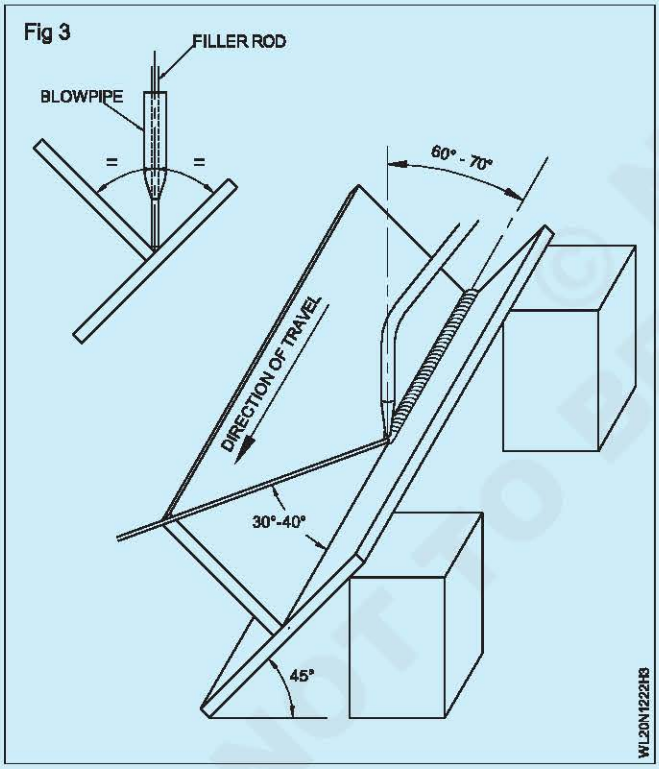
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Tack weld the joint at both ends (Fig 2) on one side of the joint.



Welding of fillet 'T' joint in flat position (Fig 3)

Place the tack welded in flat position by tilting and supporting it. Fig 3.



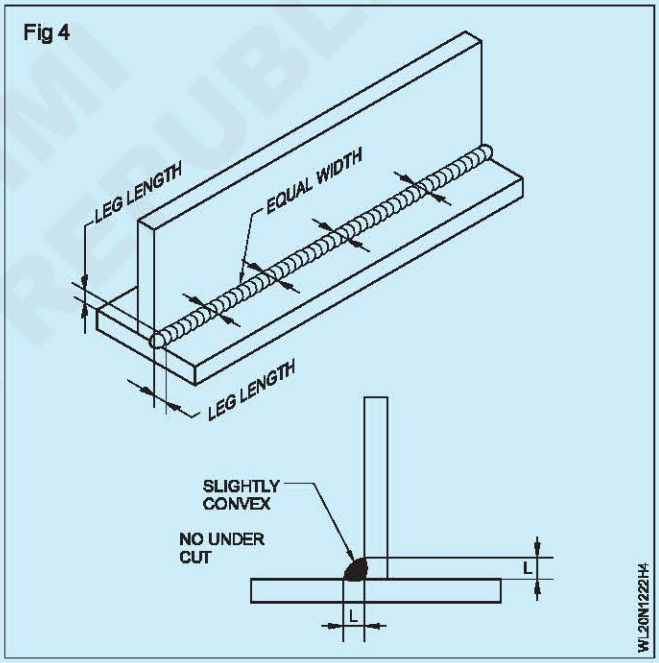
Start welding at the right hand end of the joint by fusing the tack weld and the parent metal to form a molten pool. Keep the blowpipe in the leftward direction at an angle of 60° to 70° and the filler rod at an angle of 30° to 40° to the line of travel. The blow pipe and filler rod should be held at 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.



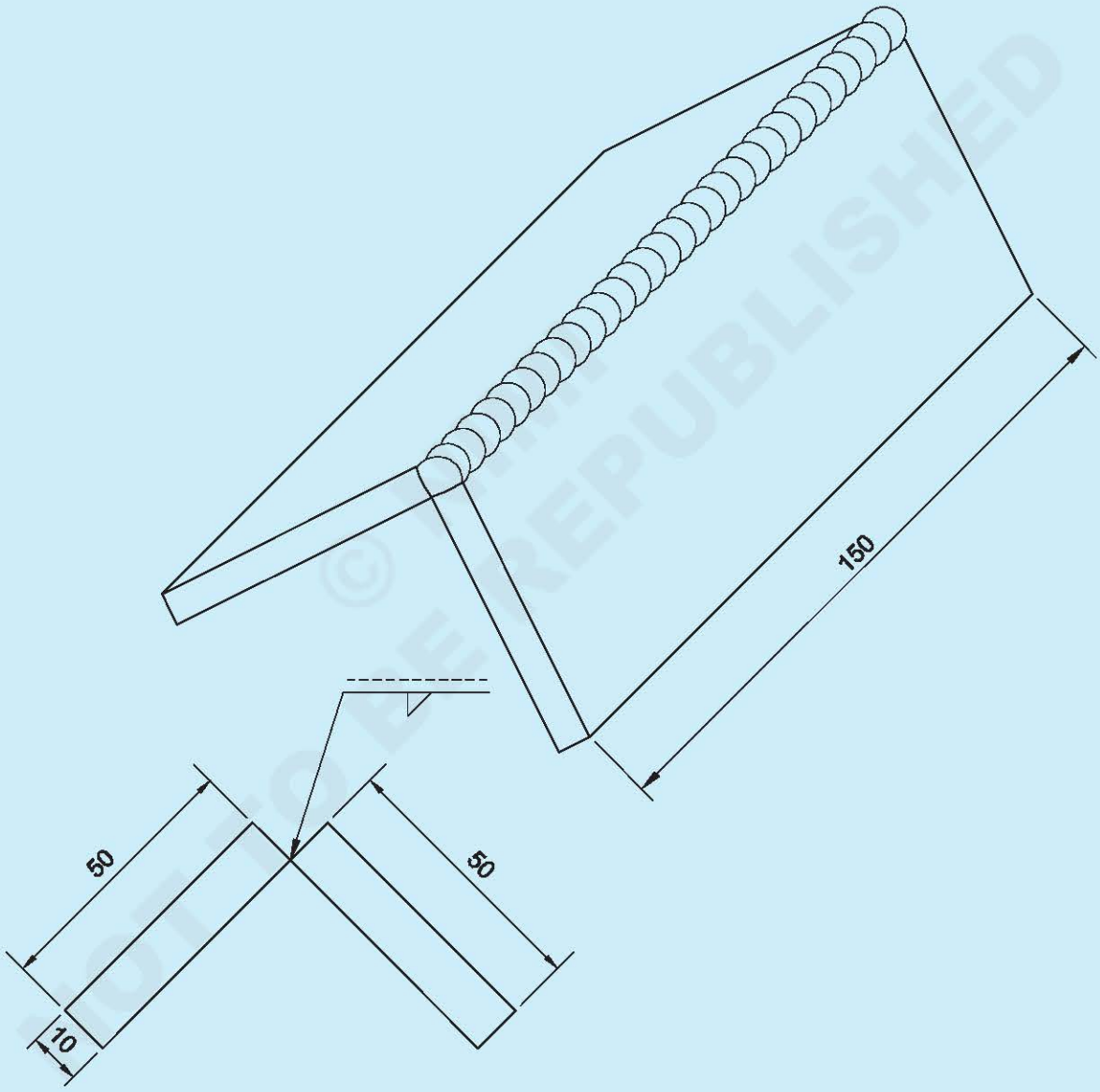
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Open corner joint on MS plate 10mm thick in flat position (1F)-(SMAW-06)

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

- **set the plates with specified root gap in flat position**
- **tack weld the pieces both ends**
- **deposit root run with the formation of a KEYHOLE**
- **deposit uniform covering layers using weaving of electrode**
- **inspect the welded joint for penetration, reinforcement and throat thickness.**

Scan the QR Code to view the video for this exercise



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2	50ISF10 - 150	-	Fe 310 - W	-	-	1.2.23
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	OPEN CORNER JOINT ON M.S PLATE 10mm THICK IN FLAT POSITION (1F)-(SMAW-06)	TOLERANCE ±1	TIME
		CODE NO. WL20N1223E1	

Job Sequence

- Prepare job plates to size as per drawing.
- Clean the joining edges and surfaces of plates.
- Set the plates as an open corner joint with a root gap of 2.5 mm using an angle iron jig.
- Select DCEN polarity, if a DC generator is used.
- Tack the joint pieces at both ends using ø 3.15 mm medium coated MS electrode and 100-110 amps current at the inside of the joint.
- Ensure safety apparels are worn. Use a proper method to control distortion.
- Clean the tacks, check alignment and reset the joint, if required.
- Set the joint on the welding table in a flat position.
- Deposit root run in the joint by forming a keyhole and obtain complete penetration.
- Deslag and clean the root run and inspect root penetration.

Ensure the crown of penetration is not more than 1.6 mm in height.

- Grind and dress the face of the root run, if required.
- Set the welding current 160 amps for 4mm ø medium coated M.S. electrode.
- Deposit an intermediate layer i.e. second run over the root run with slight weaving motion using 4mmø electrode.
- Clean the intermediate layer thoroughly and inspect for faults. Rectify the defects, if any.
- Deposit the final layer to the weld size using the same current setting, electrode and weaving motion as used for the second layer.
- Clean the final layer for inspection.
- Inspect the corner fillet weld:
  - to ensure uniform and correct reinforcement
  - to ensure that the weld face is free from porosity, slag inclusion, unfilled crater, overlap and edge of plate melted off/insufficient throat thickness.

Skill Sequence

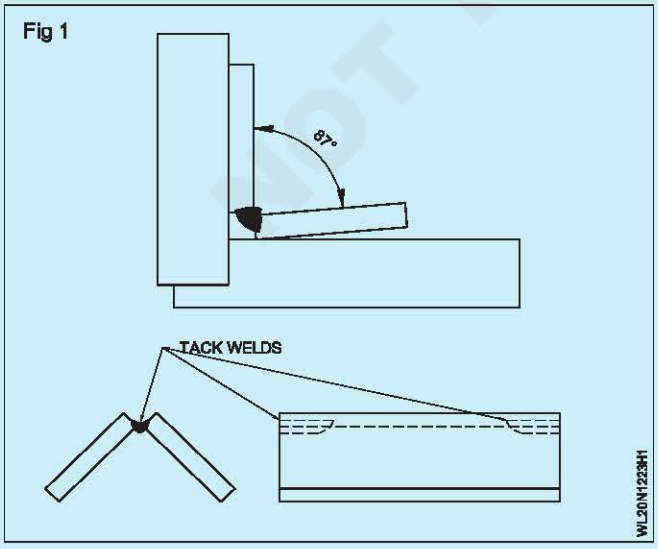
Prepare and make open corner joint in flat positon

Objectives: This shall help you to
- **make open corner joint in flat position.**

Setting and tacking plate pieces for open corner joint (Fig 1)

Set the plates as an open corner joint on the table with parallel root gap of 2.5mm throughout the joint. The angle between the plates is kept at 87° to control the distortion.

Fig 1



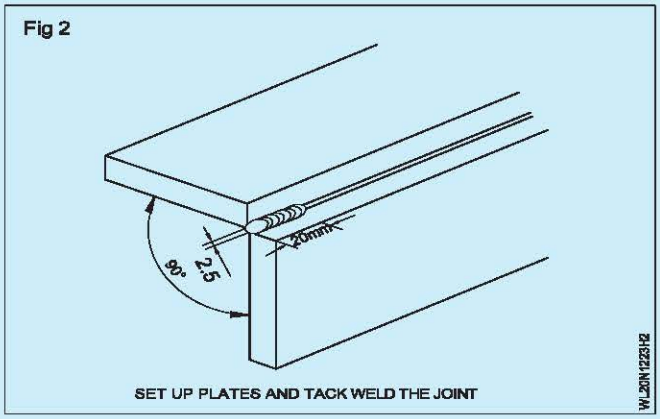
The angular distortion is normally taken as 1° per run.

Check the alignment of the joint with a try square. (Fig 1)

Another method to control distortion is, set the angle at 90° and use a right angled iron fixture to minimize the distortion. Fig 3.

Tack weld the corner joint from inside using a MS electrode ø 3.15mm and 100 - 110 amps current range. Tack weld at both ends with max tack length of 20mm each. (Fig 2)

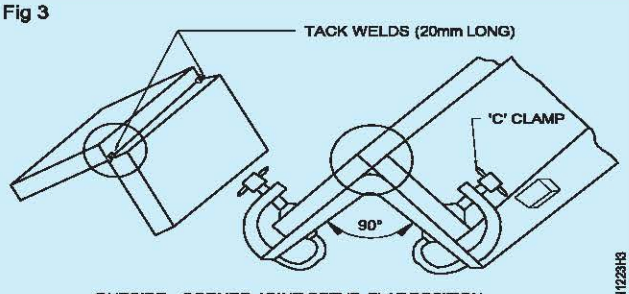
Fig 2



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Ensure that the joining edges are perfectly clean and safety apparels are worn.

Fig 3



OUTSIDE - CORNER JOINT SETUP, FLAT POSITION

Deslag and clean the tacks using chipping hammer and wire brush.

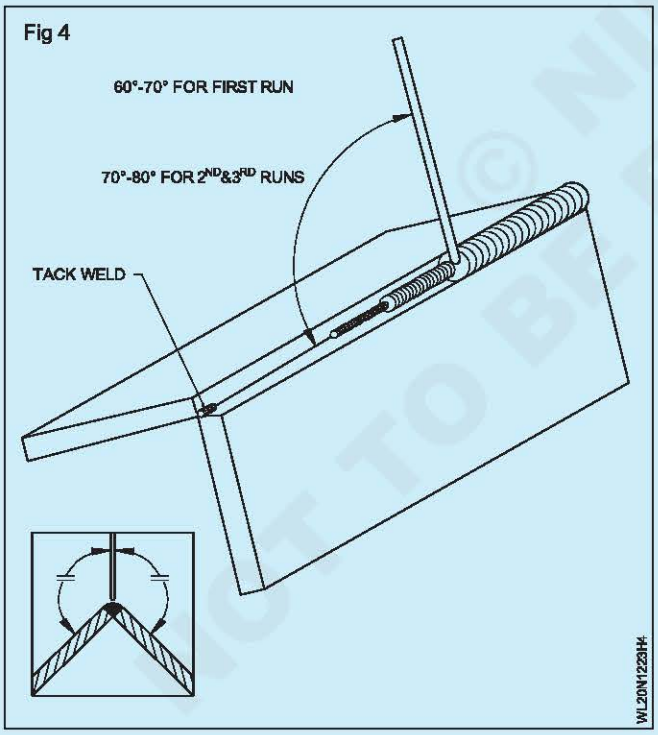
Deposition of root run

Se the joint in a flat position.

Deposit root run in the bottom of the corner by

- using a M.S. electrode ø3.15 and welding current 110 to 120 amps.
- maintaining a slightly short arc
- positioning the electrode vertically between the edge and 60° - 70° with the weld line. Fig 4

Fig 4

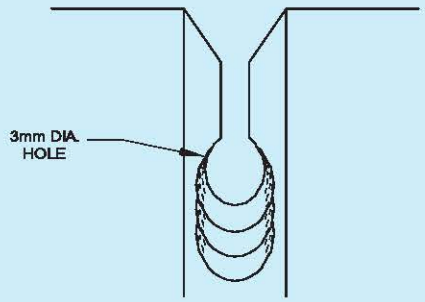


- forming a keyhole near the weld crater of the tack weld to ensure complete penetration. Fig 5
- maintaining travel speed similar to the speed used for straight beading. Clean the root run thoroughly and observe penetration.

Ensure no slag particles are adhering on the root run.

The crater is to be properly filled in each run.

Fig 5



THE KEYHOLE.

Deposition of covering layers

Deposit 1st covering layer i.e., the second run using a ø 4.00 mm medium coated MS electrode and 160 amps welding current. A weaving motion for the electrode has to be given to ensure enough metal is deposited in the groove and both edges of the plates are fused.

Ensure that the electrode angles are as shown in Fig 4. Uniform medium arc length, uniform normal travel speed should be maintained.

Clean the slag from the 1st covering layer thoroughly.

Ensure all the surface defects are rectified.

Deposit 2nd (final) covering layer i.e. the third run using:

- ø 4 mm M.S. electrode and 160 amps welding current
- wider weaving motion to the sides of corner joint
- a slower rate of travel that the 1st covering layer.
- Use the same angle of electrode and arc length as used in 1st covering layer. Fig 4.

Each movement of the weave from one side to the other will deposit more metal, and that takes more time.

Ensure restarting and stopping of the beads correctly.

The usual defect on the final layer of weld is 'edge plate melted off'. This can be eliminated if care is taken to weave the electrode to the required extent so that the edges are just fused. The arc should not be focused on the edges at all.

Inspection of fillet weld in corner joint (Fig 6)

Clean the weldment thoroughly.

Check the angle between the plates for 90°.

Check each run/layer for the following weld characteristics.

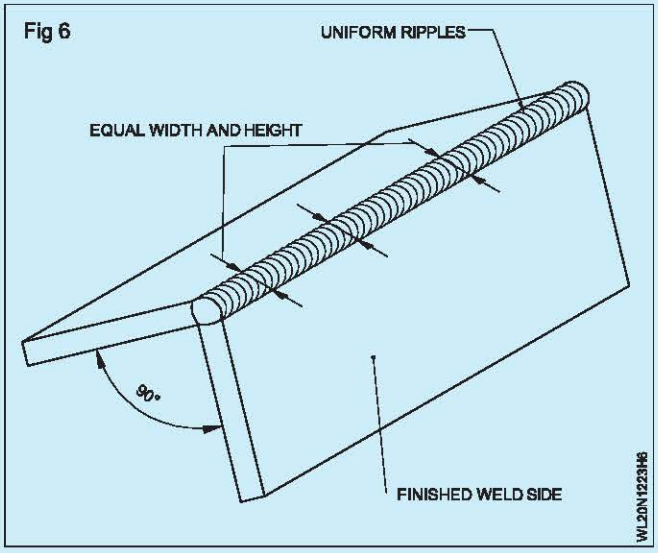
Width and height: Uniform.

Appearance: Smooth with close ripples.

Size: Full fillet without excessive reinforcement.

Face of welds: Root run and 1st covering layer flat, final layer slightly convex.

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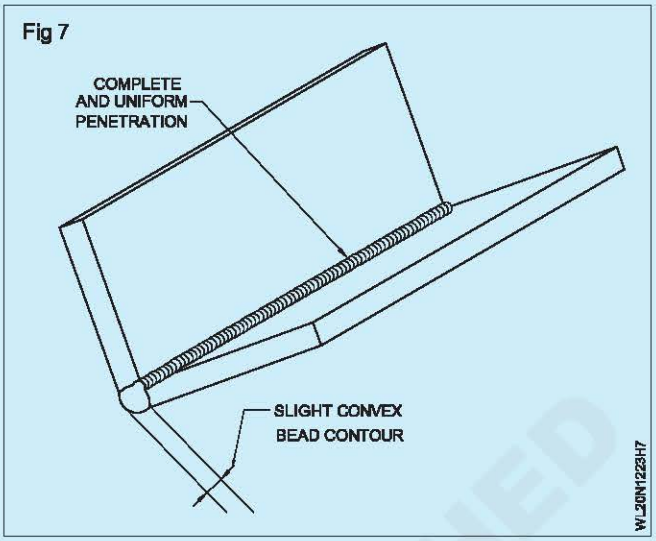


Edges of welds: Good fusion, no undercut, no overlap.

Starts and stops: Free of depression and high spots, craters filled.

Back side: Complete and uniform penetration. (Fig 7)

Surrounding plate surfaces: Free of spatter.



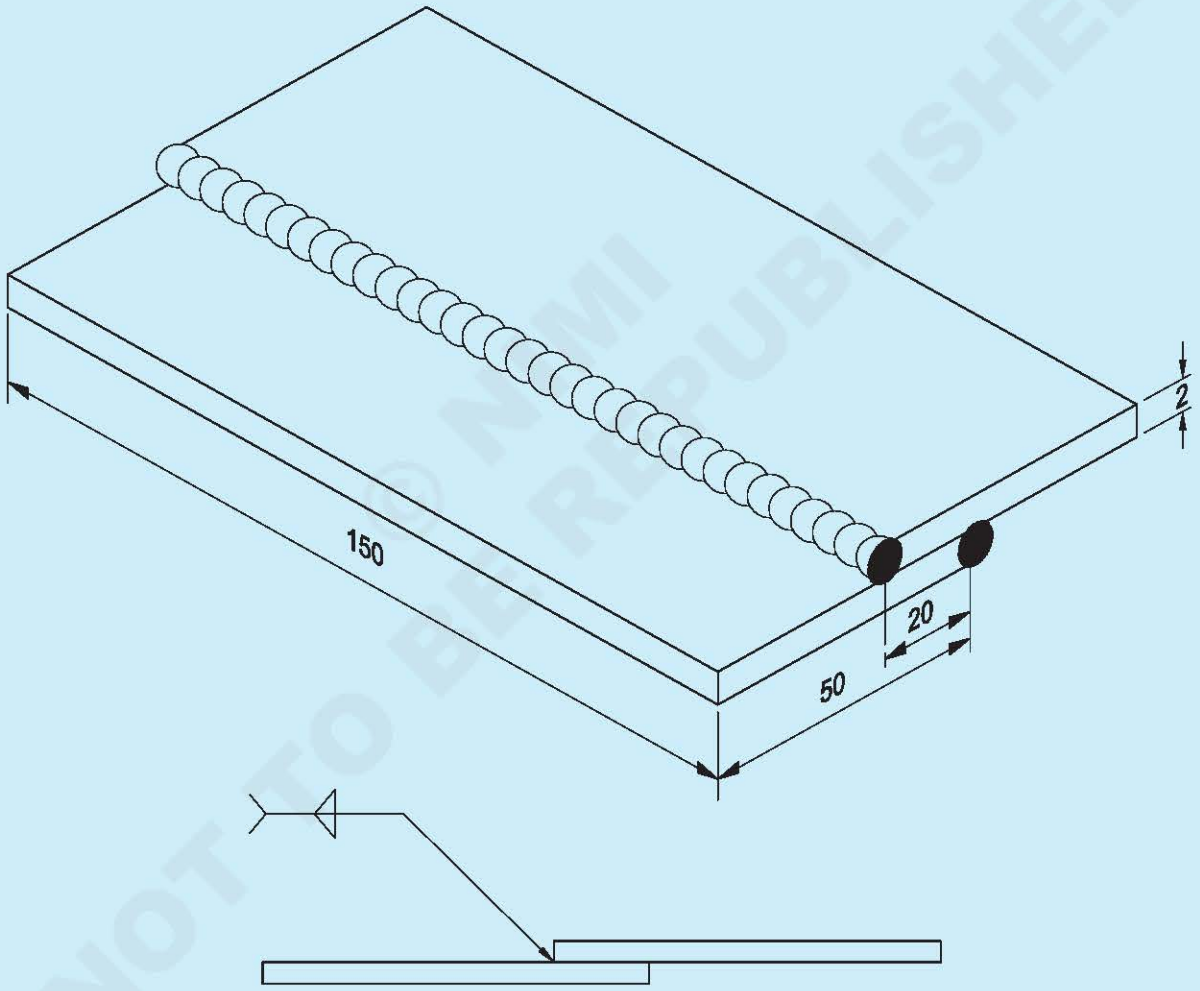
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Fillet lap joint on MS sheet 2mm thick in flat position (1F)-(OAW-07)

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

- **prepare the job as per drawing**
- **set and tack weld the job**
- **set and neutral flame and nozzle**
- **weld the job by using left ward technique**
- **clean and inspect the job**
- **identify the weld defect.**

Scan the QR Code to view the video for this exercise



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2	ISST 50 x 2 - 150		Fe 310 - W			1.2.24
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
					CODE NO. WL20N1224E1	

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/2cm for both gases.
- Select a C.C.M.S. filler rod 1.6 mm ø for tacking and 2.00 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 (2mm 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 steal wire brush.

Visual inspection: Inspect for correct size of fillet weld, slight convexity, uniform width and height, uniform ripples without edge plate melted off defect and other surface defects.

Weld the job from the other side also following the same steps.

Skill Sequence

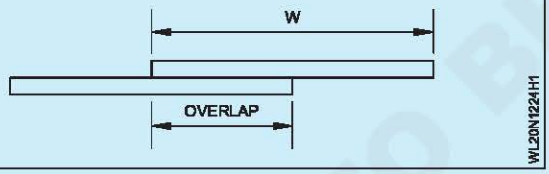
Make the lap joint on MS by OAW

Objectives: This shall help you to

- **make the lap joint on MS by OAW.**

Set and tack the job pieces in correct alignment with proper overlapping of pieces. (Fig 1)

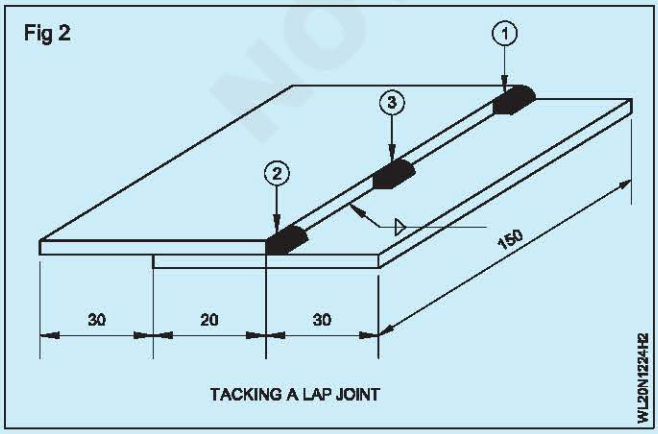
Fig 1



Place the tack welds at correct locations. (Fig 2)

Weld a uniform, well penetrated, correct size fillet lap weld in flat position by

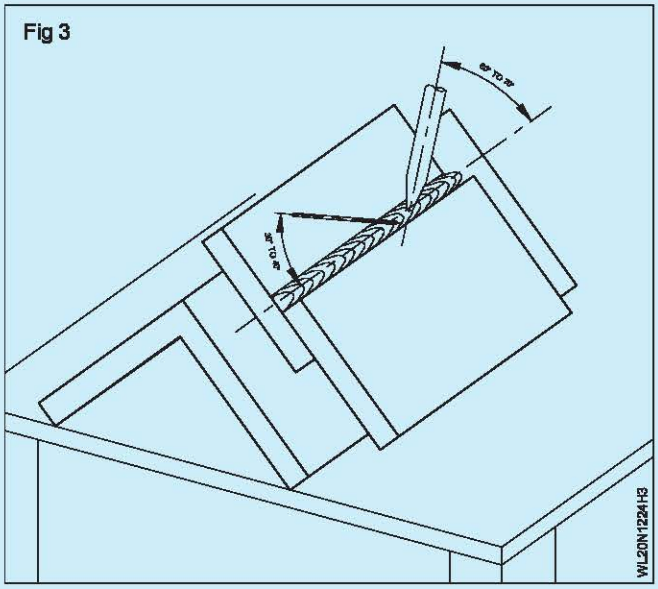
Fig 2



- proper positioning of the joint (Fig 2)
- proper angle of the blowpipe and filler rod (Figs 3 & 4)
- proper manipulation of the blowpipe and filler rod.
- using leftward welding technique.

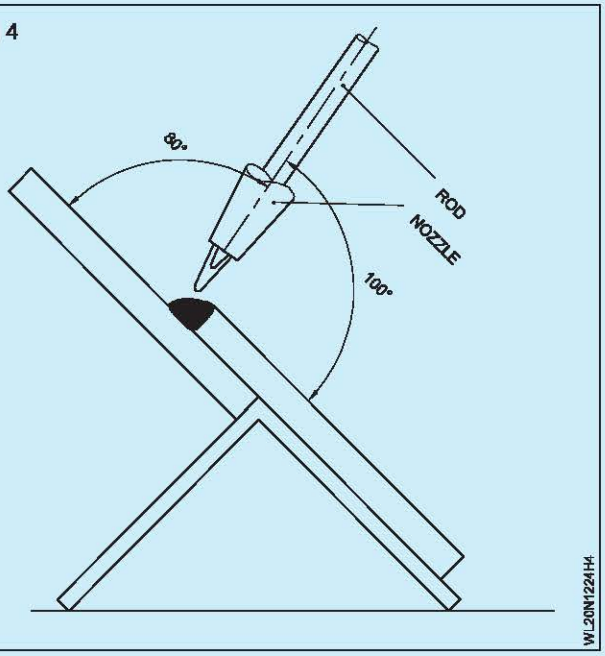
Avoid movement of blow pipe flame nearer to the edge of the top plate. This will avoid edge of the plate melted off defect.

Fig 3



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Fig 4



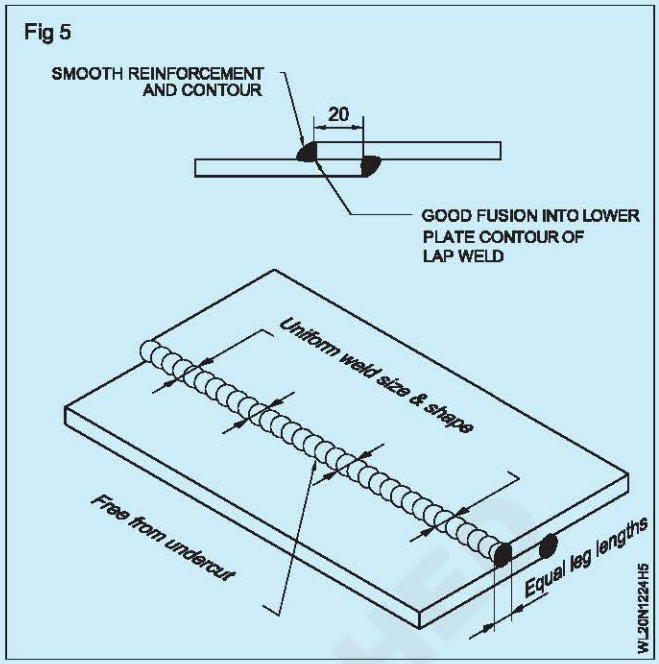
– maintaining uniform travel speed and feed.

Clean the weldment and inspect for: (Fig 5)

– uniform weld size and shape of whole length (reinforcement and contour) of the joint.

– equal leg length

Fig 5



– no undercut at the two of weld

– no fusing of the top plate edge to undersize

– smooth ripple appearance

– proper crater filling.

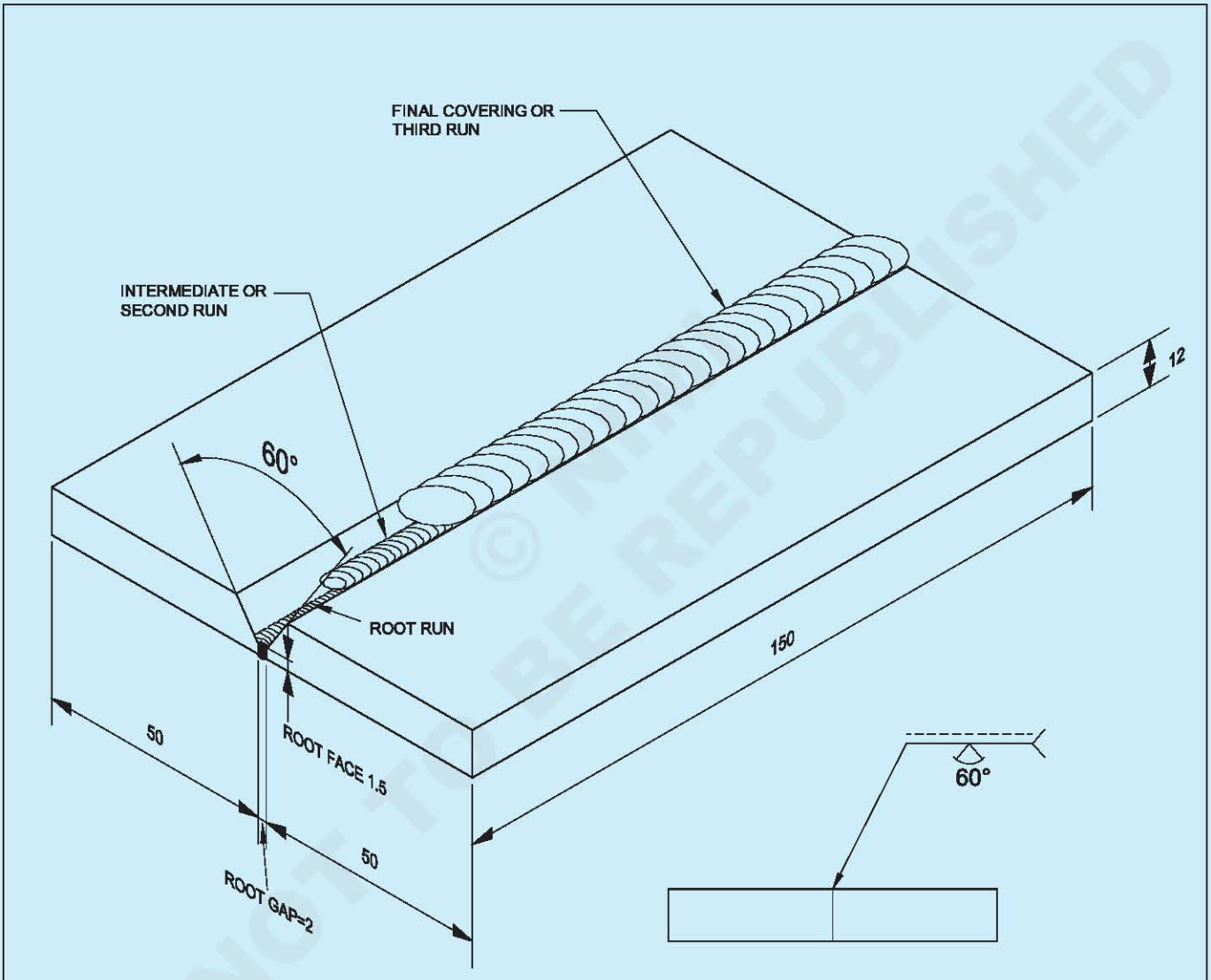
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Single "V" butt joint on MS plate 12 mm thick in flat position (1G)-(SMAW-07)

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

- **prepare the job as per drawing**
- **bevel the plate edges by gas cutting**
- **set the plates with a proper root gap and tack weld**
- **deposit root run intermediate and covering weaving run**
- **clean and inspect the job**
- **identify and rectify the weld defects.**

Scan the QR Code to view the video for this exercise



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02	50 ISF 12 - 150		Fe 310 - W			1.2.25
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**SINGLE "V" BUTT JOINT M.S. PLATE 12mmTHICK IN POSITION FLAT POSITION (1G)-(SMAW-07)**				TOLERANCE ±1	TIME
					WL20N1225E1	

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 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.
- 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

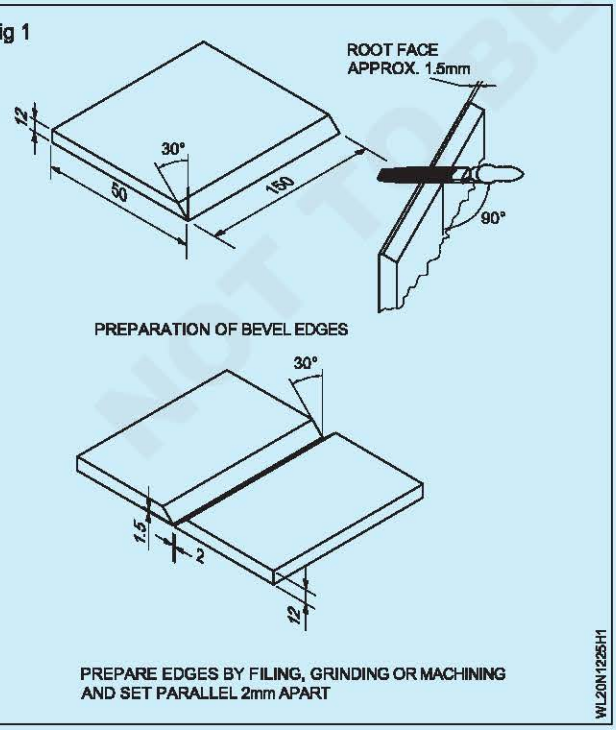
Prepare and make single 'v' butt joint on MS in flat position

Objectives: This shall help you to
- **make single 'V' butt joint on MS in flat position.**

Preparation of the pieces (Fig 1)

Cut a 30° bevel on each piece using oxy-acetylene cutting.

Fig 1



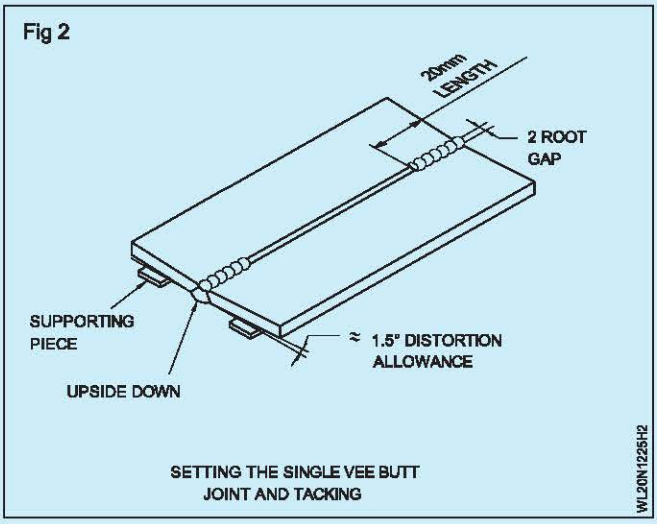
Grind the bevel edges to remove oxide deposits on the bevel.

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.

Fig 2



Tack-weld on both ends. (20mm long)

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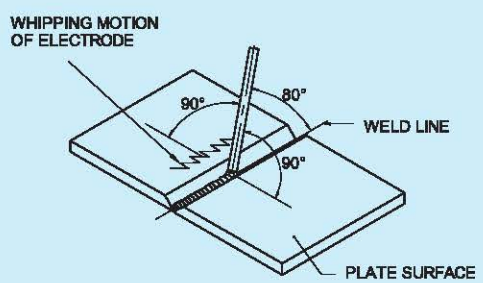
Ensure safety apparels are worn.

Place the joint in flat position after tacking.

Deposition of root bead (Fig 3)

Deposit root bead using a 3.15 dia. M.S. electrode and 110 amps welding current.

Fig 3



ELECTRODE ANGLE AND MOTION FOR SINGLE VEE BUTT JOINT IN LAYING ROOT BEAD

Proceed with a uniform normal speed holding a short arc.

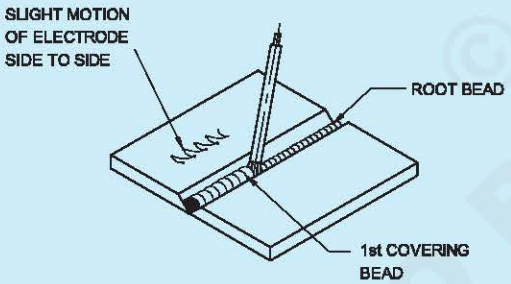
Keep the electrode angle (as shown in Fig 3) at 80° to the line of weld.

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)

Fig 4



ELECTRODE MOTION IN DEPOSITING 1st COVERING BEAD

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.

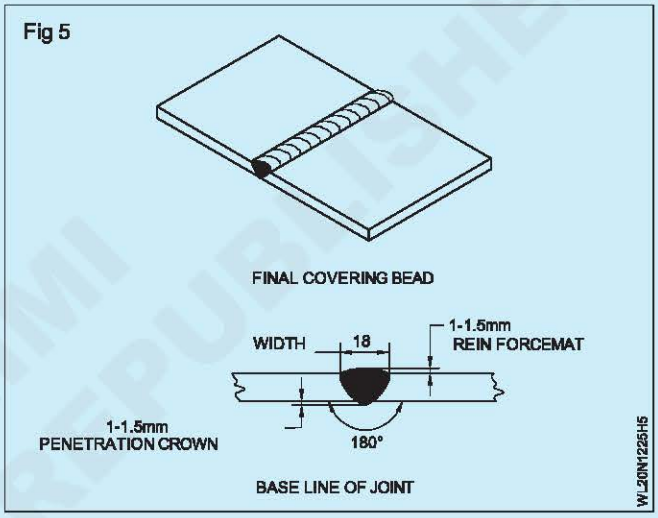
Clean the bead thoroughly and grind the humps in beads (if present).

Rectify possible defects, if any.

Deposition of final/covering bead (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.

Fig 5



Follow the other steps as done for the 1st covering bead.

Cleaning and inspection

Clean the welded joint thoroughly from both sides.

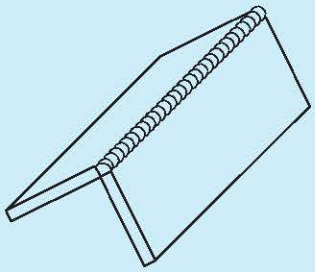
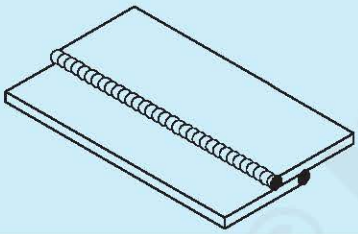
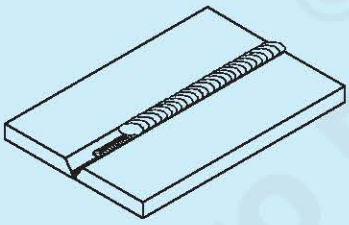
Inspect the weld size, surface defects, root penetration and distortion.

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Testing of weld joints by visual inspection (I&T-01)

Objectives: At the end of this exercise you shall able to:
- **observe the given sample of weld joint visually**
- **identify the defects using magnifying glass**
- **prepare inspection report in the given format.**

TASK 1: **Inspection of weld bead**

Weld Sample	Observations on weld bead
sample 1 	
sample 2 	
sample 3 	
Note: Instructor to provide weld samples to trainees to record the observation on the weld beads.	

1 Observe the given sample of weld joint.

2 Study the weld joint and identify the defect.

3 Record the name of defect in weld joint against each sample.

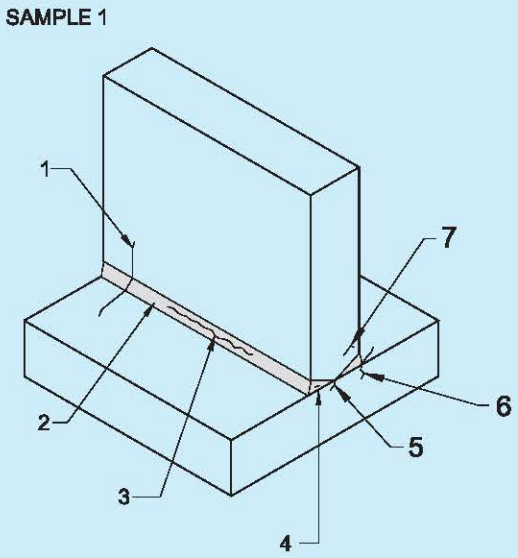
Note: Instructor to provide weld samples and ask the trainees to record the defects.

- Study the given weld sample for inspecting the bead under proper lighting.
- Observe the weld bead using magnifying glass for (2-2.5) any deviation on straight and uniform welding.
- Record the deviations by visually observed in this welded sample 1 as slag inclusion and discontinuity on the weld bead.
- Record the observations in the register with details.
- On sample 2, it is observed that porosity along the length of bead, with spatters, along the bead of weld.
- On sample 3, it is observed that non uniformity along the bead with pin holes defective.

If instructor provides actual welded samples, it may be cleaned with wire brush to be free from dirt, dust, slag which may affect the quality of appearances for visual examination.

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TASK 2: **Inspection of weld sample fillet joints**

Weld Sample - Fillet joint	Name of defect
Sample 1  	1 Spatters 2 Crack 3 Parent metal 4 Crater 5 Penetration 6 Undercut 7 Fusion Penetration **Note:** **1 Observe the given sample of weldment.** **2 Study the weld joint and identify the defect.** **3 Record the name of defect in weld against each sample.** **Instructor to provide weld samples and ask trainees to record the defect.**
Note: samples to be given by the instructor for further study.	

1 Study the given weld sample for fillet joint for inspecting the type of defects.

2 Observe the fillet weld joint and prepare ably cleaned lee force visual inspection using with wire brush.

3 Ensure that the cleaned surface is free from dirt, dust, slag etc. which may affect the quality of appearance for visual examination.

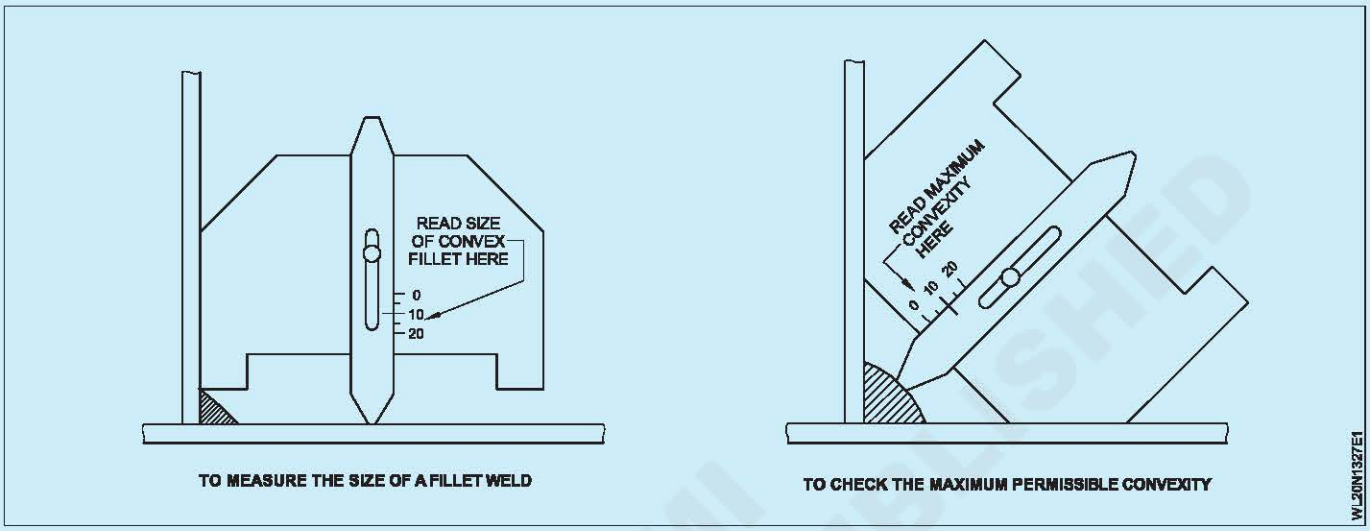
4 Record the name of the defects each mentioned is welded sample fillet joint.

5 Record the observations in the register with details.

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Inspection of welds using weld gauges (I&T-01)

Objectives: At the end of this exercise you shall be able to
- **use weld gauges for inspection of welds**
- **check the concave / convex of fillet weld profile**
- **check the leg length / weld thickness.**



TO MEASURE THE SIZE OF A FILLET WELD

TO CHECK THE MAXIMUM PERMISSIBLE CONVEXITY

Note: Instructor should provide welded samples to inspect the welding using the weld fillet gauges.

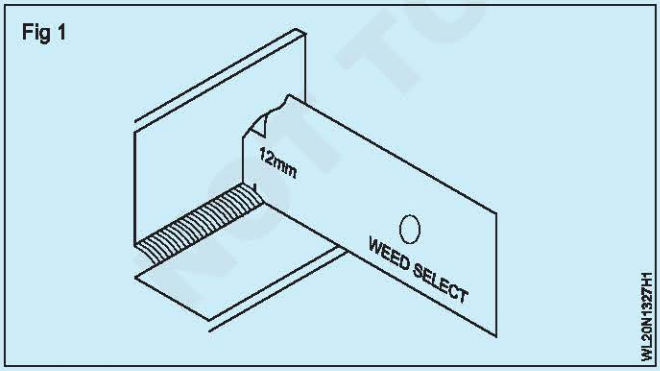
TASK 1: **Inspection of welds using weld gauges**

1 Study the given weld sample for inspecting using weld gauge.

2 Clean the weld surface using wire brush and to be free from dirt, dust, and slag.

3 Select the required size of weld gauge leaf (12mm) and place it against the weld as shown in (Fig 1).

Fig 1

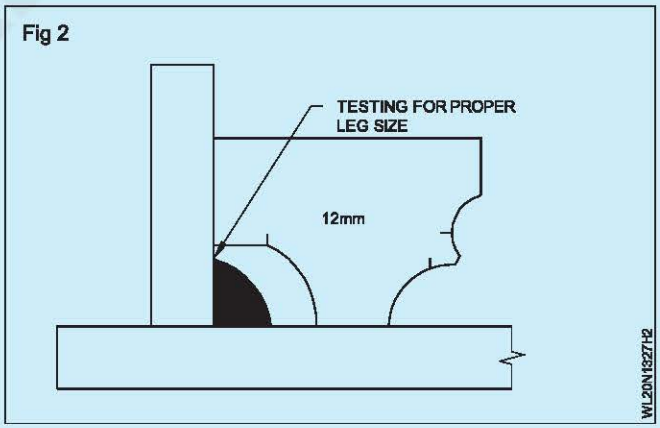


4 Slide the gauge, so that the top end touches the vertical plats.

5 The end of the gauge should exactly touch the top edge of line weld is the correct size of the weld (Fig 2).

If there is a space between gauge and the toe of the weld then it is under sized weld.

Fig 2



6 If the toe of weld is move, the gauge has more space to accommodate as shown in Fig 3. The vertical line on gauge shows that the bottom toe is larger than the required size (correct size).

7 If the weld size 12 mm is satisfied with the gauge, then it should be checked for the corrections throat thickness (Fig 4). This is done by checking for concave or convex face of weld bead. Correct face of weld coincides with gauge as in Fig 4. If there is a gap at the measuring force of gauge, then the weld may be concave as shown in Fig 5. This means the weld is not having the correct throat thickness or it is undersize then the required size. Hence it is "not acceptable". If

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it convex, but the less then the required leg size is also, a "not acceptable" weld. Fig 6 show that there is a clearance between the weld toe and gauge measuring face.

Fig 3

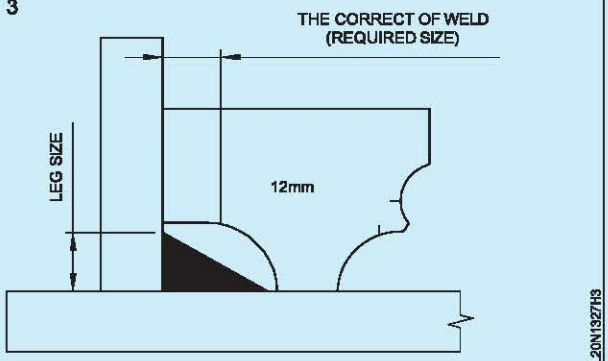


Fig 4

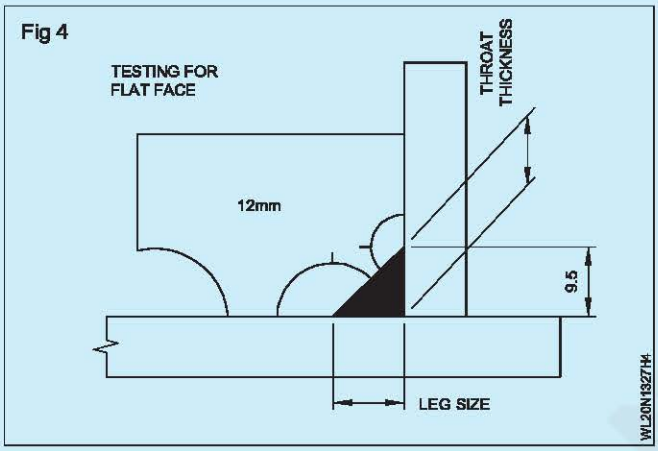


Fig 5

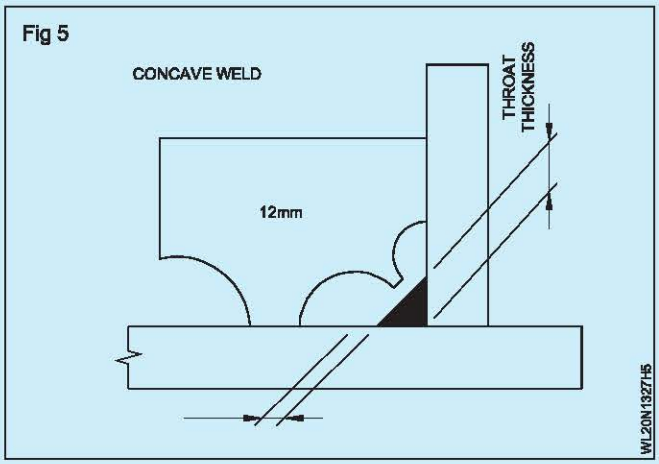
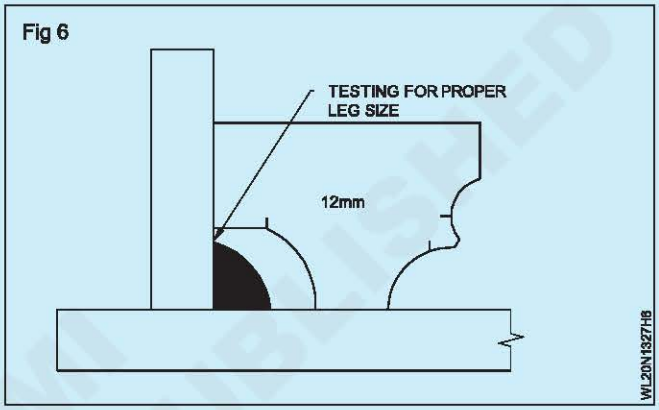


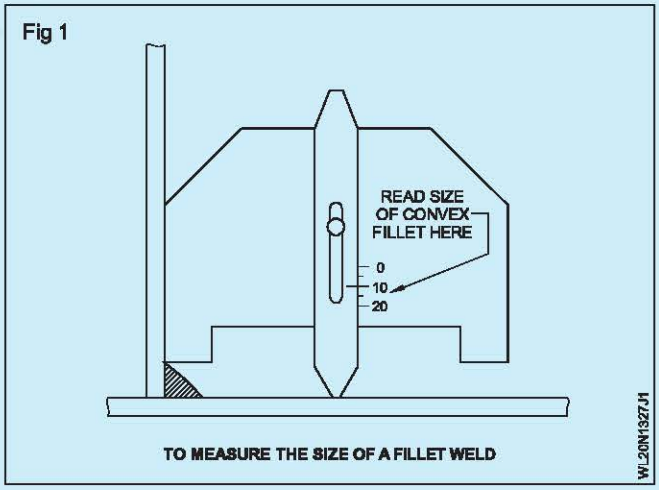
Fig 6



TASK 2: **To measure the leg size of fillet weld using AWS-Standard fillet gauge**

1 Place the gauge against the toe of the weld as shown in Fig 1. Slide the pointer to rest over the bottom plate of the job. The leg size of fillet is observed on the graduated scale of gauge. This is the leg size of fillet weld.

Fig 1



TASK 3: T**o measure the acceptable convexity of fillet weld**

1 Place the gauge against the vertical plate of fillet weld joint (as shown in Fig 2).

2 Ensure 45° sides are in contact with both vertical and bottom plate of fillet weld joint.

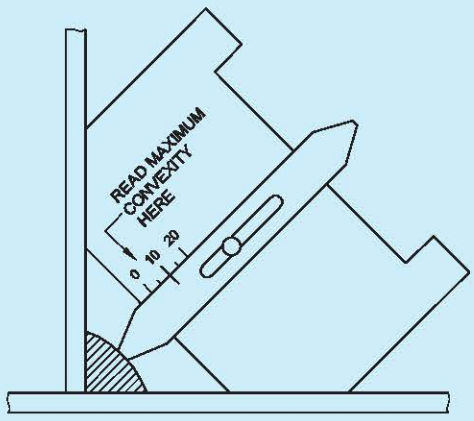
3 Slide the pointer to rest over the weld face.

4 Observe the measurement on graduated scale on coincidence with slide mark.

5 Record the measurement to find out the acceptable size of weld reinforcement.

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Fig 1



TO CHECK THE MAXIMUM PERMISSIBLE CONVEXITY

WL20N1327X1

TASK 4: **To measure the acceptable concavity of fillet weld**

1 Place the gauge against the vertical plate of fillet weld joint (as shown in the Fig 3).

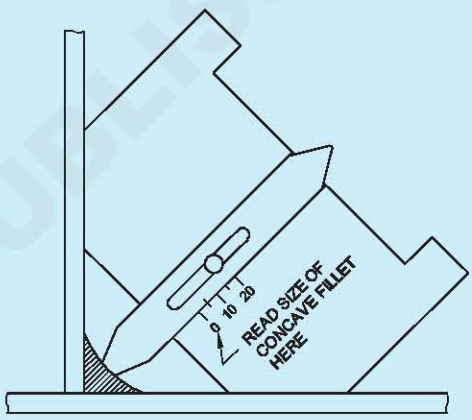
2 Ensure the 45° sides are in contact with vertical and horizontal plate of fillet weld joint.

3 Slide the pointer to rest over the concave weld face.

4 Observe the measurement on graduations and coincidence with slide mark.

5 Record the measurement to find out the acceptable size of weld reinforcement.

Fig 1



TO DETERMINE THE SIZE OF A CONCAVE FILLET

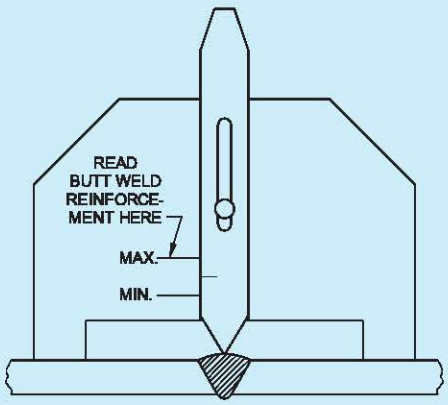
WL20N1327Y1

TASK 5: **To measure reinforcement on a butt welded joint**

1 Place the gauge so that pointer maybe seated over the weld seam as in Fig 4.

2 Observe the measurement, and record accordingly at concave portion or convex portion of the weld by placing it in position.

Fig 1



CHECKING BUTT WELD FOR MAXIMUM AND MINIMUM CONVEXITY

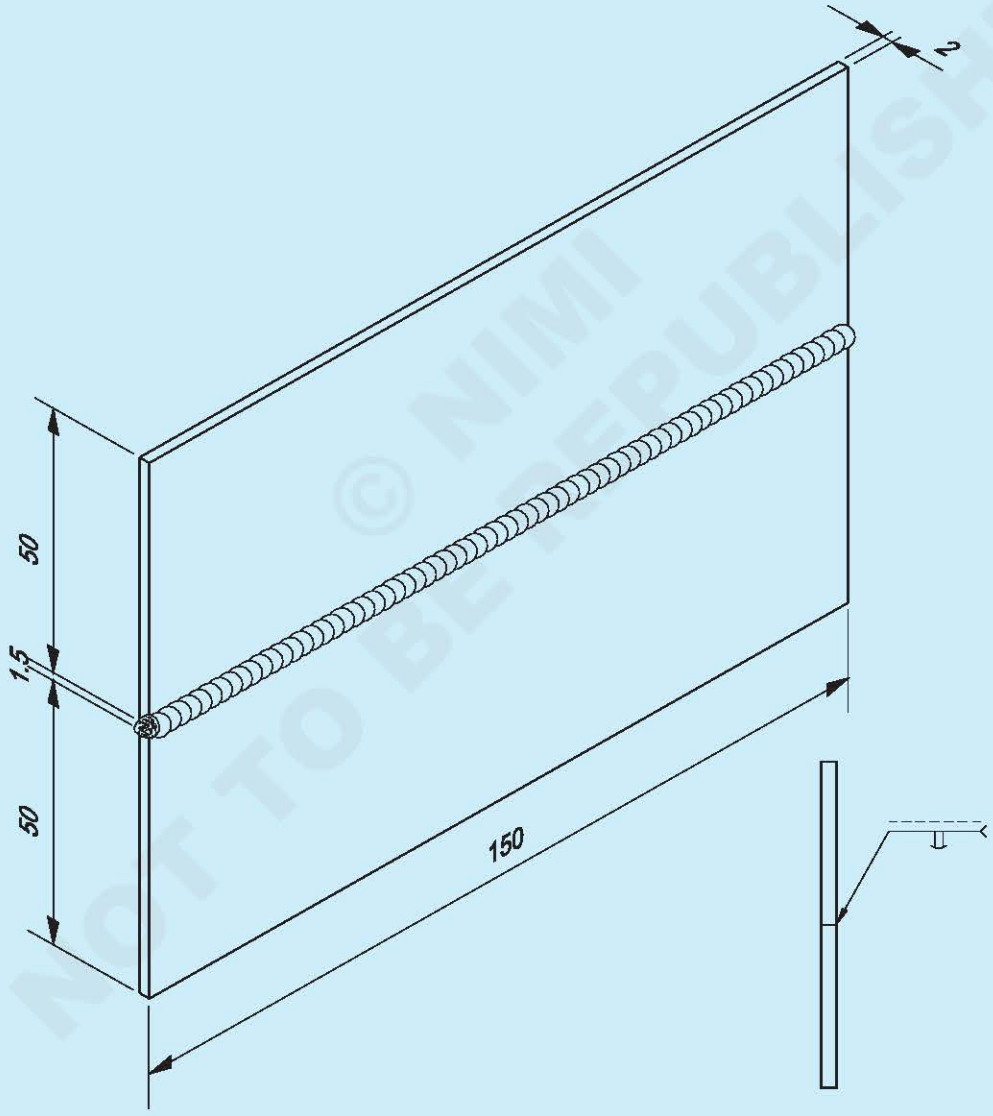
WL20N132Z7Z1

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Square butt joint on MS sheet 2mm thick in horizontal position (2G)-(OAW-08)

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

- **prepare the job as per drawing**
- **set the proper root gap neutral flame and tack weld**
- **fix the job in the positioner in horizontal position**
- **weld the job by using leftward technique**
- **clean and inspect the job**
- **identify the weld defects.**



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2	ISST 50 x 2 - 150	-	Fe 310 - W	-	-	1.3.28
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	BUTT WELD - SQUARE BUTT JOINT ON M.S SHEET 2mm IN HORIZONTAL POSITION.	TOLERANCE ±0.5	TIME
		CODE NO. WL20N1328E1	

Job Sequence

- Prepare the job pieces as per drawing.
- Clean the edges and surfaces of the metal pieces.
- Set the job pieces as square butt joint with a root gap of 1.5 mm.
- Select the nozzle No. 5 and C.C.MS. filler rod dia. 1.6mm.
- Set a gas pressure of 0.15 kg/cm^2.
- Follow necessary safety precautions.
- Tack weld the sheets and check for uniform root gap and alignment.
- Weld the joint with a single run in horizontal position.
- Clean the welded area.

Skill Sequence

Make the square butt joint on MS in horizontal position

Objectives: This shall help you to

- **make the square butt joint on MS in horizontal position.**

Position the crossbar of the positioner to the eye level. (Fig 1)

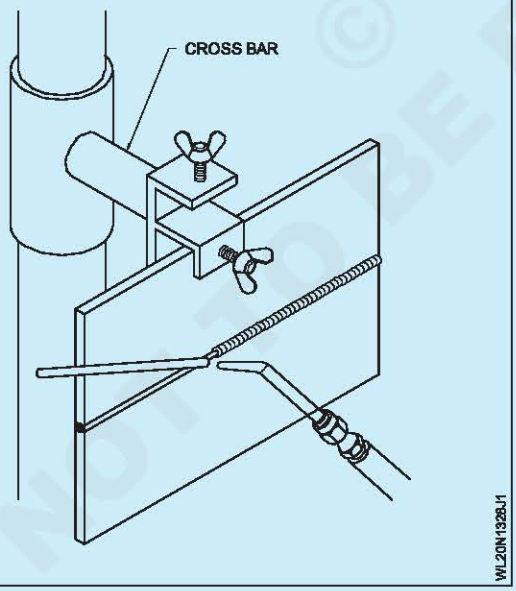
Adjust the pressure of oxygen and that of acetylene at 0.15 kg/cm^2.

Set a soft neutral flame.

Tack-weld the job at both ends and at the center with a root gap of 2.5 mm.

Fix the job on the crossbar of the positioner in horizontal position. (Fig 1)

Fig 1



Ensure the job is in horizontal position at a convenient height.

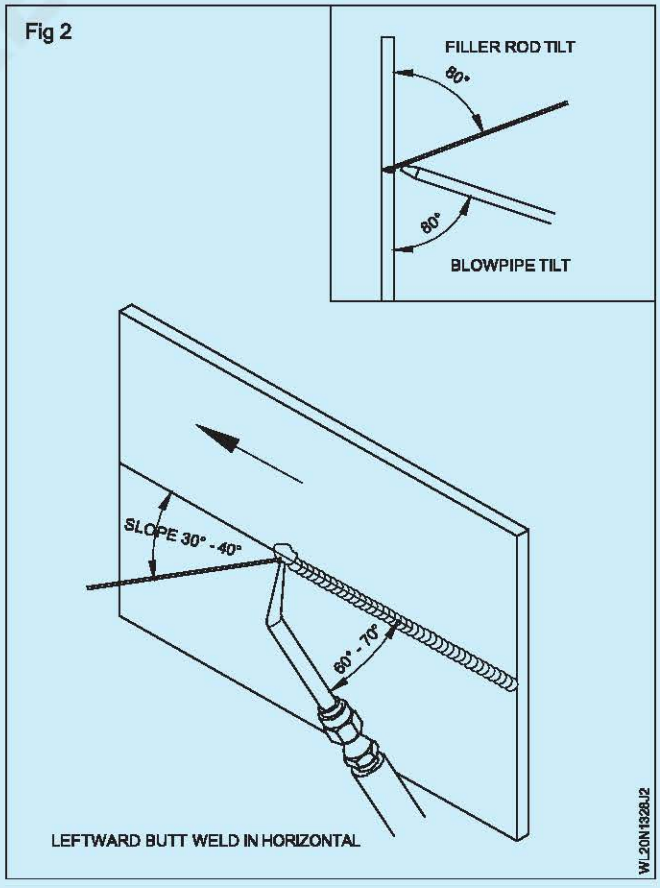
Hold the blowpipe at 60° to 70° and the filler rod at 30° to 40° to the line of weld. Deposit the bead from the right end of the joint by giving a circular motion to the blowpipe and proceed towards the left end.

Ensure both edges melt equally and up to the root of the joint.

Check the weldment for correct profile with complete penetration.

Proper angle between the blow pipe, filler rod and the sheet surface is to be maintained (Fig 2). The filler rod is added when the inner core of the flame reaches the top edge of the joint. This will help in avoiding the excessive melting of the bottom edge of the joint and will avoid sagging of weld metal.

Fig 2

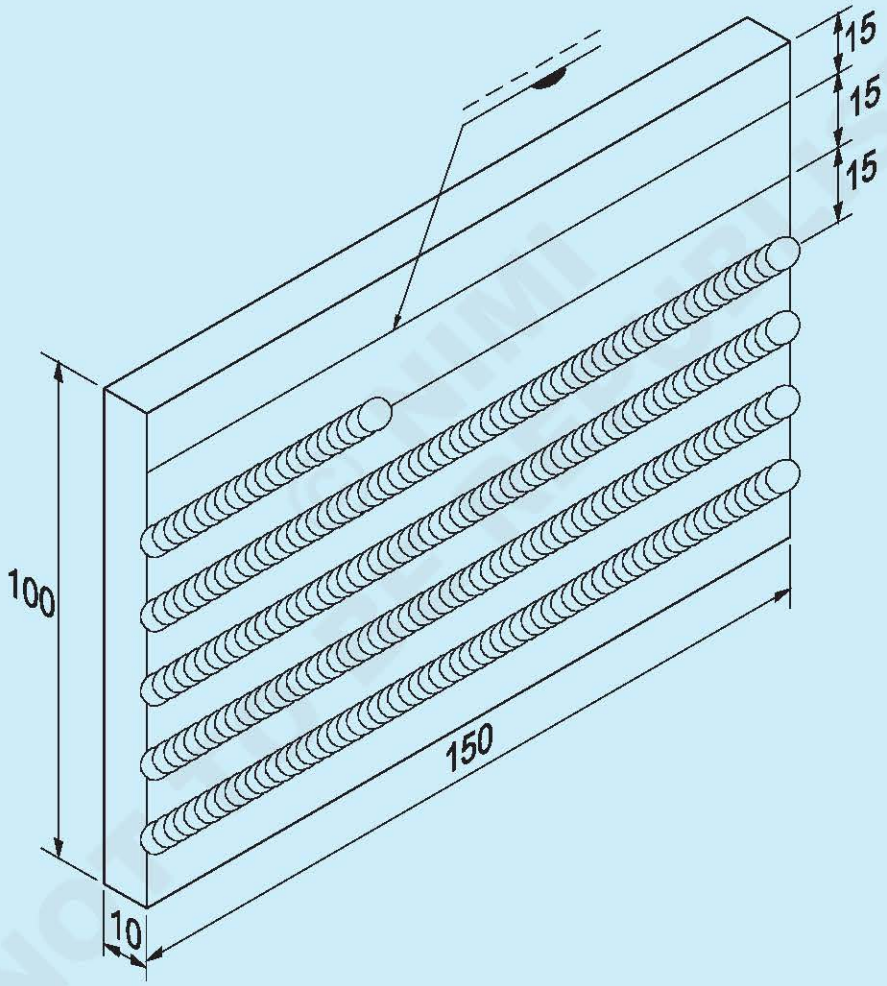


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Straight line beads and multi-layer practice on M.S. plate 10mm thick in horizontal position (SMAW-08)

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

- **prepare the job as per drawing**
- **set the job in horizontal position**
- **deposit uniform straight line beads in horizontal position**
- **clean and inspect the job.**



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1	100 ISF x 10 - 150	-	Fe 310 - W	-	-	1.3.29
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	STRAIGHT LINE BEADS ON M.S PLATE 10mm THICK AND MULTIPASS PRACTICE IN HORIZONTAL POSITION (SMAW-08)	TOLERANCE ±1	TIME
		CODE NO. WL20N1329E1	

Job Sequence

Preparation

- Mark and cut the plate as per drawing. Clean the surface and file the edges before punching the lines.
- Scribe lines and make punch marks as per job drawing.
- Select a 3.15mm electrode and set 110 amps and use DCEN. Set the job in a horizontal position.
- To avoid sagging molten metal, use a short etc.
- Convex bead will trap slag.
- Start at left hand side of the plate hold the electrode pointing upward at angle of 70° to 80° to the surface of base metal. Use a travel angle 70° to 80° to weld direction.
- Remove the slag with a chipping hammer and clean the bead with a wire brush.

Inspection of bead

- Inspect the bead weld for surface defects like undercut, slag inclusions, overlap etc.

Skill Sequence

Weld straight line bead on MS plate 10mm in horizontal position

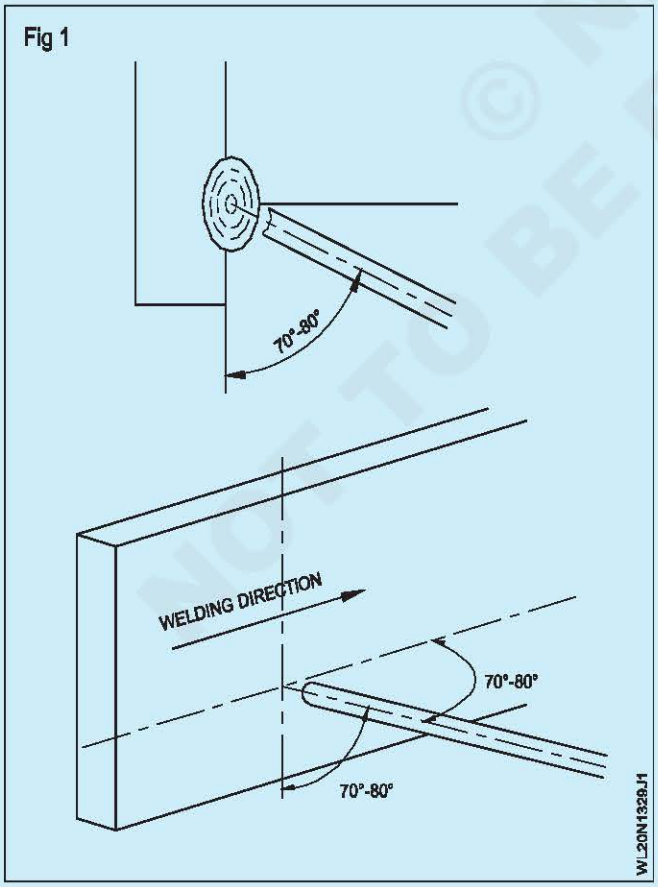
Objective: This shall help you to

- **prepare and weld straight line bead on MS plate 10mm in horizontal position.**

Making a bead on plate weld in the horizontal position is very much like making it in a flat position.

But the angle of electrode should be held at an angle to the surface and inclined to the line of travelling as shown in the Fig 1.

Fig 1

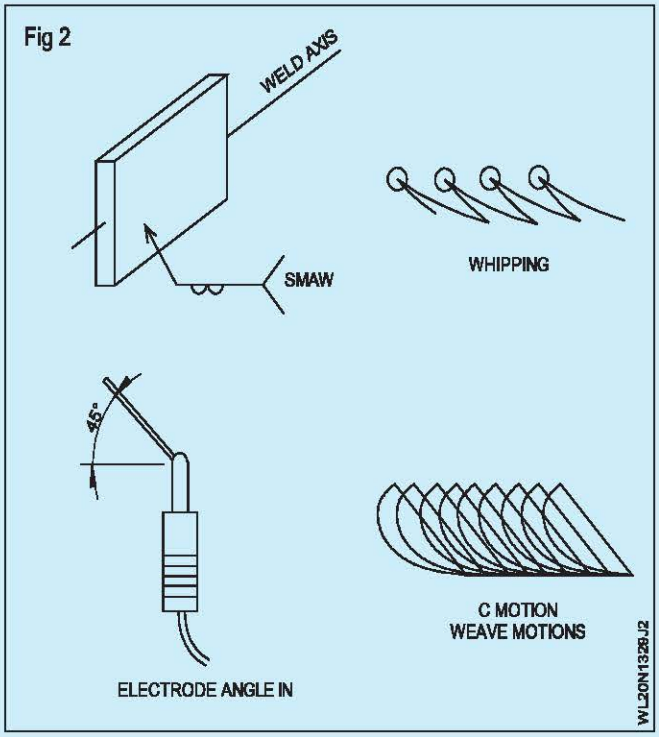


Reduce the current to get faster cooling. This helps to avoid overhanging of weld puddle at the bottom side of the plate.

Use a faster travel speed and maintain weld puddle size not larger than the coating diameter of the electrode.

Move the electrode to the right with a slight whipping motion or a "C" motion as shown in Fig 2. This helps to cool the puddle slightly, solidify faster and avoid sagging of bead. While using "C" motion pause at the upper left of the "C". Fig 2

Fig 2



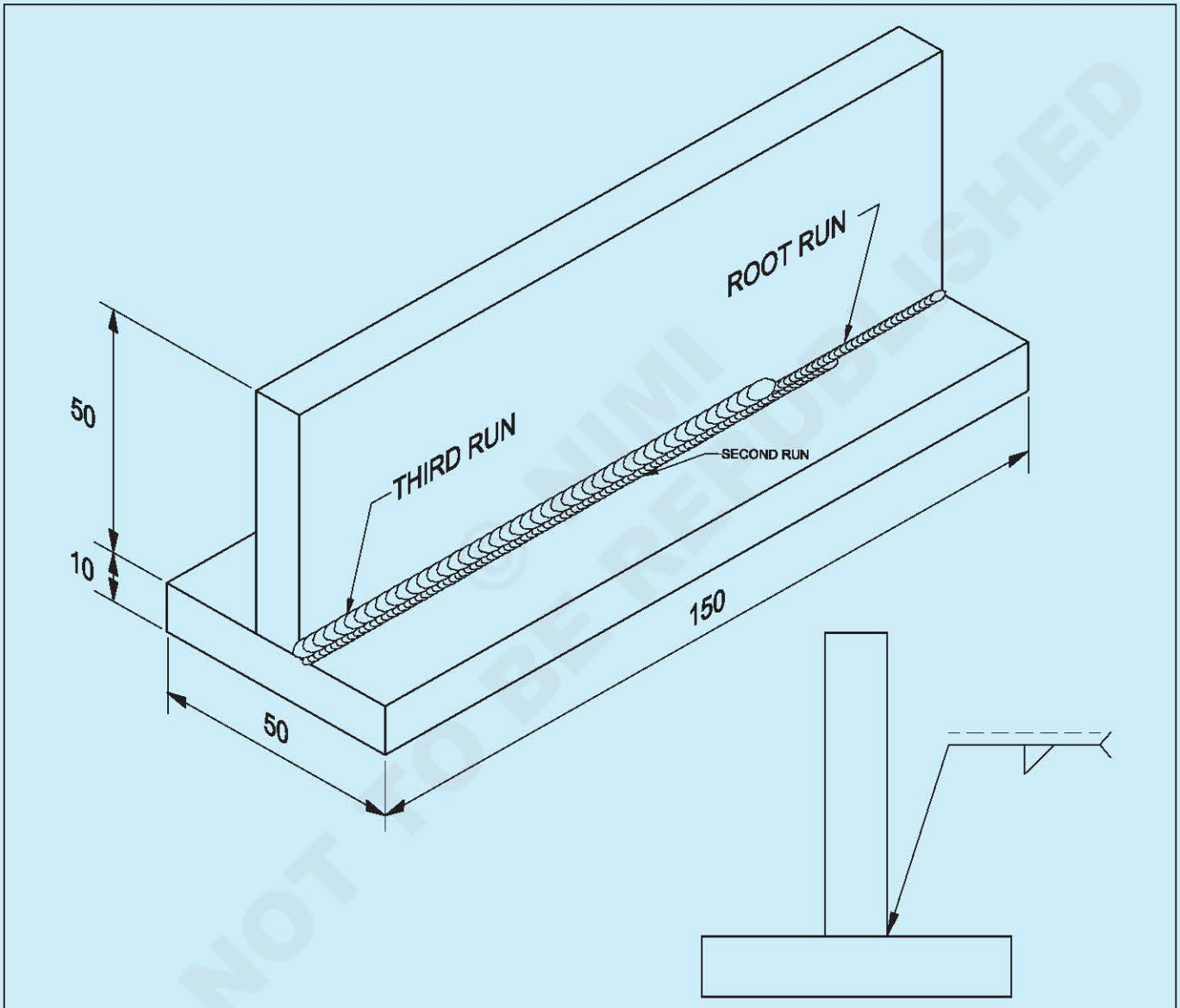
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Fillet - 'T' joint on MS plate 10mm thick in horizontal position (2F)-(SMAW-09)

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

- **prepare the job as per drawing**
- **select electrode current, polarity and are length**
- **set the job in horizontal position & tack weld**
- **deposit root run second and third run using stringer bead**
- **clean and inspect the weld defects.**

Scan the QR Code to view the video for this exercise



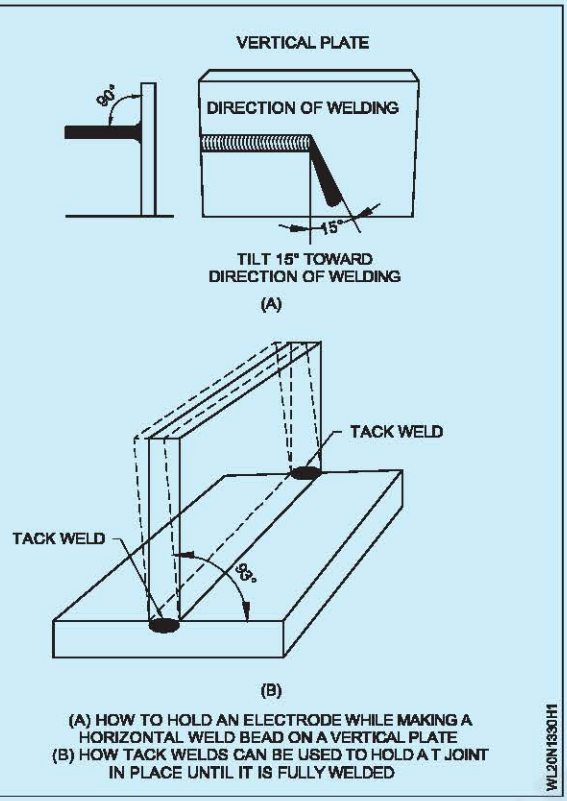
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2	50 ISF x 10 - 150		Fe 310 - W			1.3.30
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**FILLET 'T'- JOINT ON M.S PLATE 10mm THICK IN HORIZONTAL POSITION (2F)-(SMAW-09)**				TOLERANCE ±1	TIME
					CODE NO. WLN1330E1	

Job Sequence

- Prepare and clean the plates as given Fig 1.

Fig 1



(A) HOW TO HOLD AN ELECTRODE WHILE MAKING A HORIZONTAL WELD BEAD ON A VERTICAL PLATE
(B) HOW TACK WELDS CAN BE USED TO HOLD A T JOINT IN PLACE UNTIL IT IS FULLY WELDED

- Set the Tee joint as per drawing and tack weld (Fig 1)
- Fix the joint in horizontal position.
- If DC machine is used, connect the electrode to the negative and use short arc to control arc blow.
- To avoid distortion due to contraction preset the plates such a way that the angle of the tack welded joint is increased to 92° to 93° on the welding side.
- Deposit the root run without weaving.
- Hold the electrode at the center of the joint and start from leftward and use proper technique to avoid excessive metal deposition at the bottom of the plate.
- Deslag and clean the root run.
- Deposit the second and third run using stringer bead technique covering the previously laid bead partially and the plate surface.
- Ensure to fill the crater and to clean the bead.
- Check for the size of fillet, bead profile, weld defects and rectify them.

Skill Sequence

prepare the tee joint on MS in horizontal position

Objective: This shall help you to

- **prepare the tee joint on MS in horizontal position.**

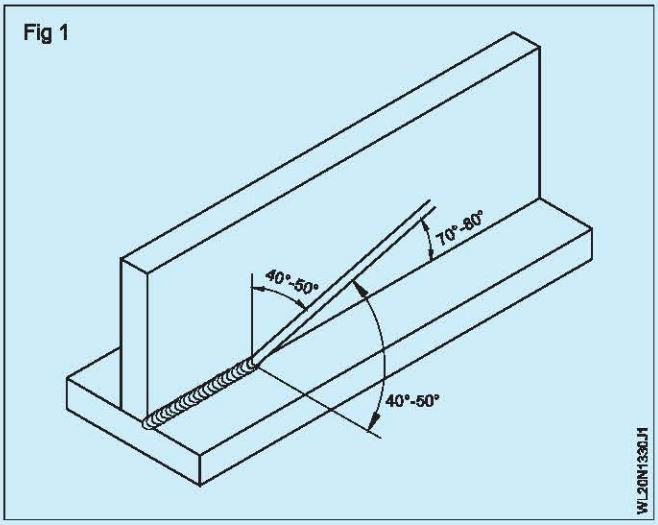
Fix the joint in a horizontal position. For this the bottom plate should be kept parallel to the ground and the other plate perpendicular. Fig 1.

Welding Tee joint (fillet) in horizontal position: Deposit root run with 3.15 mm dia. electrode and 110 amps welding current, maintaining the electrode angle 70° to 80° to the line of weld and 40° to 50° between the vertical plate and electrode (as in Fig 1).

Maintain a short arc to get uniform fusion and proper root penetration.

Deslag and clean the root bead thoroughly. Use safety goggles while deslagging to protect the eyes from flying slag particles.

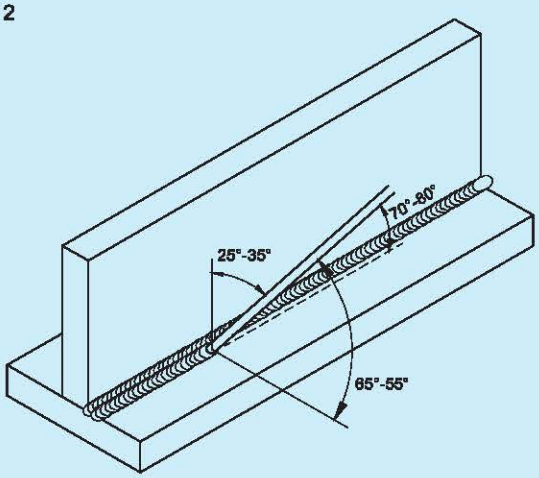
Fig 1



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Deposit second run with a 4 mm electrode and 160 amps welding current, the angle of electrode to the bottom plate to be 55° - 65° and 25° - 35° to the vertical plate and 70° to 80° to the line of weld. (As in Fig 2.)

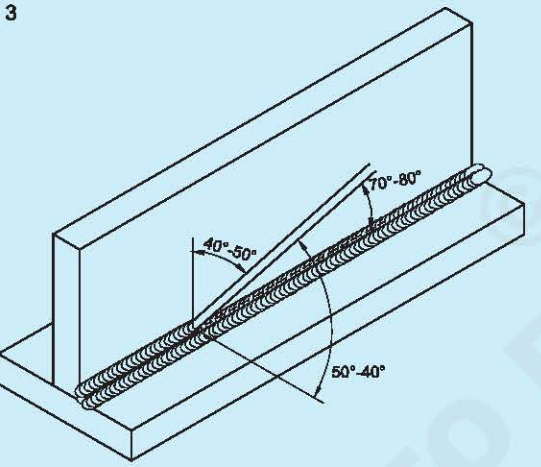
Fig 2



This second run has to be deposited partly covering the root run and partly on the bottom plate. Fig 3

Give a steady movement to the electrode using a short arc.

Fig 3



Deslag and clean the weld bead.

Deposit the third and final run with a 4 mm dia. Electrode and 160 amps welding current. Angle of the electrode to the line of weld is 70° to 80° and 40° - 50° on both plates. (Fig 3) The third run has to be deposited in such a way that the bead covers partly the root run and the second run and partly the vertical plate (Fig 4). Also there should not be a valley at the bottom toe line of the third run in order to maintain necessary throat thickness. If two pass technique is adopted second run should be done in a weaving motion. (Fig 5)

Fig 4

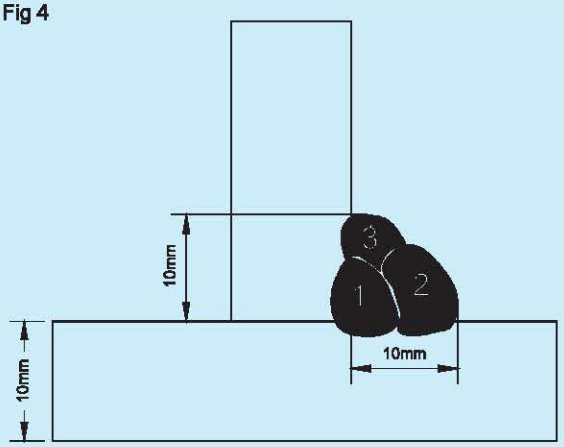
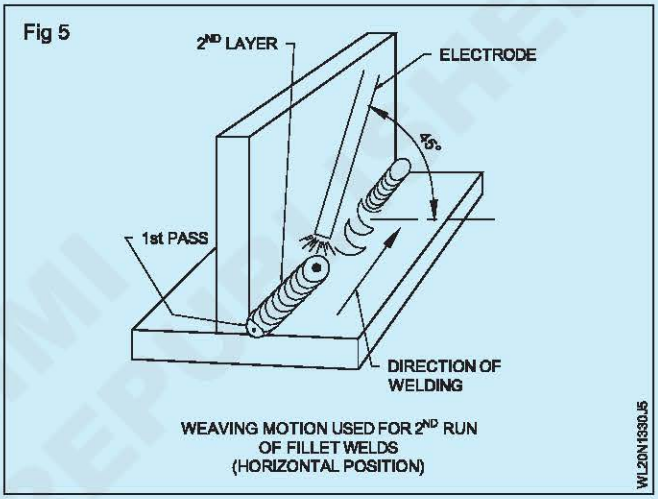


Fig 5



Deslag and clean the weld bead.

Avoid over-deposition and side undercut by using a proper angle and travel speed of the electrode.

Inspection of T joint

Inspect the fillet weld for equal leg length and correct size.

Inspect to ensure the fillet weld is free from undercut and excessive lapping on bottom plate.

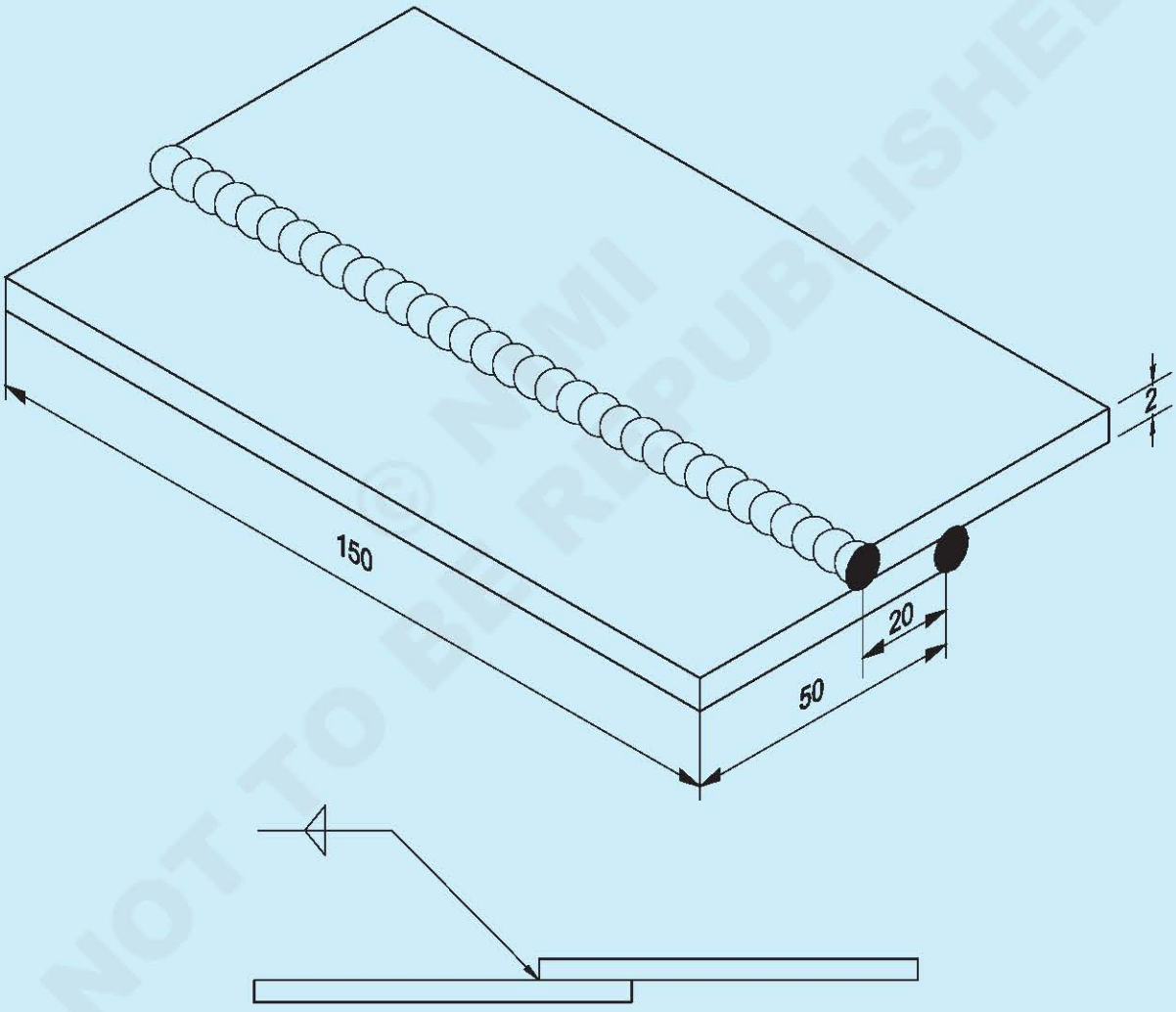
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Exercise 1.3.31

Fillet - lap joint on MS sheet 2mm thick in horizontal position (2F)-(OAW-09)

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

- **prepare the job as per drawing**
- **select the correct size filler rod & nozzle**
- **set the neutral, flame, and tack weld**
- **weld the job in horizontal position**
- **clean and inspect the weld defects**



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2	ISST 50 x 2 - 150	-	Fe 310 - W	-	-	1.3.31
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	FILLET WELD - LAP JOINT ON M.S.SHEET 2mm IN HORIZONTAL POSITION.	TOLERANCE ±1	TIME
		CODE NO. WL20N1331E1	

Job Sequence

- Prepare the job pieces as per drawing.
- Clean the edges and surfaces of the metal pieces.
- Set the job pieces as lap joint.
- Select the nozzle No. 5 and C.C.M.S. filler rod 3mmø.
- Set a gas pressure of 0.15 kg/m^2.
- Follow necessary safety precautions.
- Tack weld the sheets and check for alignment
- Weld the joint with a single run in horizontal position.
- Clean the welded area and inspect the weld for defects.

Skill Sequence

prepare and make lap joint in horizontal position

Objective: This shall help you to
• cut the triangular and hexagonal shape.

Position the cross bar of the positioner to the eye level.

Adjust the pressure of oxygen and that of acetylene at 0.15 kg/cm^2.

Set and tack the job pieces in correct alignment with proper overlapping of pieces.

Place the tack welds at correct locations.

Fix the job on the cross bar of the positioner in horizontal position.

Hold the blowpipe at 60 to 70° and the filler rod at 30 to 40° to the line of weld. Deposit the bead from the right end of the joint by giving a circular motion to the blowpipe and proceed towards the left end.

Maintain correct travel speed, manipulation of blowpipe and filler rod to produce uniform weld bead.

Clean the weldment and inspect for:

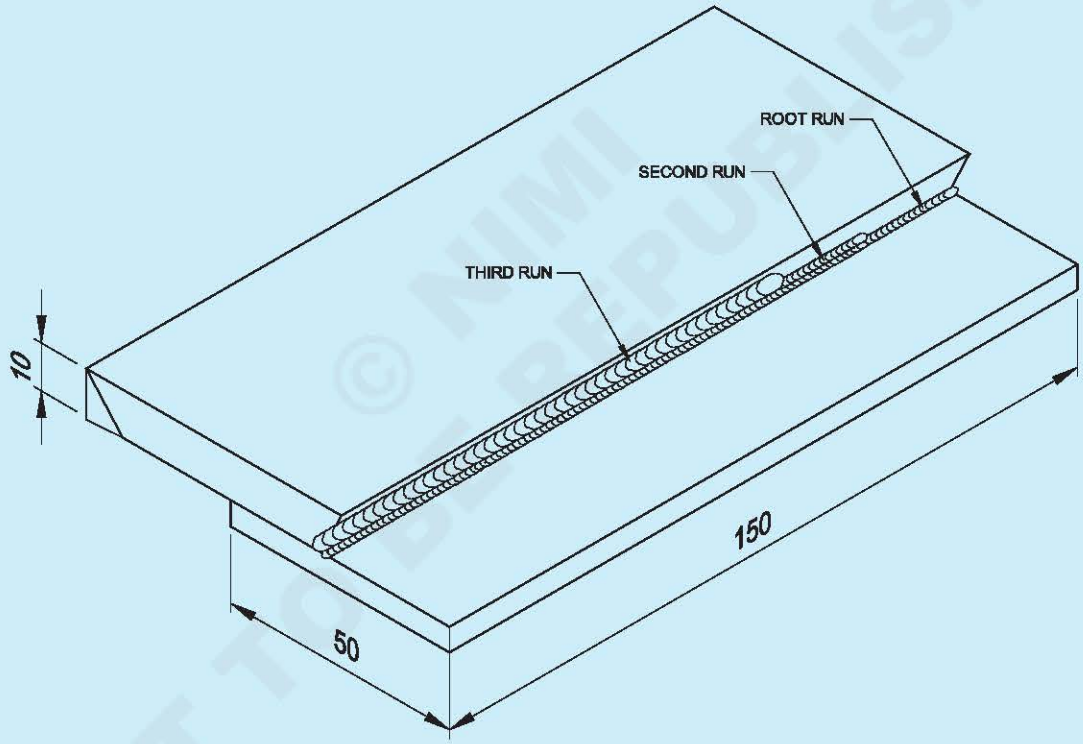
– Uniform weld size and shape of whole length (reinforcement and contour) of the joint.
– Equal leg length.
– No undercut at the toe of weld.
– Smooth ripple appearance.
– Proper crater filling.

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Fillet lap joint on MS plate 10mm thick in horizontal position (2F)-(SMAW-10)

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

- **prepare and set the job in horizontal position**
- **select electrode current, polarity and are length**
- **set the short arc and tack weld**
- **deposit root run, second and third run using stringer bead technique**
- **clean and inspect the weld defects.**



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2	50 ISF x 10 - 150	-	Fe 310 - W	-	-	1.3.32
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	FILLET WELD - LAP JOINT ON M.S PLATE 10mm POSITION HORIZONTAL BY (SMAW-10)	TOLERANCE ±1	TIME
		CODE NO. WL20N1332E1	

Job Sequence

- Prepare and clean the plates as per given dimensions.
- Set the Lap joint as per drawing and tack weld.
- Fix the joint in horizontal position.
- If DC machine is used, connect the electrode to the negative and use short arc to control arc blow.
- To avoid distortion due to contraction preset the plates such a way that the angle of the tack welded joint is decreased to 87° on the Back side.
- Deposit the root run without weaving.
- Hold the electrode at the center of the joint and start from leftward and use proper technique to avoid excessive metal deposition at the bottom of the plate.
- Deslag and clean the root run.
- Deposit the second and third run using stringer bead technique covering the previously laid bead partially and the plate surface.
- Ensure to fill the crater and to clean the bead.
- Check for the size of fillet, bead profile, weld defects and rectify them.

Skill Sequence

Fillet weld lap joint MS plate 10mm horizontal position (2F)

Objective: This shall help you to
- **prepare and weld lap joint on MS plate 10mm in horizontal position.**

Fix the joint in a horizontal position. For this the bottom plate should be kept parallel to the ground and the other plate perpendicular.

Welding Lap joint (fillet) in horizontal position: Deposit root run with 3.15 mm dia. electrode and 110 amps welding current, maintaining the electrode angle 70° to 80° to the line of weld and 40° to 50° between the vertical plate and electrode.

Deslag and clean the root bead thoroughly. Use safety goggles while deslagging to protect the eyes from flying slag particles.

Deposit second run with a 4mm electrode and 160 amps welding current, the angle of electrode to the bottom plate to be 55° - 65° and 25° - 35° to the vertical plate and 70° to 80° to the line of weld.

This second run has to be deposited partly covering the root run and partly on the bottom plate.

Give a steady movement to the electrode using a short arc.

Deslag and clean the weld bead.

Deposit the third and final run with a 4 mm dia. electrode and 160 amps welding current. Angle of the electrode to the line of weld is 70° to 80° and 40° - 50° on both plates. The third run has to be deposited in such a way that the bead covers partly the root run and the second run and partly the vertical plate. Also there should not be a valley at the bottom toe line of the third run in order to maintain necessary throat thickness. If two pass technique is adopted second run should be done in a weaving motion. Deslag and clean the weld bead.

Avoid over-deposition and side undercut by using a proper angle and travel speed of the electrode.

Inspection of Tee joint

Inspect the fillet weld for equal leg length and correct size.

Inspect to ensure the fillet weld is free from undercut and excessive lapping on bottom plate.

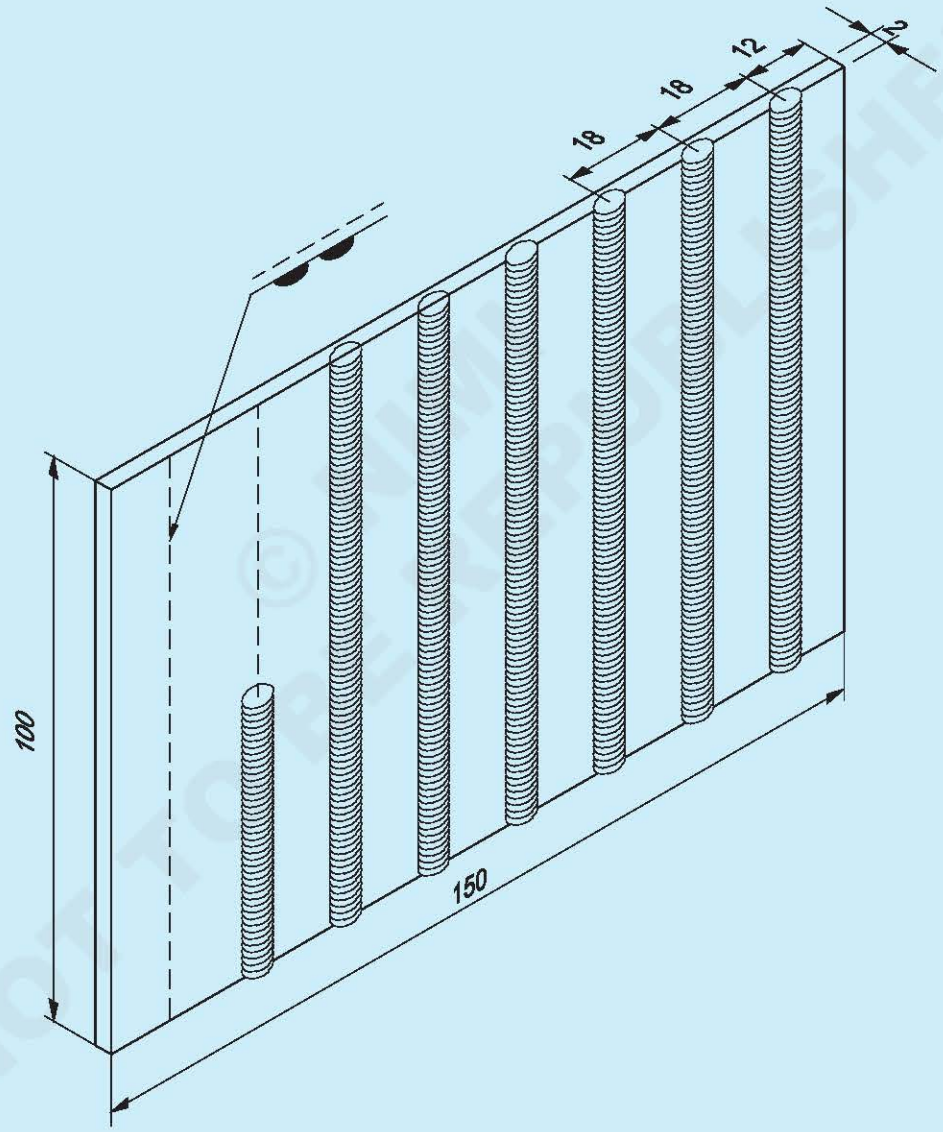
NOT TO BE PUBLISHED

Exercise 1.3.33

Fusion run with filler rod in vertical position on 2mm thick MS sheet (OAW-10)

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

- **prepare the job as per drawing**
- **fix the job in vertical position in the weld positioner**
- **select the nozzle filler rod size and the gas pressure**
- **deposit bead in vertical position in upward direction**
- **clean and inspect the bead.**



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1	ISST 100 x 2 - 150	-	Fe 310 - W	-	-	1.3.33
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	FUSION RUN WITH FILLER ROD ON M.S SHEET 2 mm IN VERTICAL POSITION				TOLERANCE ±1	TIME
					CODE NO. WL20N1333E1	

Job Sequence

- Prepare the sheet as per drawing and scribe straight lines and punch mark them as per the sketch.
- Clean the surface of the sheet.
- Fix the marked sheet on the weld positioner or vertical position at a convenient height.
- Select No. 5 size nozzle and fix it to the blow pipe.
- Select 1.6mm dia. CCMS rod and set 0.15 kg/sq.cm pressure for the gases.
- Follow necessary safety precautions.
- Ignite the blowpipe and set neutral flame.
- Hold the blow pipe at 75° and the filler rod at 30 - 40° to the line of weld. The angle between the blow pipe nozzle and filler rod and the sheet surfaces should be at 90°.
- Deposit the weld bead starting from the bottom most point of a punched line and moving upwards along the line.
- Ensure the melting of the base metal and the filler rod are kept as minimum as possible.
- Maintain proper angles for the blow pipe and filler rod.
- Move the blow pipe and filler rod without any side to side movements along the marked line at a uniform speed in upward direction.
- Do not allow the inner cone of the flame to come in contact with the molten metal (puddle) to avoid back fire.
- Complete depositing the weld bead up to the top end of the line and ensure to fill the crater.
- Ensure to avoid undercut defect by proper manipulation of the blow pipe and the filler rod.
- Clean the bead and visually inspect for any surface / external defect.

Skill Sequence

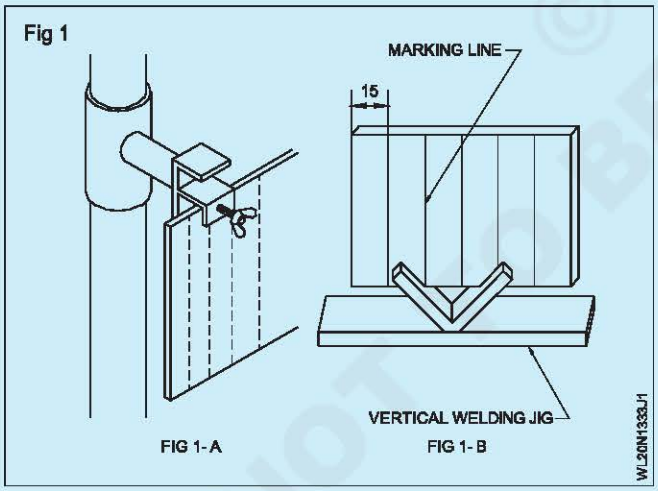
Fusion run with filler rod, 2mm MS sheet in vertical position

Objective: This shall help you to

- **prepare and carry out fusion run with filler rod in 2mm MS sheet in vertical position.**

Job setting: Fix the job in vertical position. (Figs 1A or B) at a level from the ground based on your height.

Fig 1

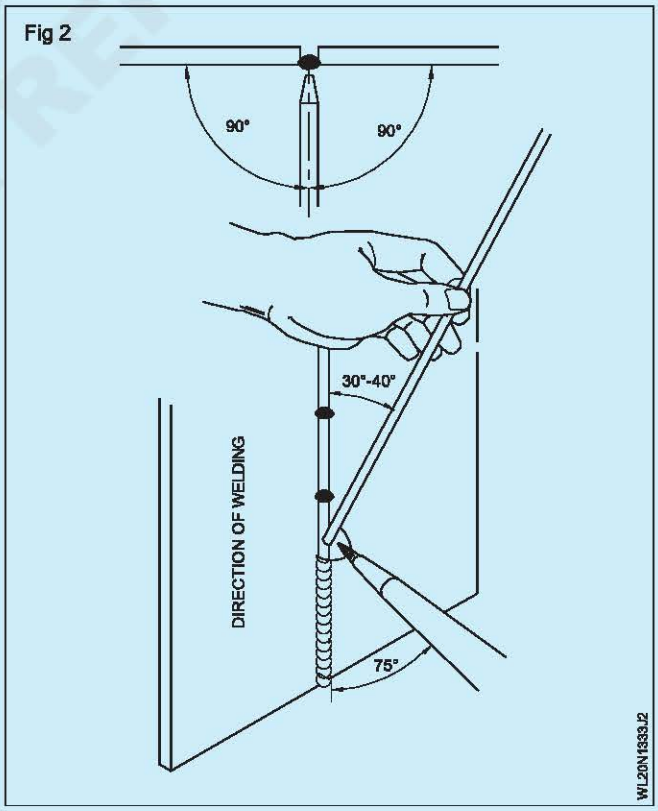


Fix nozzle No. 5 and select a CCMS rod 1.6mmø.

Welding technique: Deposit the weld in vertical upward position.

Maintain the angle of the blowpipe at 75° and the filler rod at 30° - 40°. (Fig 2)

Fig 2



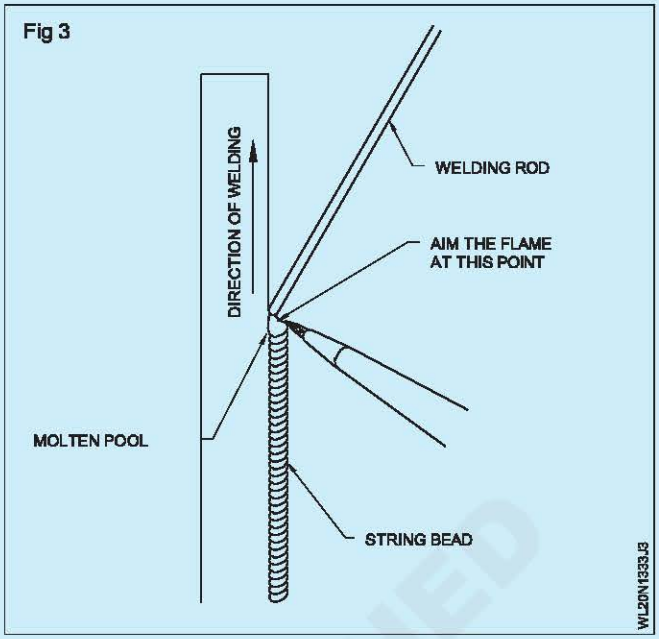
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Control the molten pool without giving any circular motion to the blowpipe. (Fig 3)

Take due care that the weight of the blow pipe and hoses do not pull your hand downwards while the deposition of weld metal progresses upwards.

Inspect the weld bead for surface defects like undercut, poor bead appearance due to sagging of weld metal, excessive reinforcement, wavy weld deposit etc.

Fig 3

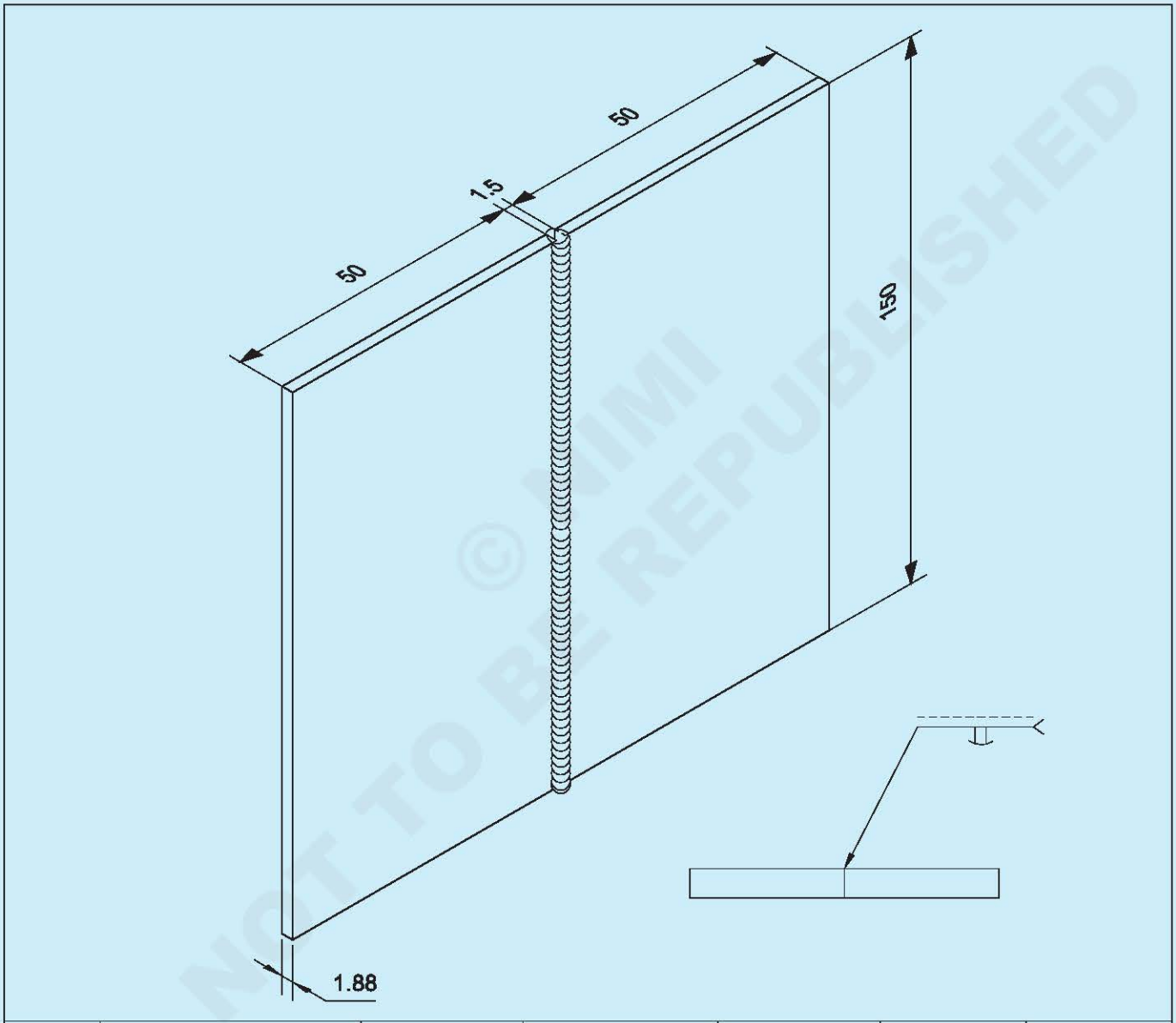


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Square butt joint on MS sheet 2mm thick in vertical position (3G)-(OAW-11)

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

- **prepare the job as per drawing**
- **set the job in the vertical position with a root gap and gas pressure**
- **select proper nozzle blow pipe and fillurd**
- **weld the job in vertical position by upward method**
- **clean the job and inspect for weld defects.**



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2	ISST 50 x 2 - 150	-	Fe 310 - W	-	-	1.3.34
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	BUTT WELD SQUARE BUTT JOINT M.S.SHEET 2mm IN VERTICAL POSITION.(OAW-11)	TOLERANCE ±0.5	TIME
		CODE NO. WL20N1334E1	

Job Sequence

- Shear the plate and file the edges. Clean the surface with a steel wire brush. Set the plate as a square butt with a 1.5 mm root gap.
- Fix nozzle No. 5 and adjust the gas pressure of oxygen and acetylene at 0.15 kg/cm^2.
- Ignite the torch and set the neutral flame.
- Select a C.C.M.S. filler rod of 1.6 mm ø.
- Tack-weld the two pieces with a 1.5 mm uniform root gap on both ends and in center.
- Check for correct alignment.
- Fix the sheet in vertical in the 'C' clamp with the bottom edge of the sheet at welder's chest height.
- Melt the tack weld and establish a weld pool at the bottom edge of the joint.
- Keep the blowpipe angle 75° - 80° to the line of travel and the filler rod angle 30° to 40° to the same plane and proceed to weld upwards.
- Continuously dip the filler rod tip in the molten pool and move upwards. Weld the joint with a single run.
- Ensure the edges of both the metals melt equally so as to achieve complete penetration.
- At the end of the joint add sufficient filler metal and fill up the crater. Use a tongs to remove the job from the fixture.
- Clean the weld and inspect for surface defects and root penetration.

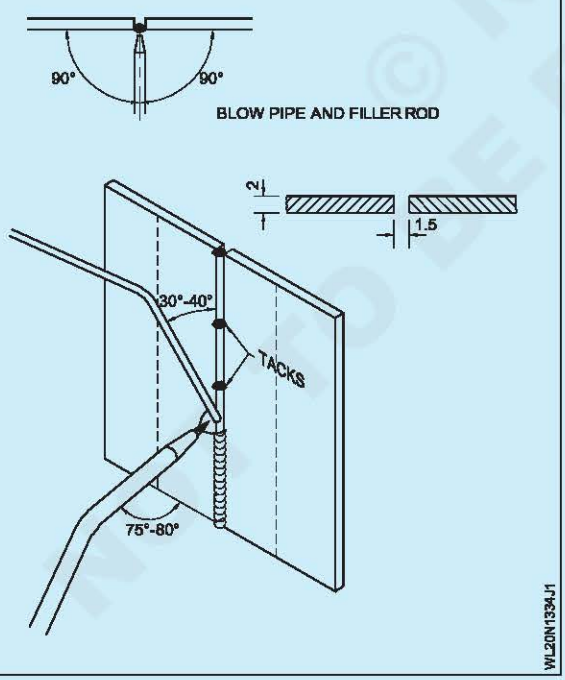
Skill Sequence

Square butt joint on MS in vertical position

Objective: This shall help you to
- **prepare the square butt joint on MS in vertical position.**

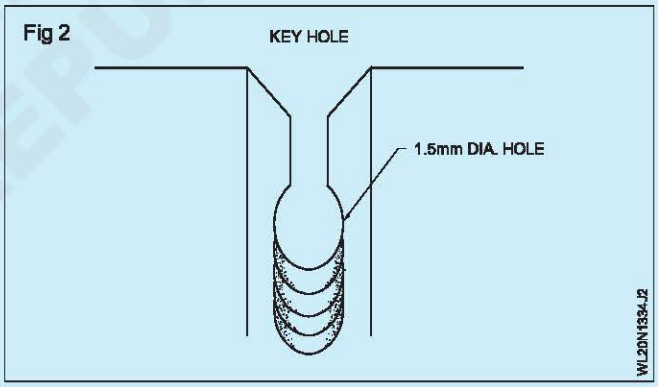
Tack the two sheets together as a square butt joint and fix the job in vertical position. (Fig 1)

Fig 1



Move the torch to the bottom of the square groove and establish a weld puddle. Continue to develop the puddle until you see the keyhole (Fig 2) that indicates complete penetration.

Fig 2



When you achieve the desired penetration, begin adding filler metal and proceed welding upwards. (Fig 1)

Use a slight side to side weaving to the blow pipe to ensure fusion of both the edges of the joint.

Progress upward at a uniform rate of travel and add filler metal to get a bead of even width with good profile and appearance.

End the weld at the top of the joint and ensure to fill the crater.

Clean the bead and check whether there is uniform root penetration for 0.5mm depth, a weld reinforcement of 0.5 to 1mm and no undercut etc.

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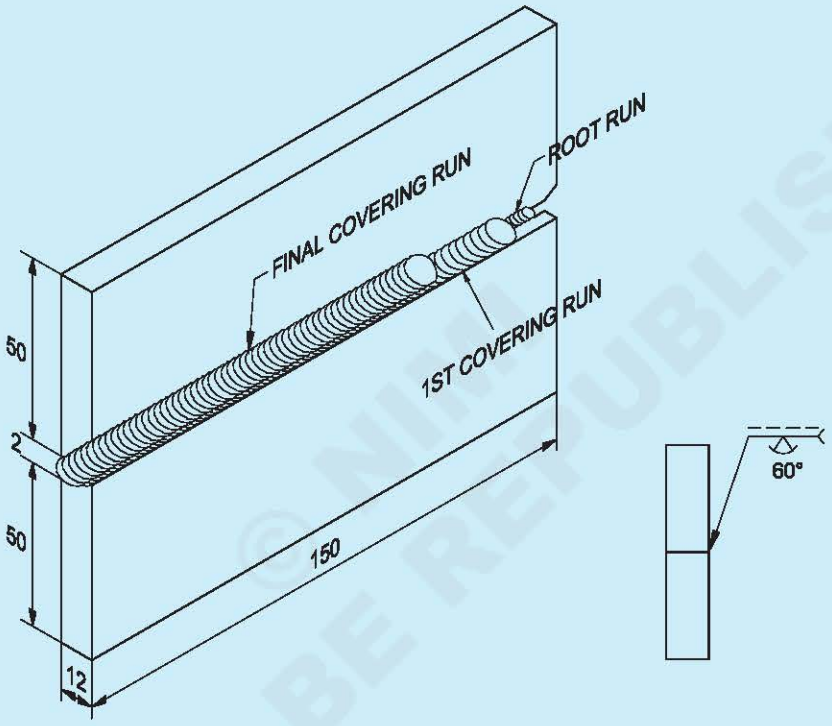
Exercise 1.3.35

Single "V" butt joint on MS plate 12mm thick in horizontal position (2G)-(SMAW-11)

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

- **prepare the job as per drawing**
- **bevel the edges by gas cutting**
- **set the job with root gap in horizontal position**
- **select the electrode, current, arc length polarity**
- **deposit, root run, 2nd run and weaving bead**
- **clean inspect for surface defects.**

Scan the QR Code to view the video for this exercise



Job Sequence

- Cut the MS plates 10mm thick to size.
- Bevel the edges.
- One of the plates is beveled to 45° by gas cutting.
- The second plate is beveled to 15° by gas cutting.
- Clean the edges and remove all the burrs.
- Preset the single 'V' for controlling the distortion.

Wear safety clothing.

- Tack the beveled plates with a root gap of 2 mm.
- Fix the joint in horizontal position such that the member with 45° bevel as the top member with 15° beveled members as the bottom member.
- Deposit the root run starting from top plate and fuse the bottom plate also. Maintain uniform penetration throughout.
- Deposit 2nd and final 3rd run to complete the joint in horizontal position.
- Deslag each run and clean the bead.
- Inspect the welded joint for defects.

2	50 ISF 12 - 150	-	Fe 310 - W	-	-	1.3.35
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	BUTT WELD - SINGLE VEE BUTT JOINT ON M.S PLATE 12mm IN HORIZONTAL POSITION (2G)	TOLERANCE ±1	TIME
		CODE NO. WL20N1335E1	

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Skill Sequence

Single 'V' butt joint on MS plate 12mm thick in horizontal position

Objective: This shall help you to

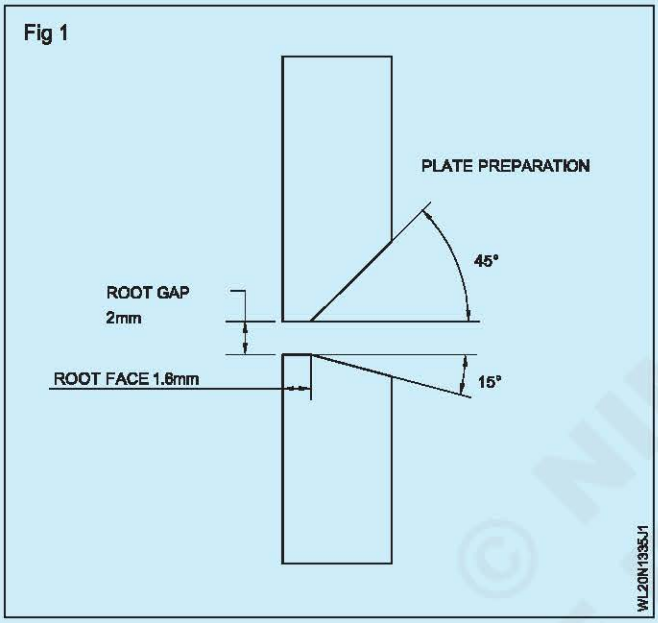
- **prepare the single 'V' butt joint on MS in horizontal position.**

Prepare the beveling by gas cutting and filling.

Prepare the plate and make 45° bevel for the top member and 15° bevel for the bottom member with a root face of 1.5 mm by filling. Fig 1

Then file the bevel and keep the root face 1.5 mm. (Fig 1) Set the job with a 2 mm root gap and tack weld on both ends.

Fig 1



This type of beveling is used specially for welding single 'V' butt joint in horizontal position to deposit the metal against the effect of gravity.

Deposit a root run without weaving motion and hold the electrode angle 90° to the vertical plate and 65° to 75° to the line of the joint.

Maintain the keyhole to obtain uniform penetration.

Deposit the 2nd run by reducing the electrode angle to the upper vertical plate 55° to 65° using slight weaving motion. (Fig 2)

Deposit the 3rd run by increasing the electrode angle 95° to 105° to the upper vertical plate using slight weaving motion. (Fig 3) Deposit the outer edge of the upper fusion face and the junction of the 2nd run.

Fig 2

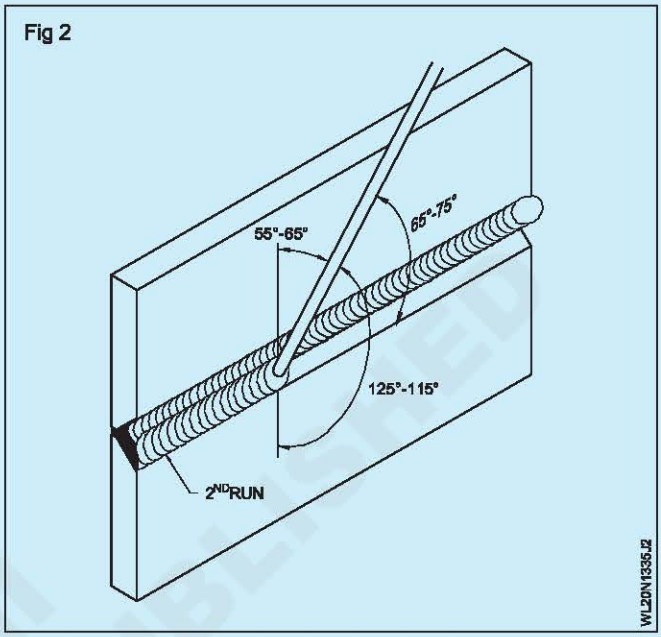
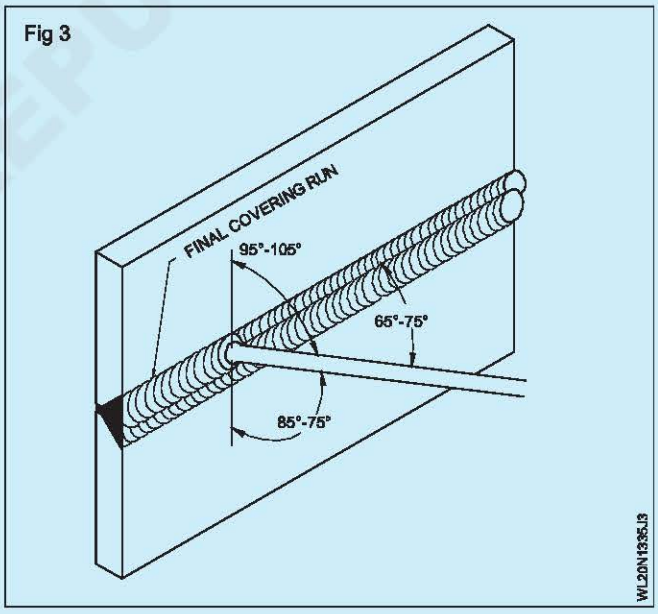


Fig 3

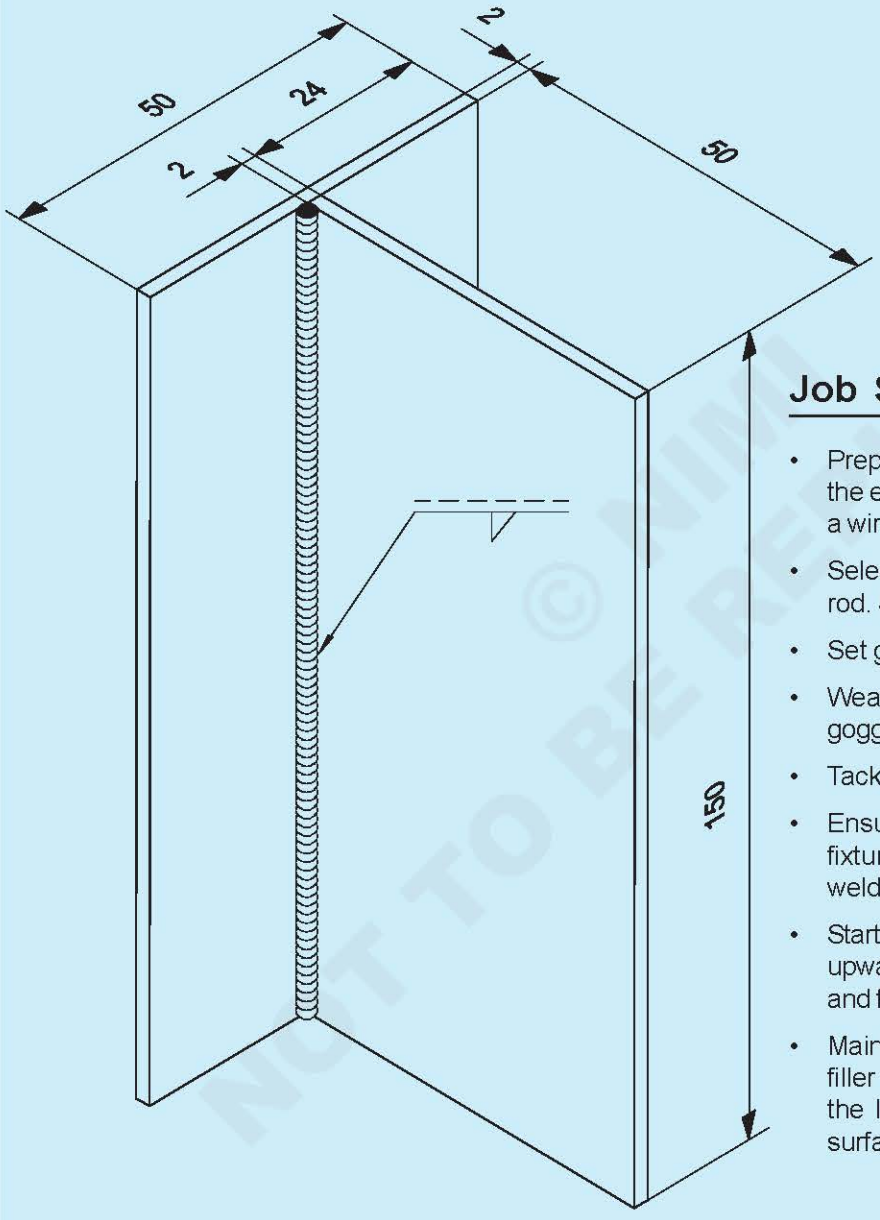


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Fillet 'T' joint on MS sheet 2mm thick in vertical position (3F)-(OAW-12)

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

- **prepare the job as per drawing**
- **set the job in vertical position**
- **select the filler rod, nozzle and gas pressure**
- **set the neutral flame and tack weld**
- **weld the job in upward directive**
- **clean the joint and inspect on used defects.**



Job Sequence

- Prepare the material as per drawing and file the edges to square. Clean the surface with a wire brush.
- Select nozzle No. 5 and a 1.5mmø C.C.M.S. rod. Set the neutral flame.
- Set gas pressure at 0.15 kg/cm^2.
- Wear protective leather clothing and welding goggles.
- Tack the work piece as a 'T' joint.
- Ensure the joint is clamped properly in the fixture in the vertical position and the line of weld becomes perpendicular to the ground.
- Start welding the joint from the bottom in the upward direction manipulating the blow pipe and filler rod properly.
- Maintain proper angles for the blow pipe and filler rod between the sheet surfaces and to the line of weld so that the root and the surfaces joined will melt properly.

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2	ISST 50 x 2 - 150	-	Fe 310 - W	-	-	1.3.36
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	FILLET - 'T' JOINT ON M.S SHEET 2mm IN VERTICAL POSITION	TOLERANCE ±0.5	TIME
		CODE NO. WL20N1336E1	

- Ensure the molten puddle does not sag too much due to gravity.
- At the end of the joint fill up the crater and complete the weld.
- Remove the work piece from the fixture and clean the weld bead.
- Inspect the weld bead for equal leg length, uniform ripple and ensure it is free from surface defects.

Skill Sequence

prepare the 'Tee' joint MS sheet in horizontal position

Objective: This shall help you to

- **prepare the 'tee' joint MS sheet in horizontal position.**

Keep one of the sheets vertically at 90° to the bottom sheet (Fig 1) and tack weld using neutral flame at the ends of the joint in proper alignment and at the center.

Fig 1

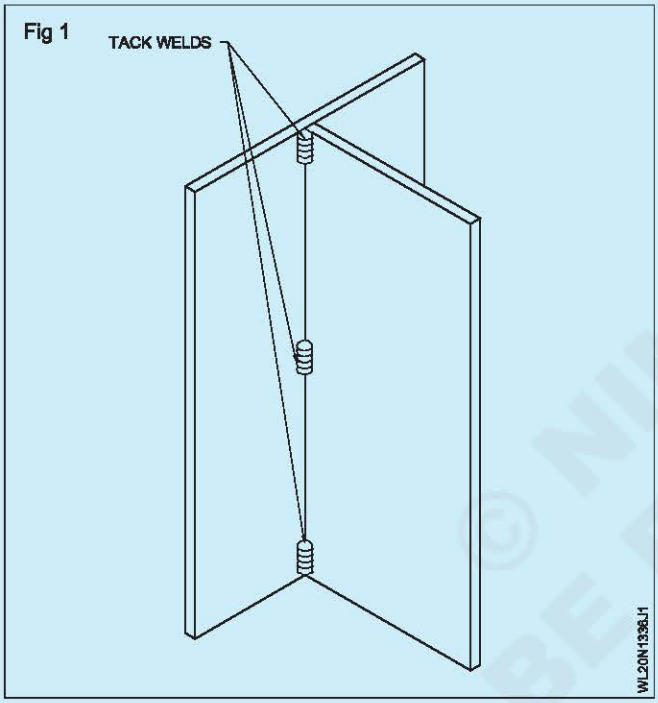
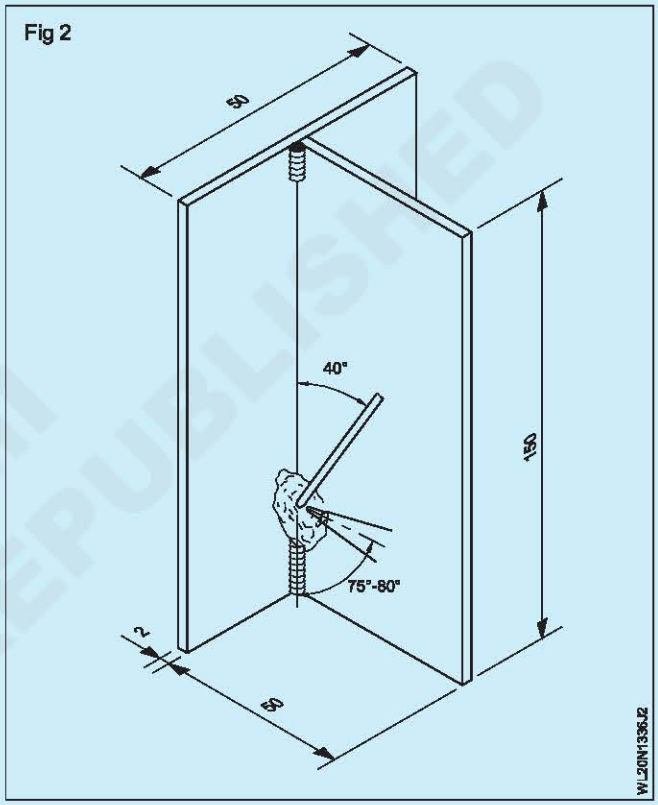
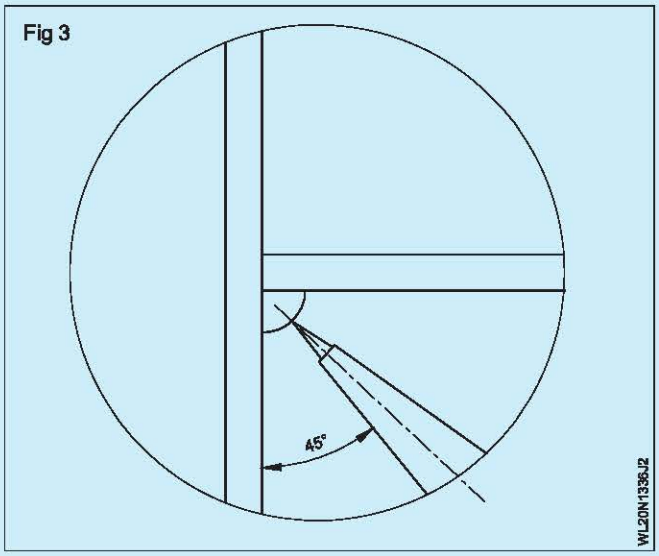


Fig 2



Maintain the angle of the blowpipe at 75-80° and filler rod at 40° respectively to the line of weld in vertical upward direction. (Fig 2) Also maintain a blowpipe angle of 45° between the sheet surfaces. (Fig 3)

Fig 3



Control the molten pool steadily and weld the fillet joint on the root by melting both the surfaces to be joined equally.

Dip the end of the filler rod continuously in the molten pool and proceed welding upward.

The above mentioned procedure will help to fuse the root and both the sheet surfaces of the joint uniformly as well as control sagging of molten metal deposited into the joint.

Ensure uniform speed of torch travel against the gravitation pull of the hand due to the weight of blowpipe, hose etc.

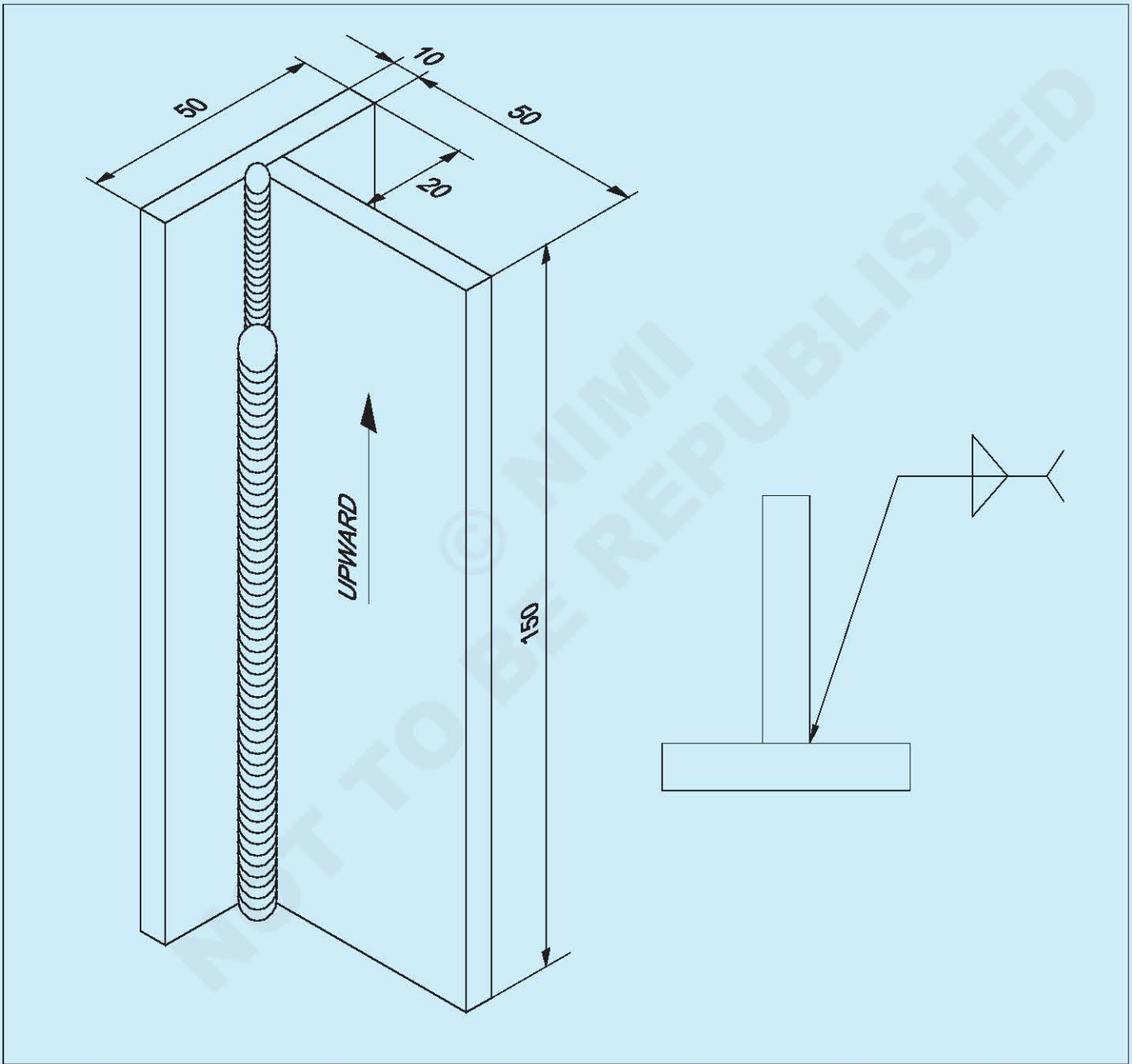
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Exercise 1.3.37

Fillet - "T" joint on MS plate 10mm thick in vertical position (3F)-(SMAW-13)

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

- **prepare the job as per drawing**
- **set the job in vertical position**
- **set the short are and tack weld**
- **deposit the root run, and 2nd weaving bead**
- **clean and inspect the surface weld defects.**



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2	50 ISF 10 - 150	TO EX.NO.28	Fe 310 - W			1.3.37
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	FILLET WELD - 'T' JOINT ON M.S PLATE 10mm IN VERTICAL POSITION (UPWARD)				TOLERANCE ±1	TIME
					CODE NO. WL20N1337E1	

Job Sequence

- Mark the plate to size and cut as per drawing.
- Prepare square edges.
- Set the work piece as a 'T' joint.
- Select a 3.15 mm D.M.Selectrode and set 110 amps current.
- Connect electrode cable to negative terminal.
- Tack-weld the work pieces at the ends.

Preset the plates to 2° to take care of distortion.

- Position the joint in vertical in the welding positioner.
- Deposit the root run with short arc length and by a slight weaving up and down motion to the electrode.
- Use whipping action for the electrode.
- Deslag and clean thoroughly with a wire brush.

Use goggles while Deslagging.

- Select a 4 mm ø electrode and set 160 amps current.
- Deposit 2nd run with short arc using a weaving motion and uniform speed of metal deposition.
- Avoid undercut.
- Ensure proper crater filling.
- Remove the welded joint from the positioner, clean and inspect for defects.

Follow the necessary safety precautions during welding.

Skill Sequence

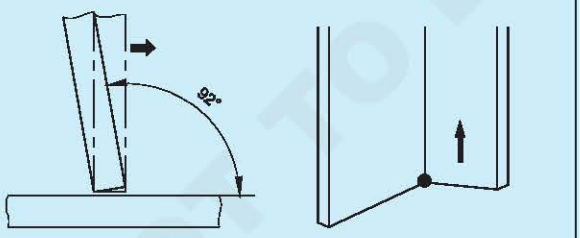
Fillet - "T" joint on MS plate in vertical position

Objective: This shall help you to

- **prepare the 'T' joint on MS plate in vertical position.**

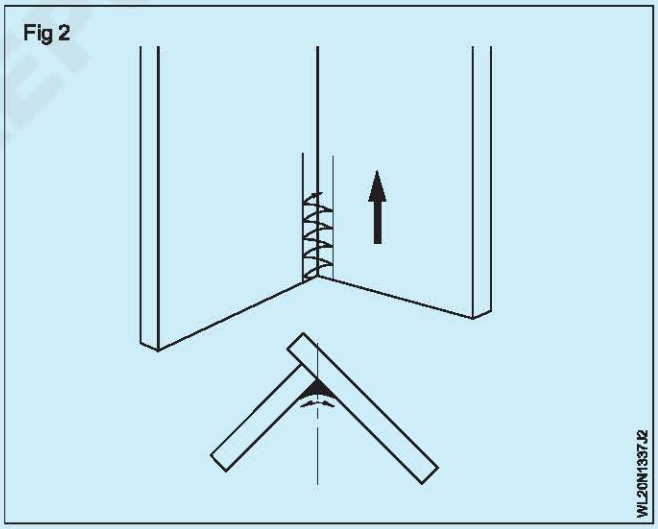
In vertical welding the difficulty to be overcome is the inclusion of slag in the weld metal, undercut and control of molten metal from sagging. These are avoided by using a short arc and proper weaving technique with a correct electrode angle. Preset the plate at 1° per run as shown in Fig 1 to take care of angular distortion. While depositing the root run start from the lowest part of the work piece. (Fig 1)

Fig 1



Depositing root run: Ensure equal deposit of weld metal on both the plates by giving a slight weaving motion.

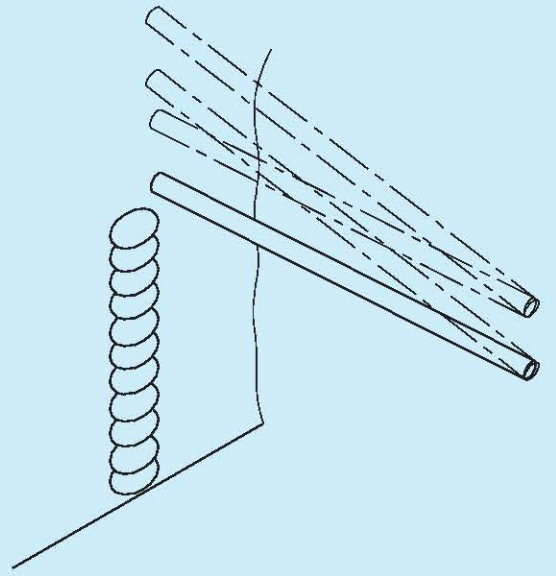
Fig 2



Use whipping action for the electrode (Fig 3). During whipping action, the electrode is raised away from the molten pool a little with a long arc and again brought back closer to the molten pool with a short arc. When the electrode is raised from the molten pool, the weld metal cools a little and partly solidifies which helps in reducing the sagging effect of the molten weld metal.

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Fig 3

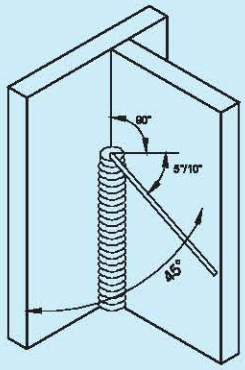


WHIPPING ACTIONS

WI_20N1337.J3

Move the electrode from side to side and stop for a short moment at each side to avoid undercut. Keep the angle of the electrode as shown in Fig 4 to deposit the metal at proper place in the joint without sagging.

Fig 4



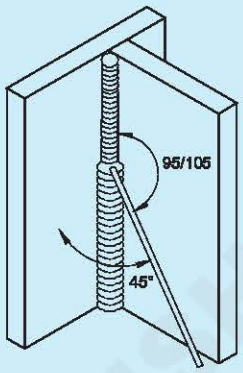
VERTICAL 'T' FILLET ELECTRODE ANGLES

WI_20N1337.J4

Clean thoroughly the root run, and specially any slag at toes should be removed.

Weld the second run to get a uniform bead of required size. Use a zigzag or triangular movement of the electrode as shown in Fig 6. Use short arc length and stop a while at the sides to fill the weld at the toes. The electrode tip pointing upwards due to the electrode angle Fig 4 and the use of short arc and the weaving technique will control the sagging of the weld metal and the slag inclusion. The stoppage of the electrode at the toes of the weld for a moment in the weaving motion will help to avoid undercuts.

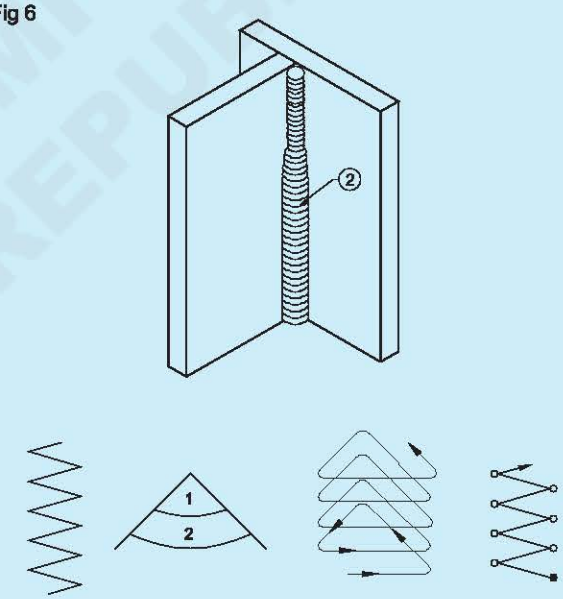
Fig 5



VERTICAL ' T ' FILLET

WI_20N1337.J5

Fig 6



WI_20N1337.J6

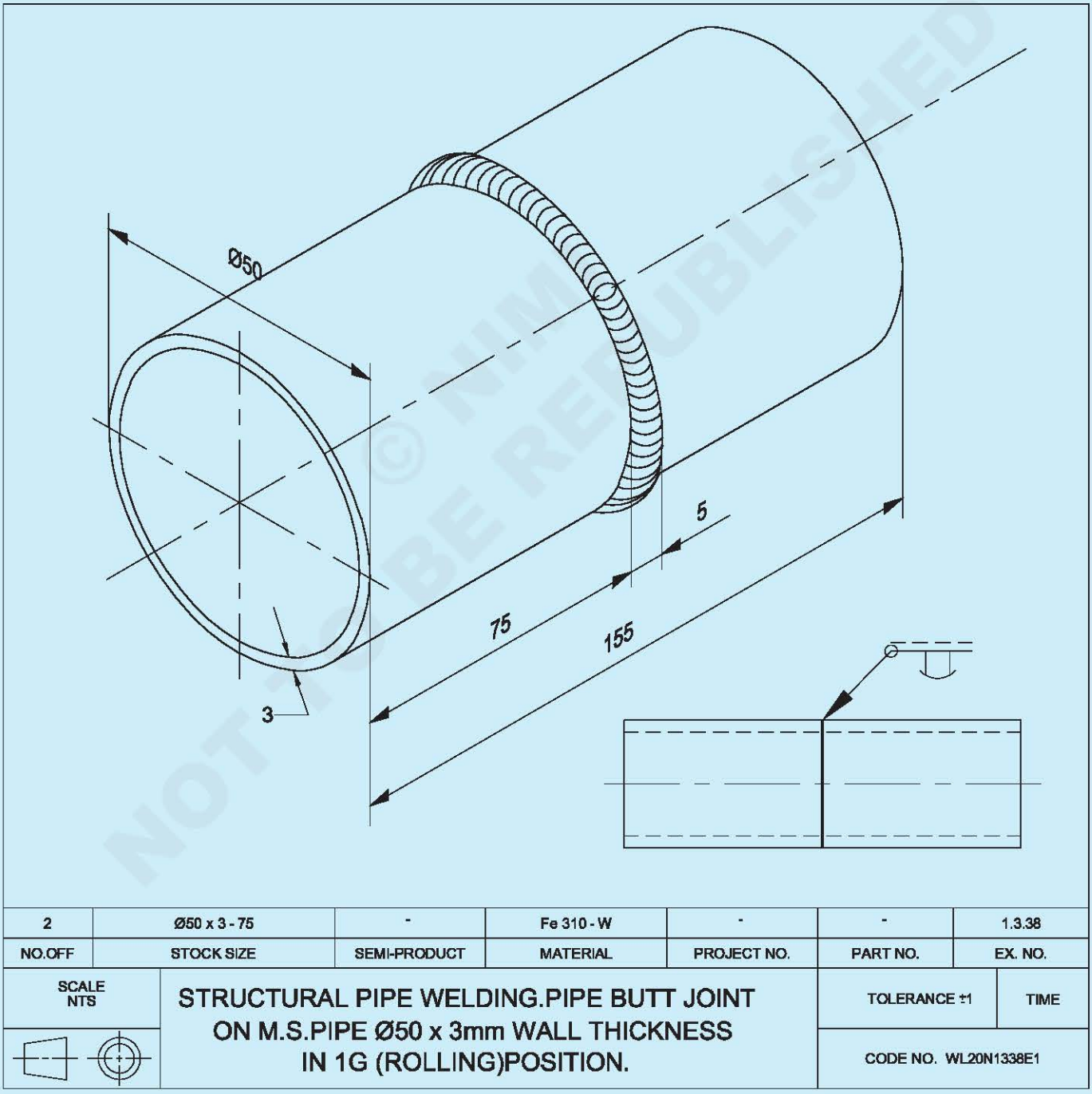
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Exercise 1.3.38

Structural pipe welding butt joint on MS pipe ø50mm × 3mm wall thickness in 1G (Rolling) position (OAW-13)

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

- **cut and prepare the MS pipe as per drawing**
- **set the pipes in flat position**
- **select nozzle, filler rod sizes, gas pressures and flame**
- **set the root gap and tack weld the pipes**
- **deposit root run from 3'o clock to 12'o clock**
- **clean and inspect for surface defects.**



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2	Ø50 x 3 - 75	-	Fe 310 - W	-	-	1.3.38
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	STRUCTURAL PIPE WELDING.PIPE BUTT JOINT ON M.S.PIPE Ø50 x 3mm WALL THICKNESS IN 1G (ROLLING)POSITION.	TOLERANCE ±1	TIME
		CODE NO. WL20N1338E1	

Job Sequence

- Cut the pipes to 75mm length by hacksaw and file its end square to 75mm length. Chamfer the outside edge of the pipe to 30 - 35° 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 coaxial pipe butt joint with proper root gap.
- Follow necessary safety precautions.
- Set neutral flame.
- Tack weld in 3 places (120° 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 o'clock position to 12 o'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 o'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. 5 size nozzle, select 2mmø 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 V 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

Structural pipe welding butt joint on MS plate ø 50 × 3 mm wall thickness in 1G (Rolling) position

Objective: This shall help you to
- **prepare butt joint on MS pipe in IG rolling position.**

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 mm ø and 75 mm long by hacksaw cutting. As the end faces of a pipe cut by a hacksaw may not be at 90° to the pipe axis, file the end faces of the pipe to get the 90° angle. Bevel the ends of the pipes by filing.

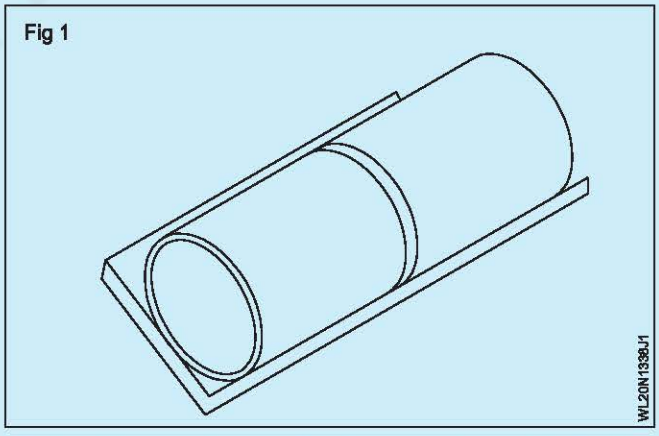
Clean the pipes and remove burrs, if any. Align the pipes in flat position as shown in Fig 1. Tack the weld joint by inserting 1.5 mm wire to maintain a uniform root gap. (Fig 2a and 2b) Ensure the tack welded pipes are coaxial. (i.e., the axis of both the pipes are the same.)

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.

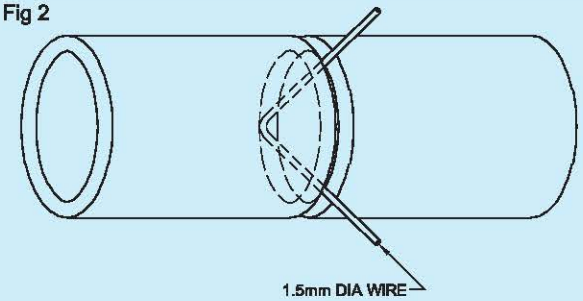
Fig 1



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" continuously and gradually. i.e. weld from 3 o'clock position to 12 o'clock position.

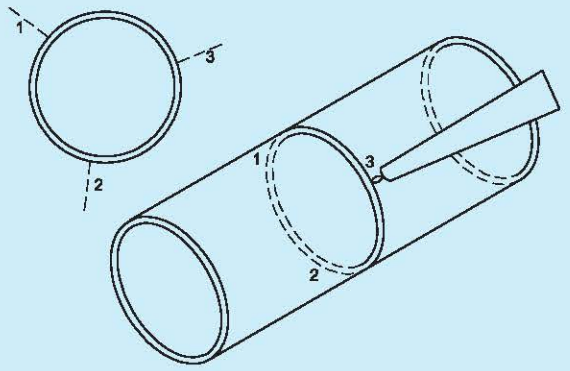
After completion of I segment welded, rotate the pipe joint in clockwise direction until the II segment will come to the position of I segment.

Fig 2



USE OF BENT WIRE OR SUITABLE SPACER TO SET ROOT GAP

(A)

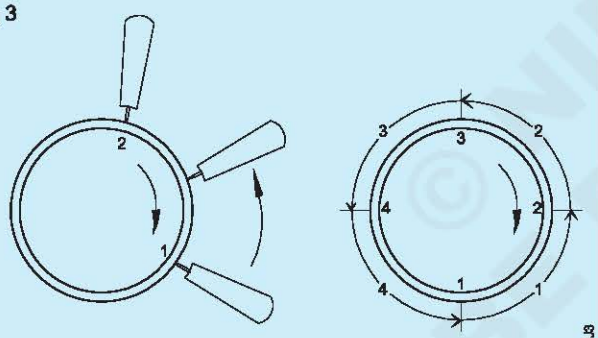


(B)

TACK WELDS AT POINTS 1, 2, AND 3

WL20N1338J2

Fig 3



TORCH POSITION AND TURNING THE PIPE

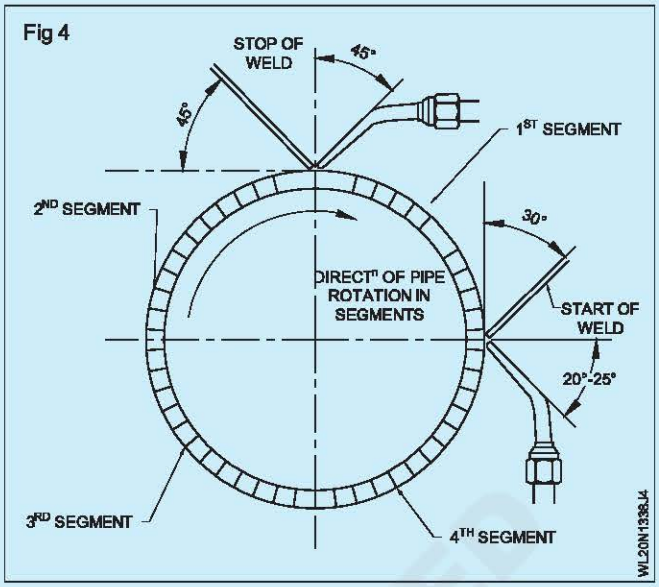
WLN1340J3

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.

Fig 4



It is very important to maintain a keyhole 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 work piece from the rotating fixture.

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 V 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.

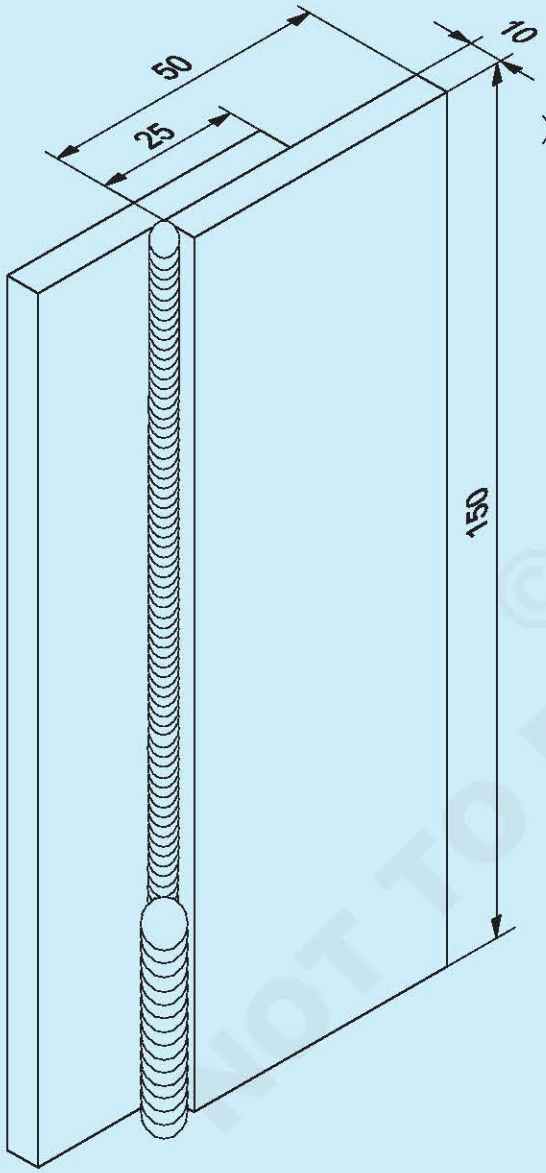
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Exercise 1.3.39

Fillet - lap joint on MS plate 10mm in vertical position (3G)-(SMAW-14)

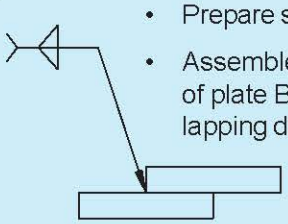
Objectives: At the end of this exercise you shall be able to

- **prepare and set the job in vertical position**
- **select electrode, current and polarity**
- **set short arc and tack weld.**
- **deposit root and wearing run**
- **clean and inspect the surface defects**



Job Sequence

- Gas cut the plate to size as per drawing.
- Prepare square edges.
- Assemble/clamp the plate C with the bottom side of plate B of the T fillet joint to form a lap joint. The lapping distance should be 25mm.



- Select a 3.15mm dia. medium coated MS electrode and set 110 amps current.
- Use electrode negative polarity if a DC machine is used for welding.
- Set the assembled job on the welding table and tack weld the plate C with plate B at their ends.
- Ensure that the surfaces of plates B and C are parallel to each other and that there is no gap between them after tacking.
- Remove slag and fix the job on the welding positioner in vertical position.
- Deposit the root run with short arc length and by a very slight weaving motion to the electrode.
- Give whipping action to the electrode to prevent sagging of molten metal and slag.
- Deslag with a chipping hammer and clean the joint and bead thoroughly with a steal wire brush, particularly at the toes of the weld.

Use goggles while deslagging.

- Select a 4mm dia. medium coated MS electrode and set 150 to 160 amp. current.

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2	50 ISF 10 - 150	-	Fe 310 - W	-	-	1.3.39
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	FILLET LAP JOINT ON M.S PLATE 10mm IN VERTICAL POSITION (UPWARD)	TOLERANCE ±0.5	TIME
		CODE NO. WL20N1339E1	

- Deposit the 2nd run with short arc and weaving motion.
- The weaving motion and the movement of the arc in the upward direction should be at uniform speed.
- Ensure the correct fillet size with proper bead profile is obtained and the edge of the plate B is not melted off. Also ensure that there is no undercut at the toe of the weld on the bottom plate C.
- Remove the welded joint from the positioner after filling the crater.
- Clean the joint using a wire brush and inspect for any external defect.

Follow the necessary safety precautions during welding.

Skill Sequence

Fillet lap joint on MS plate 10mm thick in vertical position

Objective: This shall help you to
- **prepare and weld fillet lap joint on MS plate 10mm thick in vertical position.**

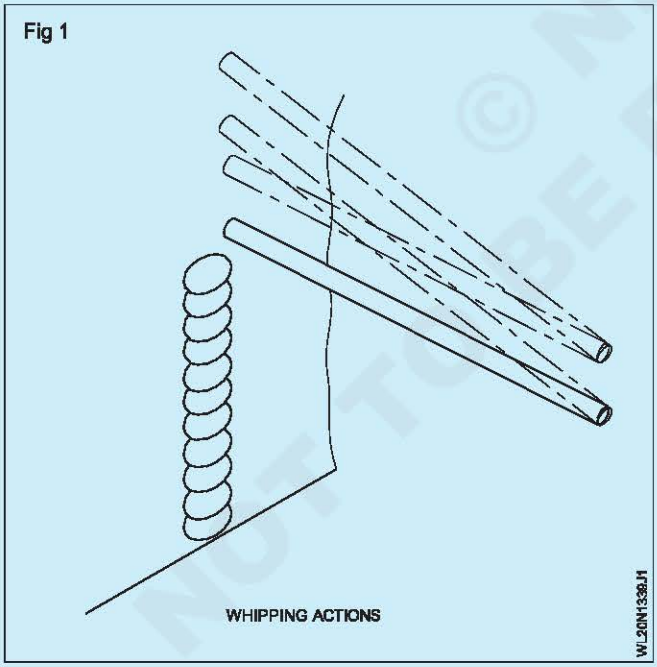
Welding a lap joint in vertical position has always been a problem - one of the upper edge of the plate being burnt (edge melted off). This can be overcome by using proper electrode manipulation.

Method of depositing bead in vertical on lap joint

Set a minimum current so as to maintain a small molten pool.

Use a short arc for depositing root run with whipping motion so as to prevent sagging of the weld metal. (Fig 1, 2) Deposit the 2nd run with weaving motion and this will avoid sagging of the molten metal. The angle of the electrode should be 75° - 80°. (Fig 3)

Fig 1



Any one of the weaving motion shown in Fig 2 can be used.

Do not break the arc while moving in the upward direction.

The motion of the electrode should be a weaving motion.

Keep the electrode motion confined to the weld width so that the edge of the upper plate is not melted off.

Fig 2

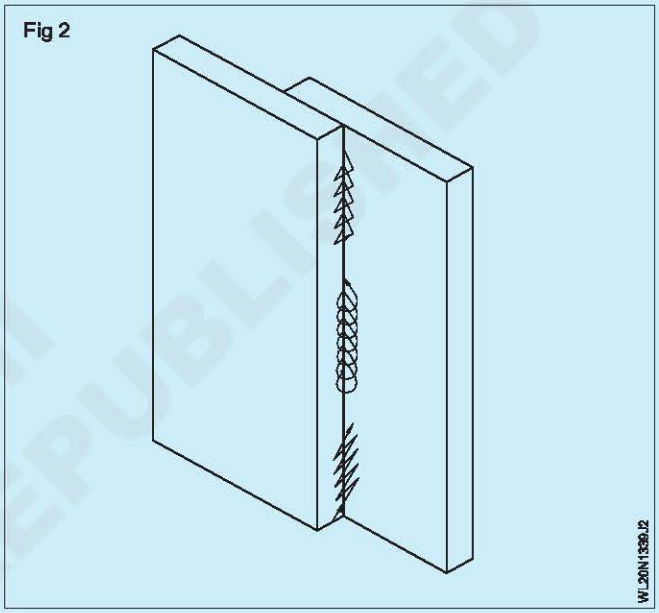
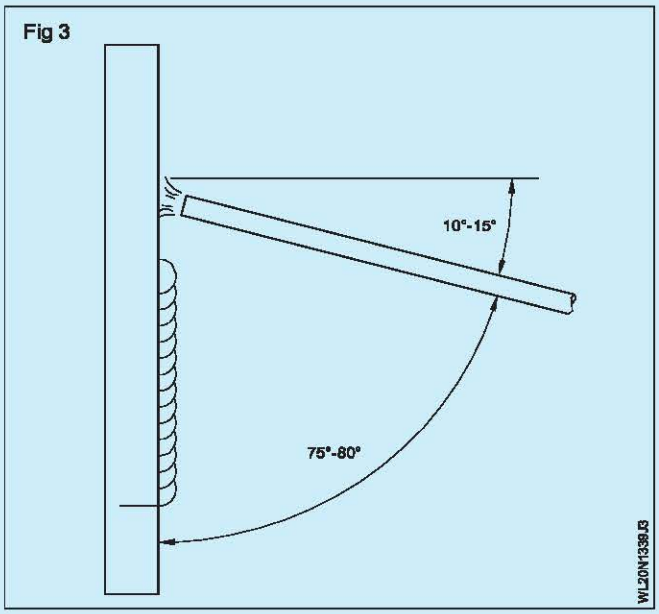


Fig 3



The rate of travel should be even for obtaining a uniform bead with a good appearance.

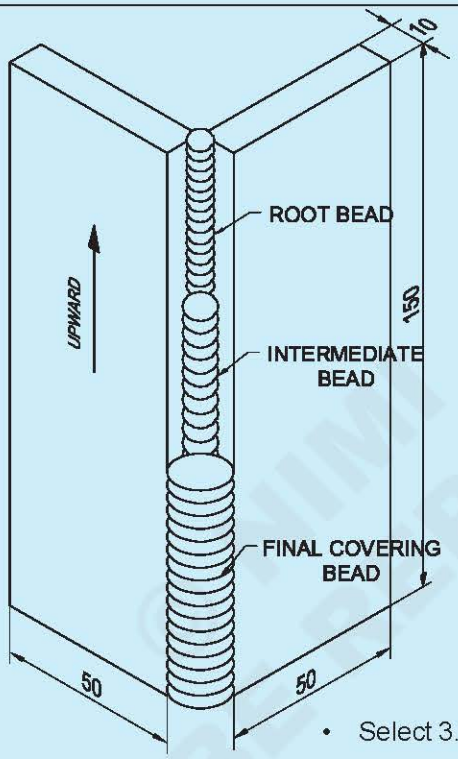
Overlapping distance should not be more than 3 times the thickness of the base metal.

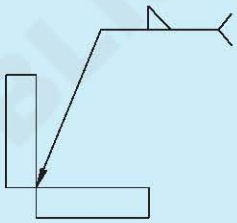
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Open corner joint on MS plate 10mm thick in vertical position (3F)-(SMAW-15)

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

- **prepare and set the job as per drawing**
- **select electrode, current, and polarity**
- **set the short arc and tack weld**
- **deposit root, 2nd and 3rd weaving run in upward direction**
- **clean and inspect foe surface defects.**





Job Sequence

- Mark the plate to size and gas cut as per drawing.
- Prepare square edges and clean the parts to be welded.
- Set the 2 pieces as an open corner joint and use spacers to maintain a uniform root gap of 1.5 to 2mm. Then tack weld the two pieces together to form a 87° angle between the inner faces of the plates.
- Remove the spacers and set or fix the weldment in vertical position on the weld positioner.
- Select 3.15mmø electrode and set 110 Amps DCEP.
- Deposit root run with short arc length.
- Deslag and clean thoroughly with a wire brush.

Use goggles while deslagging.

- Select 4mmø electrode and set 160 amps.
- Deposit 2nd run using short arc and slight weaving motion.
- Deslag and deposit third and final run with 4mm dia. electrode.
- Avoid undercut.
- Clean the joint and inspect for defects.

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2	50 ISF 10 - 150	-	Fe 310 - W	-	-	1.3.40
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	OPEN CORNER JOINT ON M.S. PLATE 10mm THICK IN VERTICAL POSITION (UPWARD) (SMAW-15)	TOLERANCE ±1	TIME
		CODE NO. WL20N1340E1	

Skill Sequence

Open corner joint on MS plate vertical position

Objective: This shall help you to

- **prepare open corner joint on MS plate vertical position.**

Setting and tacking of the fillet open corner joint

Mark and punch the plates, to cut square by gas cutting.

Grind or file the gas-cut edges to square.

Remove the grinding burrs and clean the surfaces by filing and with a wire brush.

Using PPE while cutting, grinding.

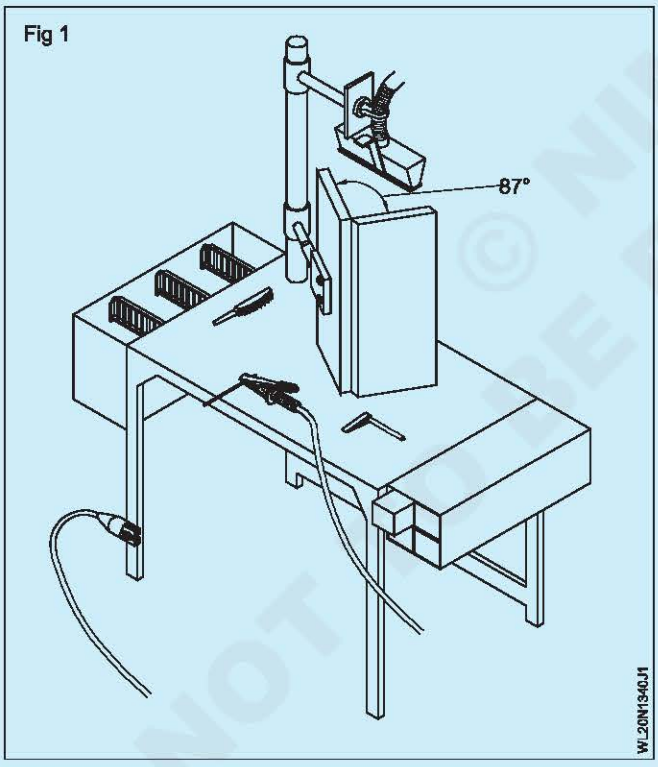
Set the fillet open corner joint with a 1.5 to 2mm root gap and an angle of 87° between the inside surfaces of the plates to control the distortion. Fig1.

Tack-weld on the root side of the joint on both ends.

Use a 3.15 mm dia. M.S. electrode and 110 amps current.

Position the joint in vertical and the angle of the line of weld with the top of the table should be 90°. (Fig 1)

Fig 1



Welding fillet open corner joint in vertical position: Deposit root run with a 3.15 mm dia. electrode and 110 amps welding current. (Fig 2)

Maintain an electrode angle of 80° to the line of weld and the electrode movement slightly sideways, and deposit weld bead from the bottom to the top. Give whipping motion to the electrode. Maintain a short arc to get uniform fusion and a keyhole to ensure proper root penetration.

Keep 1.6 mm root penetration depth.

Fig 2

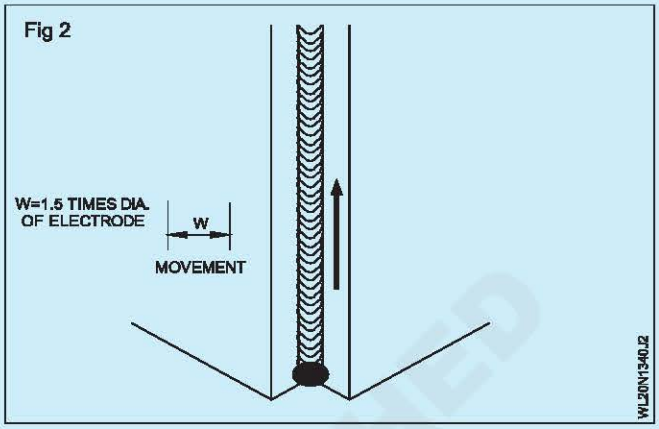
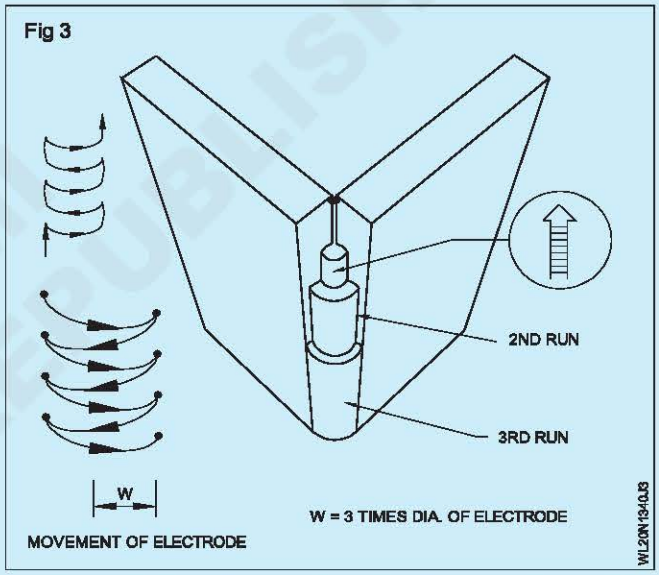


Fig 3



Deslag and clean the root bead at the toes thoroughly; also Deslag and clean the weld bead.

Wear safety goggles.

Deposit the second run with a 4 mm dia. electrode and 160 amps welding current. The angle of electrode should be 80° to the line of weld and the arc length should be short. Move the electrode steadily upwards and sideways as done in excise No. Deslag and clean the weld bead: Deposit the third and final run with a 4 mm dia. electrode and 160 amps welding current with short arc length and sideways movement. (Fig 3)

Deslag and clean the weld bead.

Avoid over-reinforcement height and edge burning.

Inspect the open corner fillet weld for:

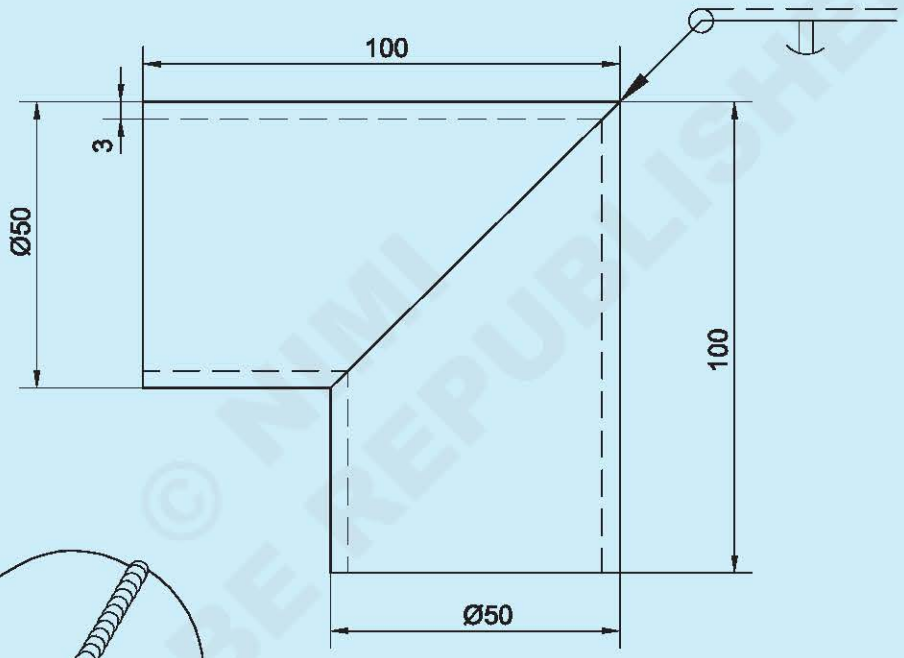
- external weld defects
- edge burning and reinforcement height
- depth of root penetration.

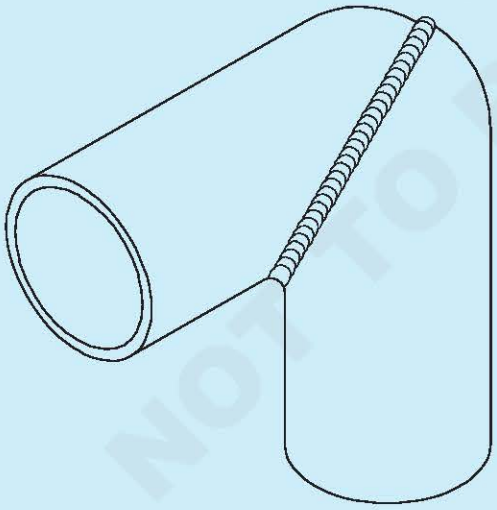
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Pipe welding - Elbow joint on MS pipe ø50mm and 3mm wall thickness in (1G)-(OAW-14)

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

- **draw the development for "ELBOW" pipe joint**
- **prepare as per drawing the pipes**
- **set root gap and tack weld**
- **weld the elbow joint in flat position**
- **clean and inspect the weld defects.**





Job Sequence

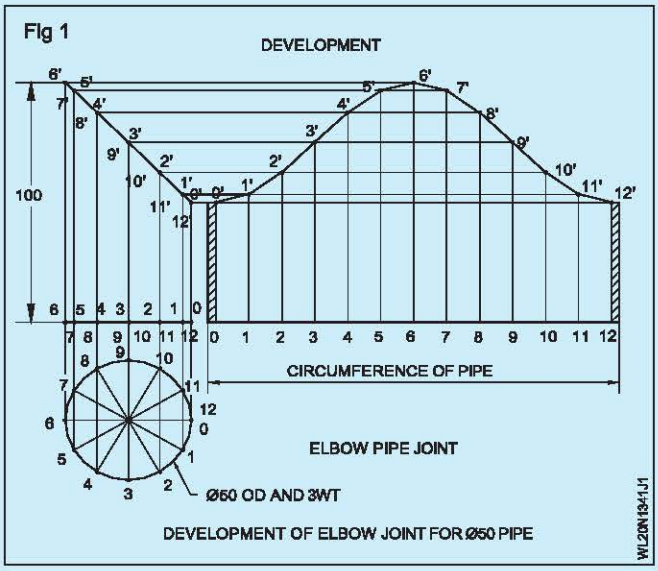
- Ensure the correct size of the pipes are used.
- Draw development for an "elbow" joint. Fig 1 on a drawing sheet scale full size.
- Cut the development of the pipe elbow from the drawing sheet and paste it on one end of both the 100mm long pipes.
- Make punch marks along the profile of the development on the pipes and cut the pipe along the punch marks using a hacksaw.

2	Ø50 x 3 - 100	-	Fe 310 - W	-	-	1.3.41
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PIPE WELDING - ELBOW JOINT ON M.S. PIPE Ø50 x 3mm WALL THICKNESS IN (1G) POSITION.	TOLERANCE	TIME
		CODE NO. WL20N1341E1	

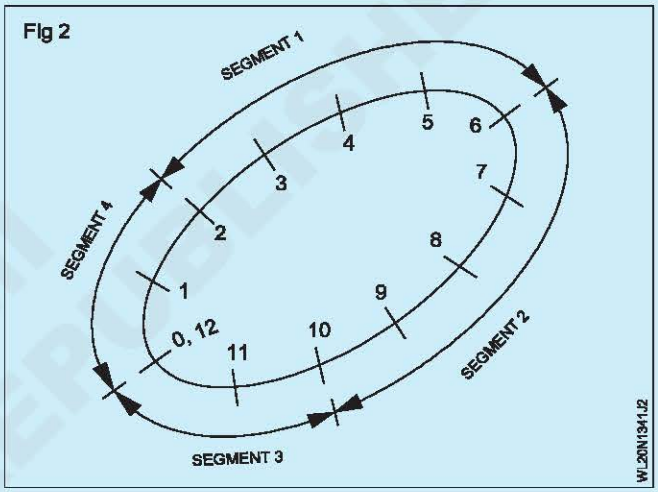
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Fig 1



- Deburr the cut edges and file it to correct any irregularity on the cut edges.
- Clean the surface of the pipe of any oxide and other contaminants.
- Set and align the pipe to on angle of 90°.
- Select nozzle No. 7 and ø3mm CCMS filler rod with 0.15 kg/cm^2 pressure for both gases.
- Set neutral flame.
- Follow necessary safety precautions.
- Tack weld the joints at 4 places with 1.6mm root gap and keep the joint in alignment. Check the 90° angle between the pipe axes using try square.
- Use leftward and vertical welding technique.
- Weld the joints by manipulating the blowpipe and filler rod in one run using 3mmø CCMS rod dividing the weld into 4 segments.
- The joint which will be in the form of an ellipse has to be welded in 4 segments. Fig 2 The order of sequence of welding is 2 to 6 (segment 1). 10 to 12 (segment 3) 10 to 6 (segment 2) and 2 to 0 (segment 4). This order of welding sequence will help to keep the tacked joint such that the welding is partially done in vertically upwards and partially in flat position.
- Ensure maintaining keyhole and ending the weld of each segment properly to get the root penetration without fail.
- Avoid excessive penetration.
- Clean the welded joint and inspect for weld defects.

Fig 2



Skill Sequence

Pipe weld - Elbow joint on MS pipe in IG rolling

Objective: This shall help you to
- **prepare and weld elbow joint on MS pipe in IG rolling.**

Fix no. 7 nozzle to the blowpipe to help in fusing both the edges of the joint (which is 3mm thick) to the full depth and get good root penetration.

Also the joint which is elliptical in shape can be welded properly with good fusion and root penetration only if the tack welded pipes are welded in 4 segments.

The segments are divided on the tacked pipe elbow joint as shown in Fig 2 under job sequence.

This division into 4 segments will help to keep the job in the required position so that the welding is done partially by vertical welding technique and partially by flat position.

In addition, the distortion in the pipe joint due to welding can be controlled by welding the segment in the sequence 1,3,2 and 4.

Maintaining a continuous keyhole as done in pipe square butt joint will help in getting good root penetration.

During welding fuse the tacks fully and also ensure proper fusion of edges and root of the joint of each segment.

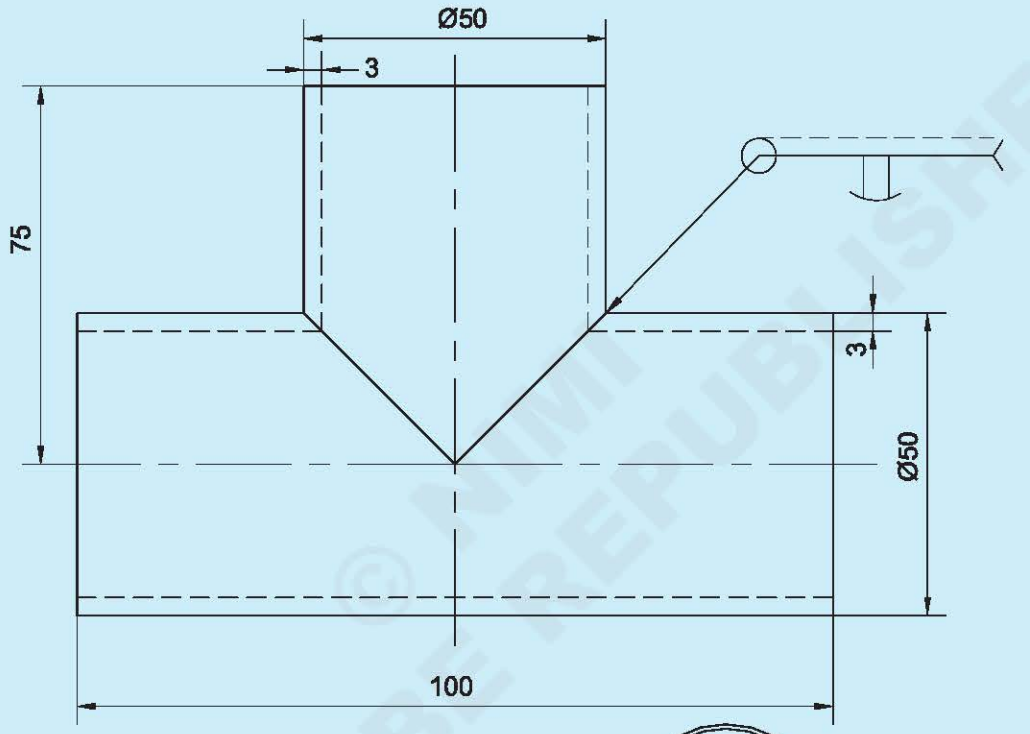
Use the blow pipe and filler rod angles of 60 - 70° and 30 - 40° to the tangent at the point of welding. Give a very slight side to side motion to the blowpipe.

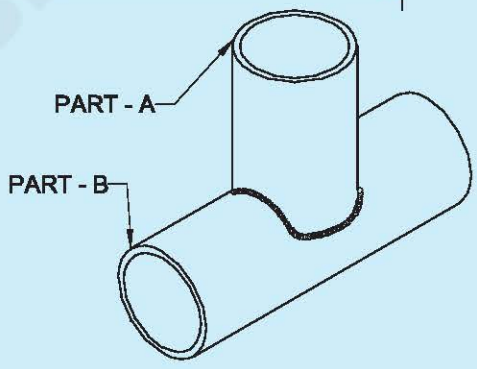
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Pipe welding 'T' joint on MS pipe ø50mm and 3mm wall thickness in flat position (1G) - (OAW-15)

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

- **draw the development for 90° T branch**
- **cut and prepare the pipes as per dimensions**
- **set the pipe in position and tack weld**
- **start and complete the weld in two halves**
- **clean and inspect for external weld defects.**





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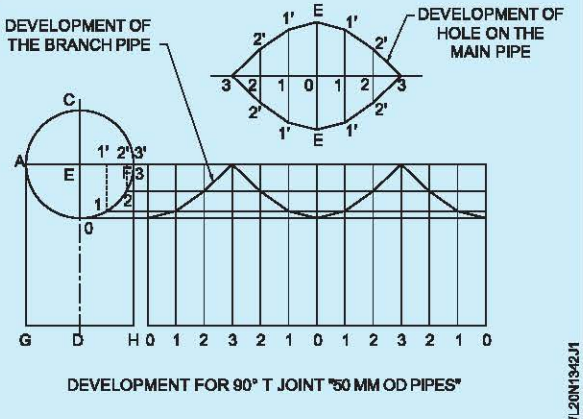
1	Ø50 x 3 - 100	-	Fe 310 - W	-	B	1.3.42
1	Ø50 x 3 - 75	-	Fe 310 - W	-	A	1.3.42
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PIPE WELDING - 90° 'T' JOINT ON M.S.PIPE Ø50 x 3 mm WALL THICKNESS IN 1G POSITION.	TOLERANCE ±1	TIME
		CODE NO. WL20N1342E1	

Job Sequence

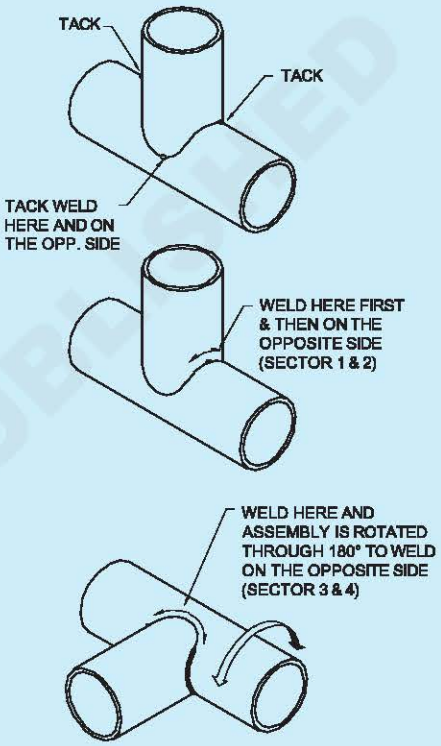
- Ensure the correct size of pipes are used.
- Prepare development for 90° branch. (Fig 1) on a drawing sheet.

Fig 1



- Cut and paste it on the pipes.
- Punch mark the profile of the development on both pipes. Cut the branch pipe along the punch marked profile and file it. Cut the profile marked on the main pipe by gas cutting and file it.
- Deburr the gas cut edges and file the edges.
- Clean the surface of the pipe to remove any oxide and other contaminants.
- Set and align the branch pipe with the main pipe at an angle of 90°. (Fig 2)
- Select no. 7 nozzle, ø3mm CCMS rod and use neutral flame with 0.15 kg/cm^2 pressure for both gases.
- Follow necessary safety precautions.
- Tack-weld the joint at 4 place with 90° intervals and with a 2 mm root gap to ensure root penetration.
- Ensure the tacked pipe "T" joint is positioned properly to make it convenient to manipulate the blow pipe and filler rod without any obstruction.
- Weld the joint by manipulating the blow pipe and filler rod without rotation of the pipe.
- Maintain keyhole throughout the welding and give side to side motion to the blow pipe to ensure good root penetration and fusion of both the edges of the joint.
- Take care to properly fuse the crater of the previous sector welded with the starting of the new sector.
- Complete the weld in 4 sectors 1, 2, 3 and 4 along the curved joint using leftward technique. Fig 2

Fig 2



Avoid excess penetration.

- Clean the weld and inspect the weldment for defects.

Skill Sequence

Pipe welding 'T' joint on MS pipe ø50mm and 3mm wall thickness in flat position

Objective: This shall help you to

- **prepare and weld 'T' joint on MS pipe in IG position.**

Refer Exercise.No. 1.3.41

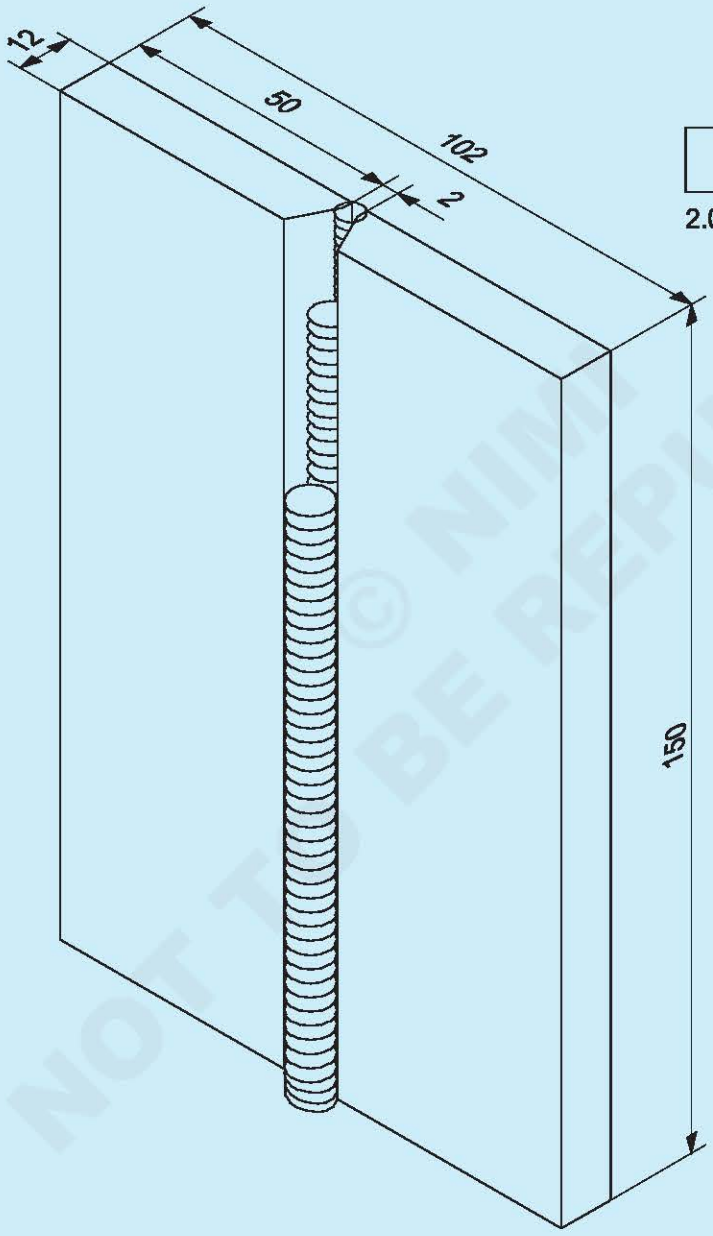
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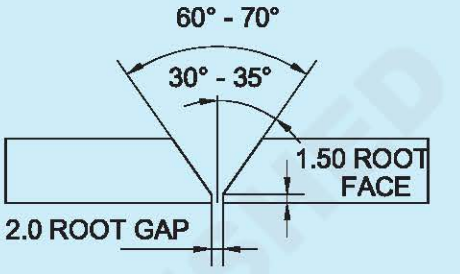
Single "V" butt joint on MS plate 12mm thick in vertical position (3G)-(SMAW-16)

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

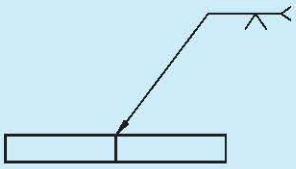
- **prepare the job as per drawing**
- **bevel the plates by gas cutting**
- **set the job with root gap and tack weld**
- **deposit root, second and third run in vertical position**
- **clean and inspect the surface defects**

Scan the QR Code to view the video for this exercise





JOINT PREPARATION DETAILS



2	50 ISF 12 x 150	-	Fe 310 - W	-	-	1.3.43
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	SINGLE VEE BUTT JOINT ON M.S PLATE 12mm THICK IN VERTICAL POSITION 3G (UPWARD)	TOLERANCE ±1	TIME
		CODE NO. WL20N1343E1	

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Job Sequence

- Cut the MS plate 12mm thick to size (2 Nos).
- Bevel the edges as per drawing.
- Both plates will have 30 to 35° bevel angle and 1.5mm root face and with no burr at the edges.
- Using spacers maintain a uniform gap of 2mm throughout and tack weld the plates.
- Preset the plates to 177° on the root side of the joint.
- Set the tack welded joint in vertical position
- Use ø3.15mm MS electrode and DCEN polarity for DC welding.
- Deposit the root run starting from bottom of the plate upward and maintain a uniform root penetration.
- Use short arc.
- Remove slag etc. and clean the weld with wire brush.
- Use ø4mm MS electrode and 150-amp current.
- Deposit 2nd, 3rd run using proper weaving technique and complete the weld in vertical position.
- Check the proper root penetration and other external weld defects.
- Rectify the defects whenever possible.

Skill Sequence

Single "V" butt joint on MS plate 12mm thick in vertical position

Objective: This shall help you to
- **prepare and weld single 'V' butt joint on MS plate in vertical**

Preparation of pieces

Cut and bevel the edges to an angle of 30 to 35° by using oxy-acetylene cutting.

Grind the bevel edges to remove oxides, and get smoothness.

Use goggles PPE while cutting and grinding.

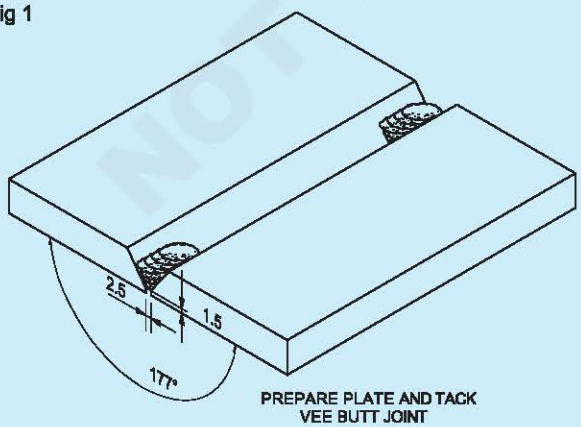
Prepare a 1.5mm root face throughout the length by filing.

Setting and tacking of single 'V' butt joint

Keep the bevel edges parallel with the 2.5mm root gap. The 2.5mm thick spacers are used to get a uniform and parallel root gap.

Tack-weld on both ends with correct alignment and presetting of 3° to control distortion. (Fig 1) i.e. on the root side the angle between the plates should be 177°.

Fig 1

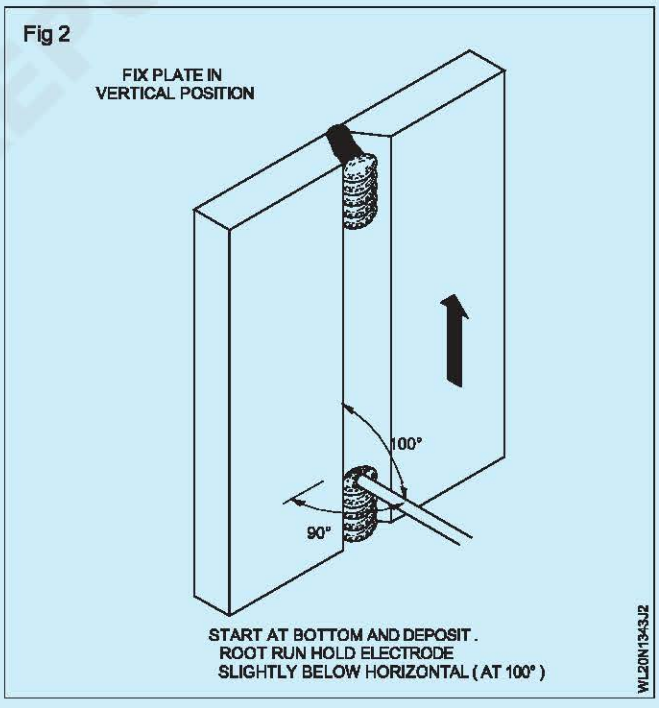


Position the joint in vertical using the weld positioner.

Deposition of weld beads

Deposit the root run using a 3.15 mm dia. M.S. electrode and 110 amps current with a slight sideways movement of the electrode. (Fig 2)

Fig 2



Ensure a keyhole throughout the root run.

The angle of the electrode in the holder should be 120° so that it is convenient to hold the electrode at 80° to the line of weld.

The arc length should be short.

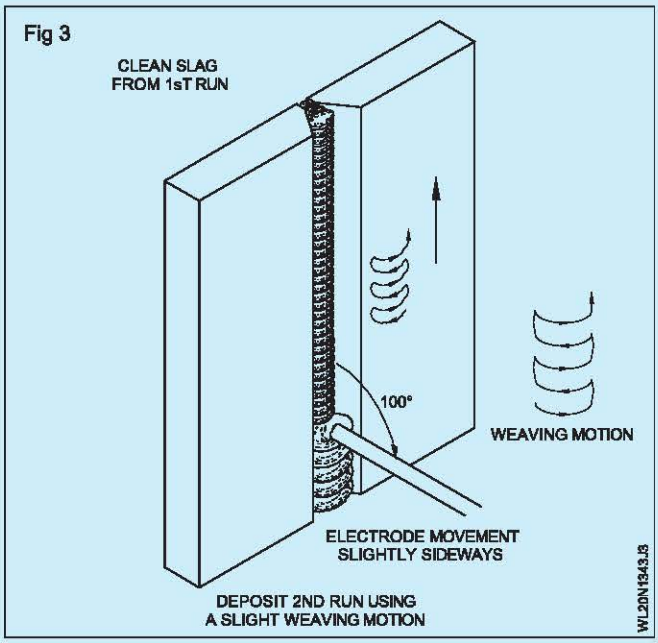
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The root penetration depth should not exceed 1.6 mm.

Remove the slag and clean the root run by using a chipping hammer and wire brush.

Deposit the second run using a 4 mm dia. M.S. electrode over the root layer with 160 amps current and an electrode movement slightly sideways. (Fig 3)

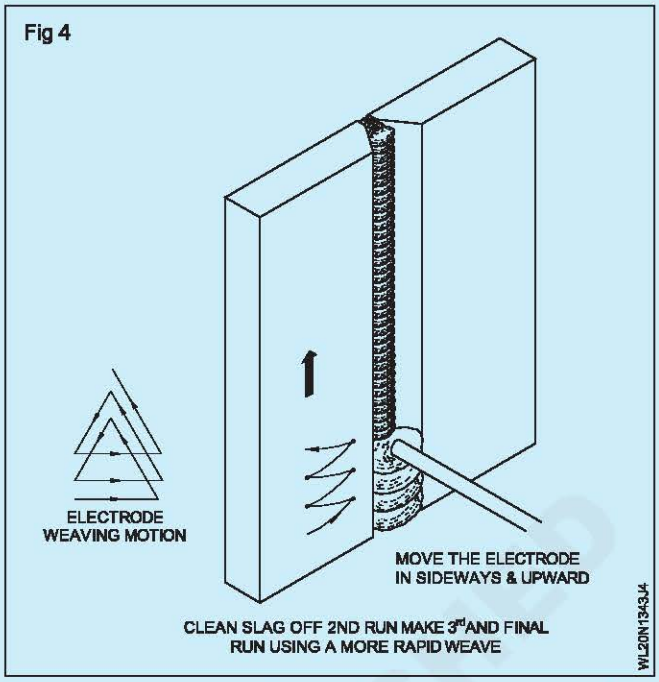
Fig 3



Remove the slag and clean the weld bead thoroughly.

Deposit the third layer using a 4 mm dia. M.S. electrode and 160 amps current (Fig 4) pausing regularly at the toes of the weld.

Fig 4



The weaving motion of electrodes can be anyone of the three patterns shown in Fig 3 and Fig 4.

The arc length should be short which helps to control sagging of weld metal.

Avoid undercut and excessive convexity, concavity.

Remove slags with a chipping hammer and clean the weld bead thoroughly with a wire brush.

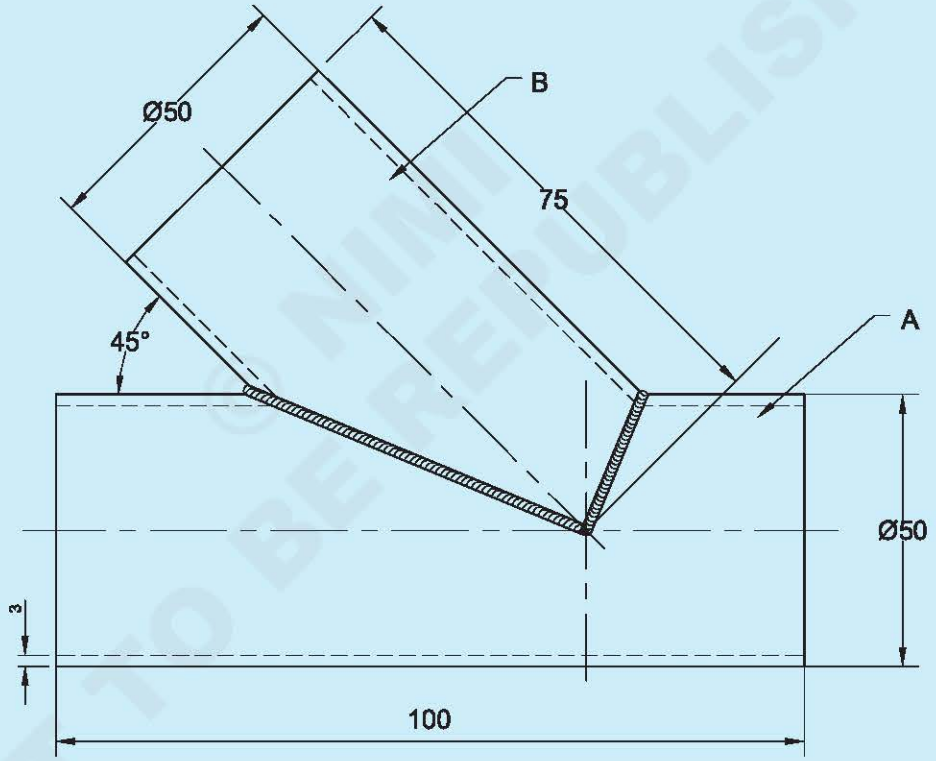
Inspect for root penetration, undercut, blow holes and excess reinforcement.

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Pipe welding 45° angle joint on M.S. pipe ø50mm and 3mm wall thickness (1G)-(OAW-16)

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

- **prepare the development of pipe for 45° branch joint**
- **cut and prepare the pipes as per dimensions**
- **tack and complete the welding by manipulating the torch and filler rod.**
- **clean and inspect the surface defects**



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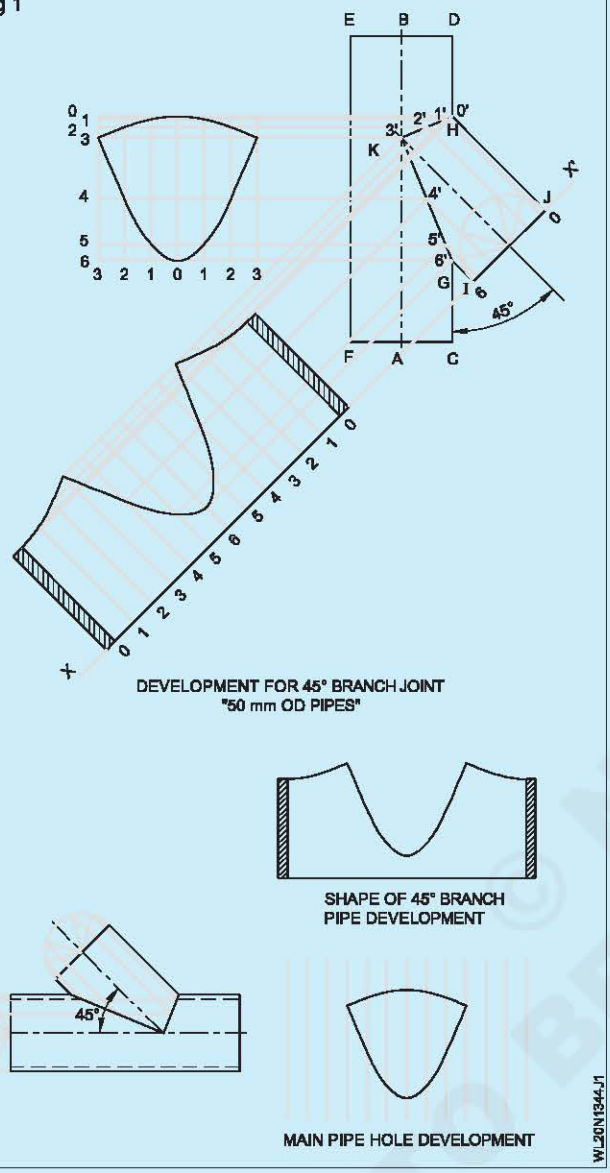
1	Ø 50 x 3 - 100	-	Fe310 - W	-	A	1.3.44
1	Ø 50 x 3 - 75	-	Fe310 - W	-	B	1.3.44
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PIPE WELDING 45° ANGLE JOINT ON M.S PIPE Ø 50 & 3mm WT BY OAW.	TOLERANCE ±1	TIME
		CODE NO. WL20N1344E1	

Job Sequence

- **Procedure for development of 45° branch pipe:** Refer Fig 1. Draw a center line AB.

Fig 1



- Mark the points C, D, E and F taking the radius and the length of the given pipe with the center line AB as reference line.
- On the line "CD" locate the position of the 45° branch pipe. This will be "G".
- Draw a 45° angle at the point "G".
- Choose a suitable height and mark the height of the branch pipe (GI) in 45° line from point G.
- From I, draw a horizontal line on both sides (XX'). This XX' will be the base line for drawing development.
- From I, plot the outside diameter of the branch pipe IJ on the line XX'.
- Draw a center line for the branch pipe. This line will cut the main pipe's center line AB at K.
- Join GK. Draw a perpendicular line to GK at K which meets CD at H. Join KH. Now IGKHJ will be the shape (outline) of the branch pipe.
- Draw a semicircle equal to the branch pipe outside diameter.
- Divide the semicircle into 6 equal parts as 0-1; 1-2; 2-3; 3-4; 4-5 & 5-6.
- Draw vertical lines from these points 1,2,3,4,5. Already there will be two vertical lines IG from the point 6 and JH from point 0. These vertical lines will cut the branch pipe lines 'GK' and 'KH' at points 6', 5', 4', 3', 2', 1' & 0'. Note that points 6' and G as well as points 0' and H are the same points. In the base line XX' plot 13 points equal to the distance of '0-1' as 0, 1,2,3,4,5,6,5,4,3,2,1,0.
- Draw vertical lines to XX' from these 13 points.
- Draw horizontal lines parallel to XX' from points 6', 5', 4', 3', 2', 1', 0'. These 7 horizontal lines will cut the 13 vertical lines from the base line at 13 points.
- Join the 13 cutting points with a regular smooth curve. Now the required development for the 45° branch pipe will be ready. Give allowance of 3 to 5mm at the edges of the development. (Fig 1)
- **For developing a hole in the base pipe:** Above the main pipe, draw 7 lines parallel to AB namely 3,2,1,0,1,2,3 equal to the distance of 0-1 on the semi circle.
- Draw vertical lines from 0', 1', 2', 3', 4', 5', 6'. These vertical lines will intercept the 7 horizontal lines. Join the intercepting points with a smooth curve. The required development for hole is now ready.
- Ensure the correct size of pipes are used.
- Prepare development for 45° branch on a drawing sheet.
- Cut and paste it on the pipes.
- Punch mark the profile of the development on both pipes. Cut the branch pipe along the punch marked profile and file it. Cut the profile marked on the main pipe by gas cutting and file it.
- Deburr the gas cut edges and file the edges.
- Clean the surface of the pipe to remove any oxide and other contaminants.
- Set and align the branch pipe with the main pipe at an angle of 45°.
- Select no. 7 nozzle, ø3mm CCMS rod and use neutral flame with 0.15 kg/cm^2 pressure for both gases.
- Follow necessary safety precautions.
- Tack-weld the joint at 4 place with 45° intervals and with a 2 mm root gap to ensure root penetration.
- Ensure the tacked pipe "Branch" joint is positioned properly to make it convenient to manipulate the blow pipe and filler rod without any obstruction.
- Weld the joint by manipulating the blow pipe and filler

rod without rotation of the pipe.

- Maintain keyhole throughout the welding and give side to side motion to the blow pipe to ensure good root penetration and fusion of both the edges of the joint.
- Complete the weld in 4 sectors 1, 2, 3 and 4 along the curved joint using leftward technique.
- Take care to properly fuse the crater of the previous sector welded with the starting of the new sector.

Avoid excess penetration.

- Clean the weld and inspect the weldment for defects.

Skill Sequence

Pipe welding 45° angle joint on M.S. pipe ø50mm and 3mm wall thickness (1G)-(OAW-16)

Objective: This shall help you to

- **prepare and weld 45° angle joint on MS pipe in IG position.**

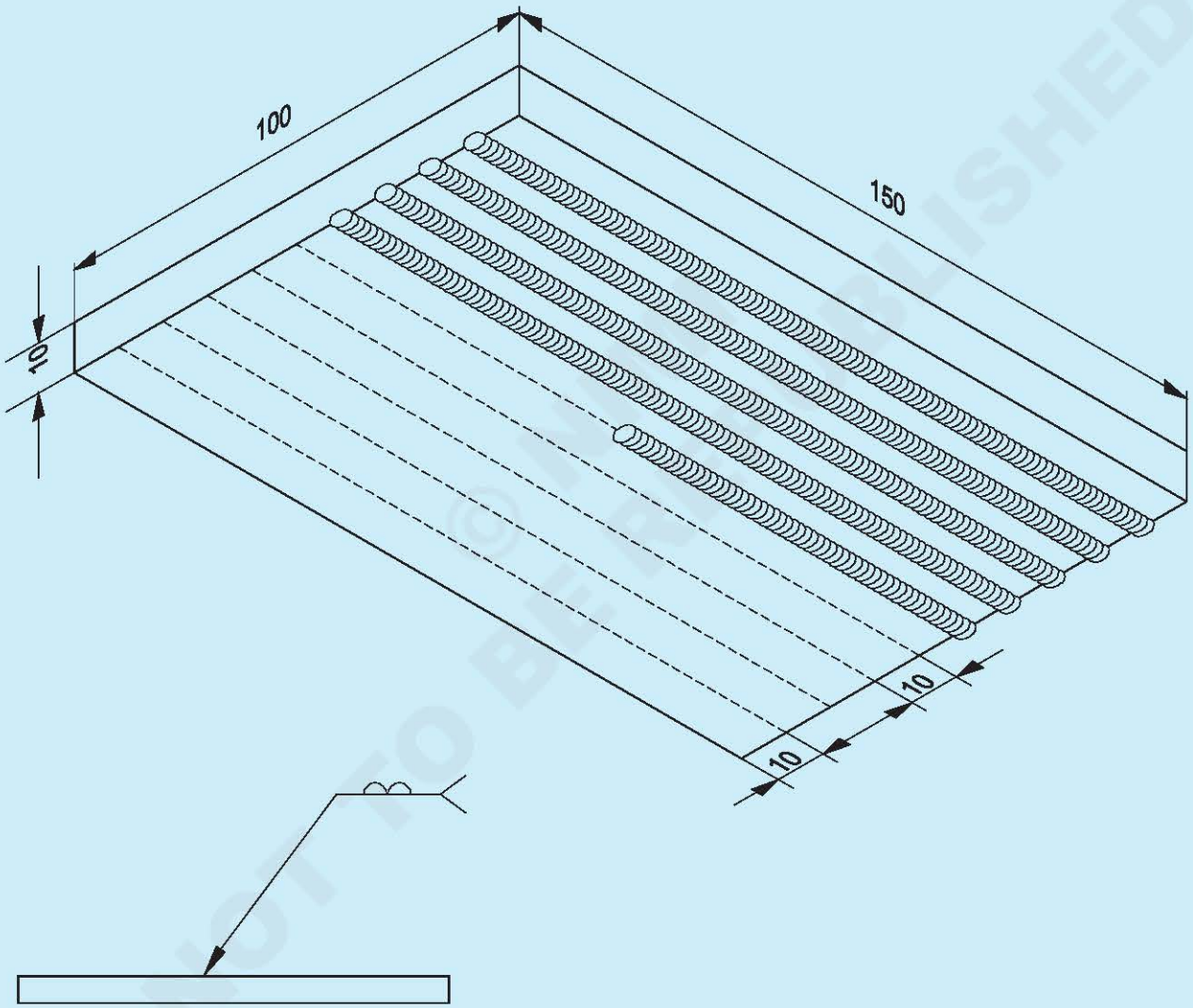
Refer Exercise.No. 1.3.41

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Straight line beads on MS plate 10mm thick in overhead position (SMAW-17)

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

- **set the M.S. plate in overhead position**
- **select the electrode, current polarity and arc length for overhead welding**
- **deposit uniform beads in straight line**
- **clean and inspect the straight line beads for surface defects.**



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1	150 ISF 10 - 100	-	Fe 310 - W	-	-	1.3.45
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	STRAIGHT LINE BEADS ON M.S PLATE 10mm THICK IN OVER HEAD POSITION.	TOLERANCE ±1	TIME
		CODE NO. WL20N1345E1	

Job Sequence

- Prepare and clean the plate.
- Lay out parallel lines as per drawing.
- Mark and punch lines with a center punch.
- Fix the plate in overhead position in the positioner. Adjust the job to suit your height.
- Select and fix a 3.15 mm dia. M.S. electrode and set 100-110 amperes current.

Use a helmet specially when welding in over-head position.

Run and support the electrode-holder cable over your shoulder.

Use hand sleeves and leg guards in addition to other protective clothing.

- Deposit the first bead along the punched line with short arc at normal speed.

Control the molten pool and slag using proper technique.

- Deslag, clean the bead and inspect for defects.
- Deposit the other beads along the punched line as done in the case of the first bead.
- Inspect the weld beads for defects.

Practice until you are able to deposit uniform straight beads without defects.

Skill Sequence

Straight line bead on MS plate 10mm thick in over head position

Objective: This shall help you to

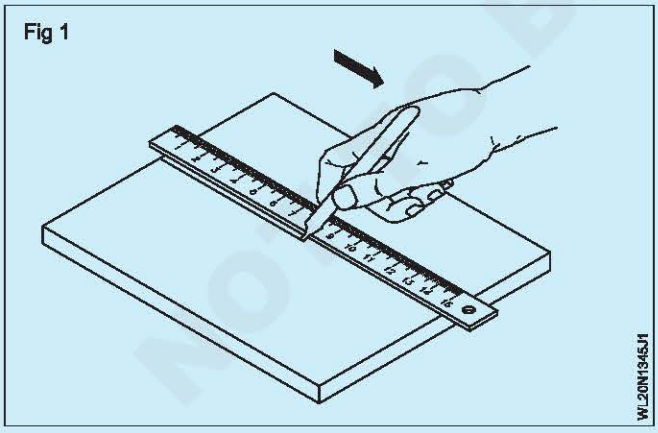
- **prepare and practice straight line bead on MS plate 10mm thick in over head position.**

Introduction

Though overhead welding is the most difficult one, it can be made easy by following proper welding techniques. Welding in overhead position is done in piping work, ship building and in structural fabrication.

Mark parallel lines with a scriber (Fig 1) and punch the line with a center punch.

Fig 1

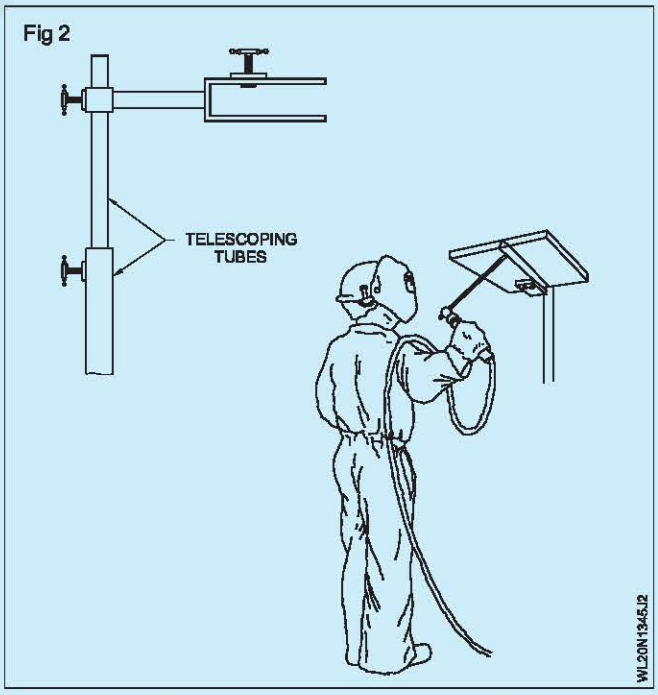


When setting the job in overhead position, the job with the punched line should be facing the ground. (Fig 2)

The height of the job is to be adjusted depending on your height using the telescoping tubes of the jig or positioner. (Fig 2) Small particles of molten metal and spatters will fall down from the joint during welding in overhead position and to protect yourself from these hot particles it is very important to use a helmet, hand sleeves, leg guards, gloves, apron and shoes.

In this position, the hand will be pulled down due to the weight of the cable. Due to this it is difficult to maintain a short arc constantly. This can be reduced by placing the cable over the shoulder as shown in Fig 2.

Fig 2

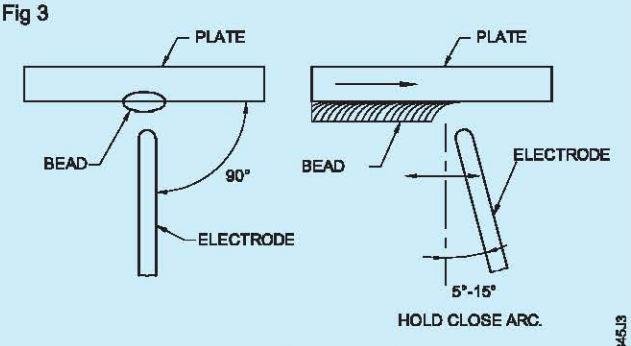


Use 3.15 mm ø MS electrode and set 100 - 110 amperes current. The current is set around 10amp less than that used for flat position, because maintaining a small molten pool is very important to reduce the pulling effect of gravity.

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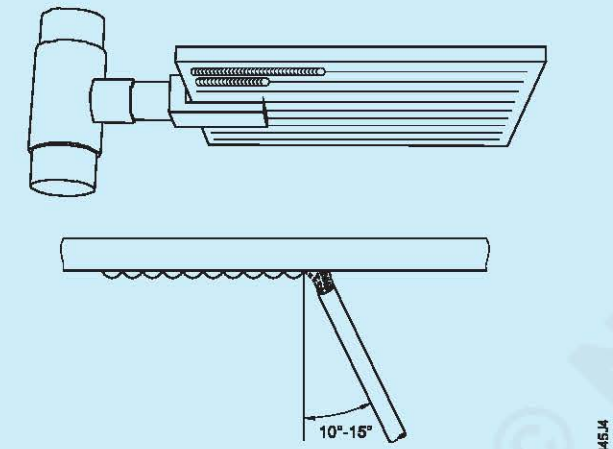
The electrode should be held at 90° to the base metal surface and at 5° to 15° to the direction of the weld. (Fig 3 & 4)

Fig 3



ELECTRODE POSITION WHEN MAKING BEADS IN OVERHEAD POSITION

Fig 4



POSITION OF THE ELECTRODE FOR OVERHEAD WELDING

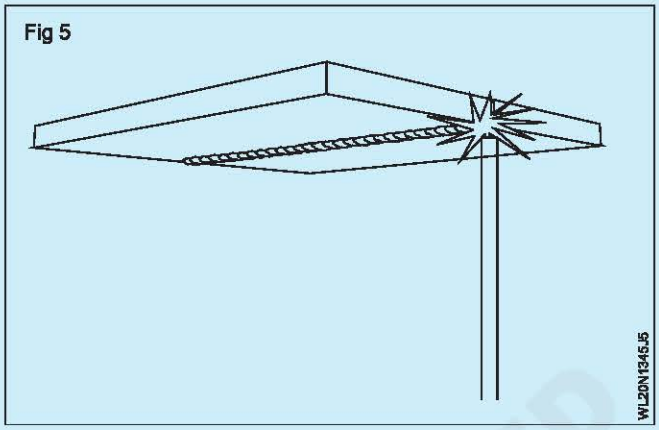
You can successfully overcome the force of gravity by using a short arc.

Deposit the first bead along the punched line. Care should be taken to maintain a very small molten pool to reduce the gravitational effect.

This will also help to control the molten slag from entering the molten metal.

Deposit the run up to the end of the work piece. (Fig 5)

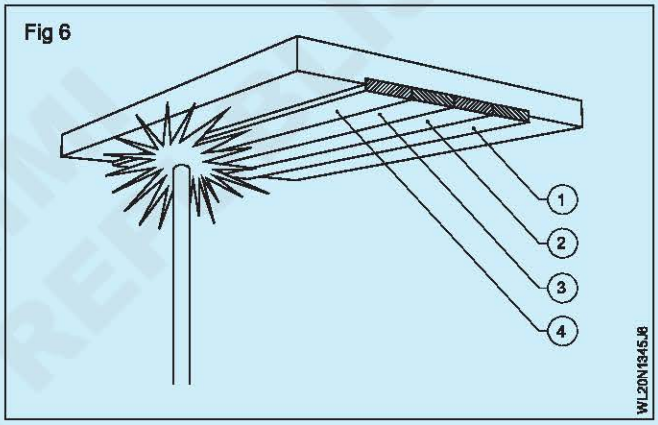
Fig 5



Repeat the same procedure to weld the second and subsequent beads. (Fig 6)

Inspect the weld for surface defects like uniformity of beads, undercuts, slag inclusions, blow holes etc.

Fig 6



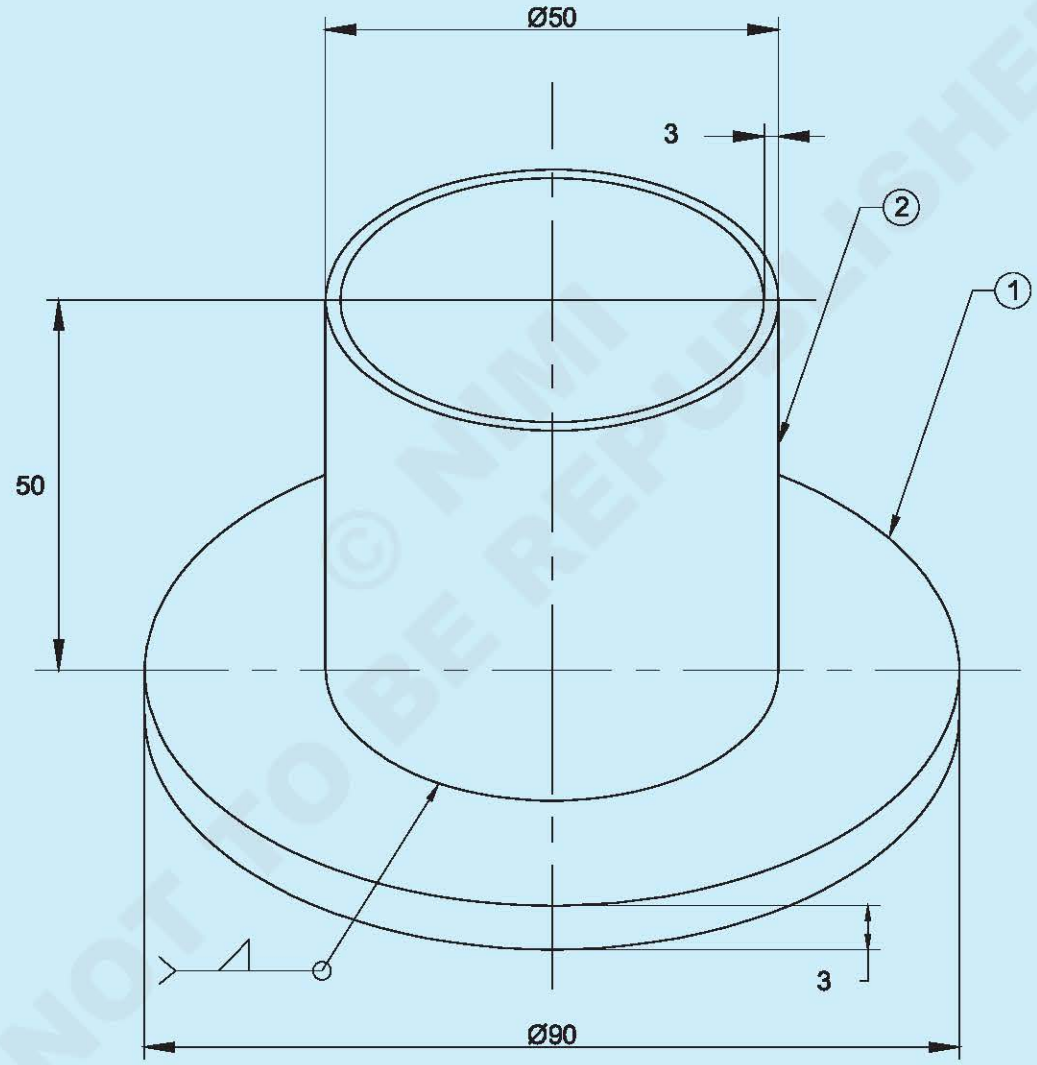
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Exercise 1.3.46

Pipe flange joint on MS plate with MS pipe ø50mm × 3mm wall thickness (1F) (SMAW-18)

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

- **mark an internal and external circle on a square plate**
- **cut the internal and the external circles by oxy-acetylene gas cutting**
- **insert an MS pipe into the internal circle and tack weld**
- **weld the pipe with the flange by arc in 1G position (rolling)**
- **clean the joint and inspect for any external weld defect.**



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1	Ø50 x 3 - 50	-	Fe 310 - W	-	2	1.3.46
1	100 ISF 3 - 100	-	Fe 310 - W	-	1	1.3.46
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PIPE FLANGE JOINT ON MS PIPE Ø 50mm x 3mm WALL THICKNESS AND MS PLATE 3mm THICK IN FLAT POSITION.	TOLERANCE ±1	TIME
		WL20N1346E1	

Job Sequence

- Find the center of the given 3mm thick square plate by joining the 2 diagonals of the square plate using a scriber and mark a dot on the meeting joint of the diagonals using a dot punch.
- Using a spring divider scribe/draw a circle of radius 50mm at the center of the square plate and another larger circle with a radius of 45mm and punch mark both the circumference of the circles.
- Select 0.8mm size cutting nozzle and fit it with the cutting torch.
- Set a pressure of 0.15 kg/cm^2 for acetylene gas and 1.5 kg/cm^2 for oxygen gas for cutting 3mm MS plate.
- Set neutral flame and preheat at the center point of one of the edges of the square plate until it reaches bright red hot condition/kindling temperature.
- Press the oxygen cutting lever and move the torch by hand from the edge of the plate until the punch marked circumference of the larger circle is reached.
- Now using a roller guide and circle cutting attachment start cutting the larger external circle of 90mm diameter.

Ensure necessary safety precautions to be used for gas cutting is followed.

- To cut the internal circle, first pierce a small hole at about 10mm inside the circumference of the 50mm dia. circle.
- Move the torch towards the circumference from the pierced hole and complete the 50mmø hole cutting using a small circle cutting attachment.
- Clean the cut edges and trim the inside face of the cut edges using a half round file.
- Insert the given pipe of 50mm outside diameter in the cut hole of the plate such that the end of the pipe is flush with the flat surface on the other side of the 6mm plate to form a pipe flange joint.
- Select a 3.15mm medium coated MS electrode and set 110 amperes current and DCEN if a DC welding is used.
- Tack weld at four places at 90° intervals on the other side of the joint.

Ensure that the pipe is at 90° to the plate surface while tacking.

- Change the electrode to 4mm dia. medium coated MS electrode and set 160 ampere current.
- Position the joint on a suitable weld fixture so that welding can be done by 1G rolling method.
- Complete the welding of the joint in one run using segment welding method.
- Deslag and clean the joint with a wire brush.
- Inspect visually for any external weld defects.

Ensure proper crater filling at the end of each segment welding.

Use appropriate safety precaution during arc welding and deslagging.

Skill Sequence

Pipe flange joint on MS plate with MS pipe in flat position

Objectives: This shall help you to

- **prepare the 'T' joint on MS plate in vertical position.**

For external circle cutting to get a 90mm dia. circular plate from the given 100mm square plate, the cut can be started from the free edge of the plate Fig 1. After the cut reaches the punch marked circumference line, fix the circle cutting attachment (Fig 4) at a distance of 45mm from the center of the cutting nozzle and keeping the conical point of the circle cutting attachment at the center of the plate and cut the external circle of radius 45mm.

To cut an internal circle, a small hole called pilot hole is to be drilled or pierced by gas cutting inside the circumference of the circle/profile before starting to cut the required circle/profile. The procedure to pierce a pilot hole is as follows. Refer Fig 2.

Fig 1

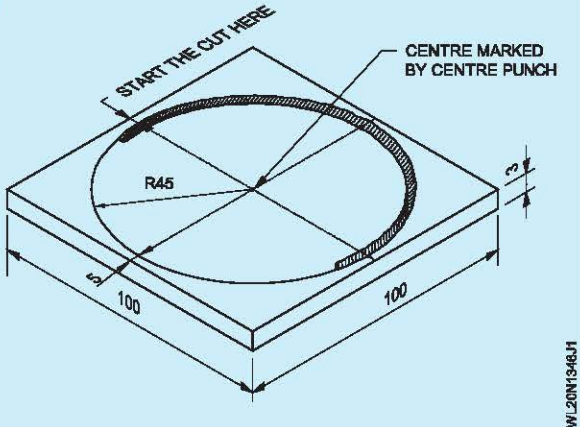
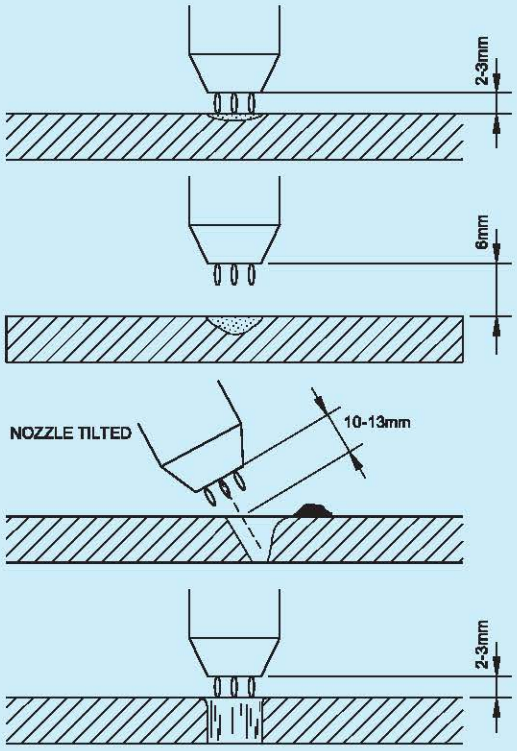


Fig 2



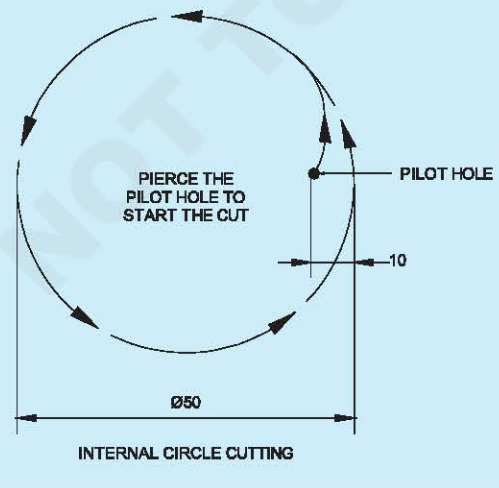
PIERCING A PILOT HOLE

Set the flame in the usual manner then:

- Preheat the spot with the torch about 6mm from the plate, so that inner cones almost touch the plate.
- When the spot is bright red, lift the torch to about 13mm above the plate until the metal nearly melts and tilt the torch to the side a little.
- Press the cutting oxygen lever slowly and move the torch around slightly until the cut is through the plate.

After piercing the pilot hole move the torch as shown in Fig 3 until it reaches the circumference of the 50mmø circle.

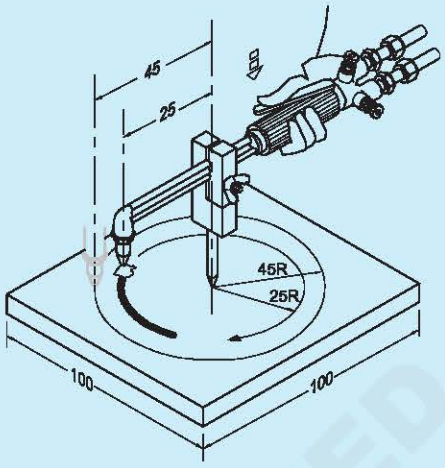
Fig 3



INTERNAL CIRCLE CUTTING

To cut a circle, it can be done by free hand movement along the circumference or a circle cutting attachment as shown in Fig 4 can be used which will give an accurate cut surface very close to 50mm diameter. To get a fine and uniform cut surface the torch has to be moved steadily with a uniform speed along the circumference.

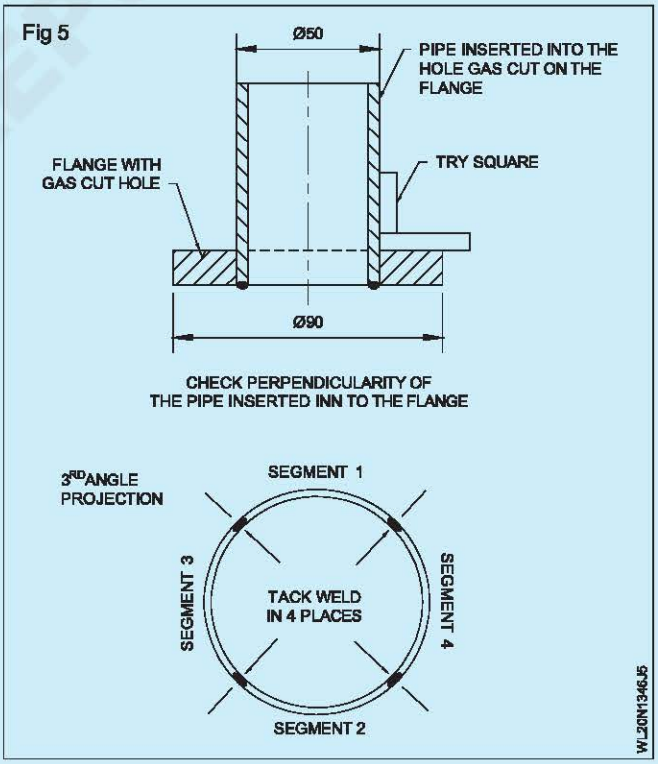
Fig 4



While tacking the pipe with the gas cut flange ensure that perpendicularly is maintained. Refer Fig 5 Tacking is done at 4 places on the other side of the flange joint. Fig 5. Use 4mm dia. electrode so that the required fillet size of 3 to 3.5mm can be maintained.

To weld the joint in 1G (rolling) position, use a weld fixture as shown in Fig 6 to make it convenient to weld in 1G position and complete the weld in 4 segments. 1, 2, 3 and 4 (Fig 5)

Fig 5



Maintain as short an arc as possible and an electrode angle of 45° between the plate and pipe surfaces.

Follow the weld sequence as shown in the Fig 5 which will help to control distortion i.e. First weld segment (1) in down hand position. Then rotate the joint by 180° and weld segment (2) in down hand position. Similarly, weld

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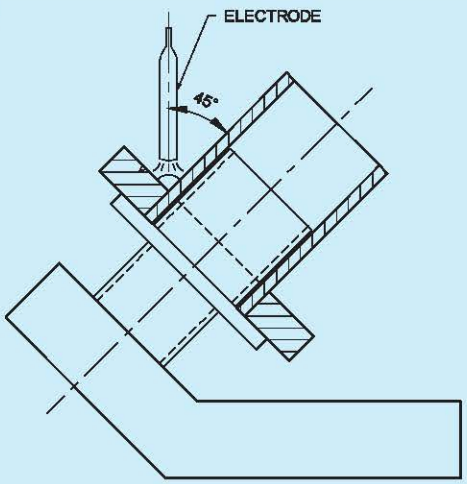
segment (3) and segment (4) by rotating the joint on the fixture to bring the segments for welding in down hand position. Fig 6.

While welding segments 3 and 4 the weld deposit should cover about 10mm distance over the previous deposit to ensure crater filling and continuity in the root penetration.

Deslag after welding each segment and avoid undercut by proper current setting and speed of welding.

Clean the weld using wire brush. Check the fillet size with a weld gauge.

Fig 6



WELD FIXTURE USED TO WELD
PIPE FLANGE JOINT 1F POSITION

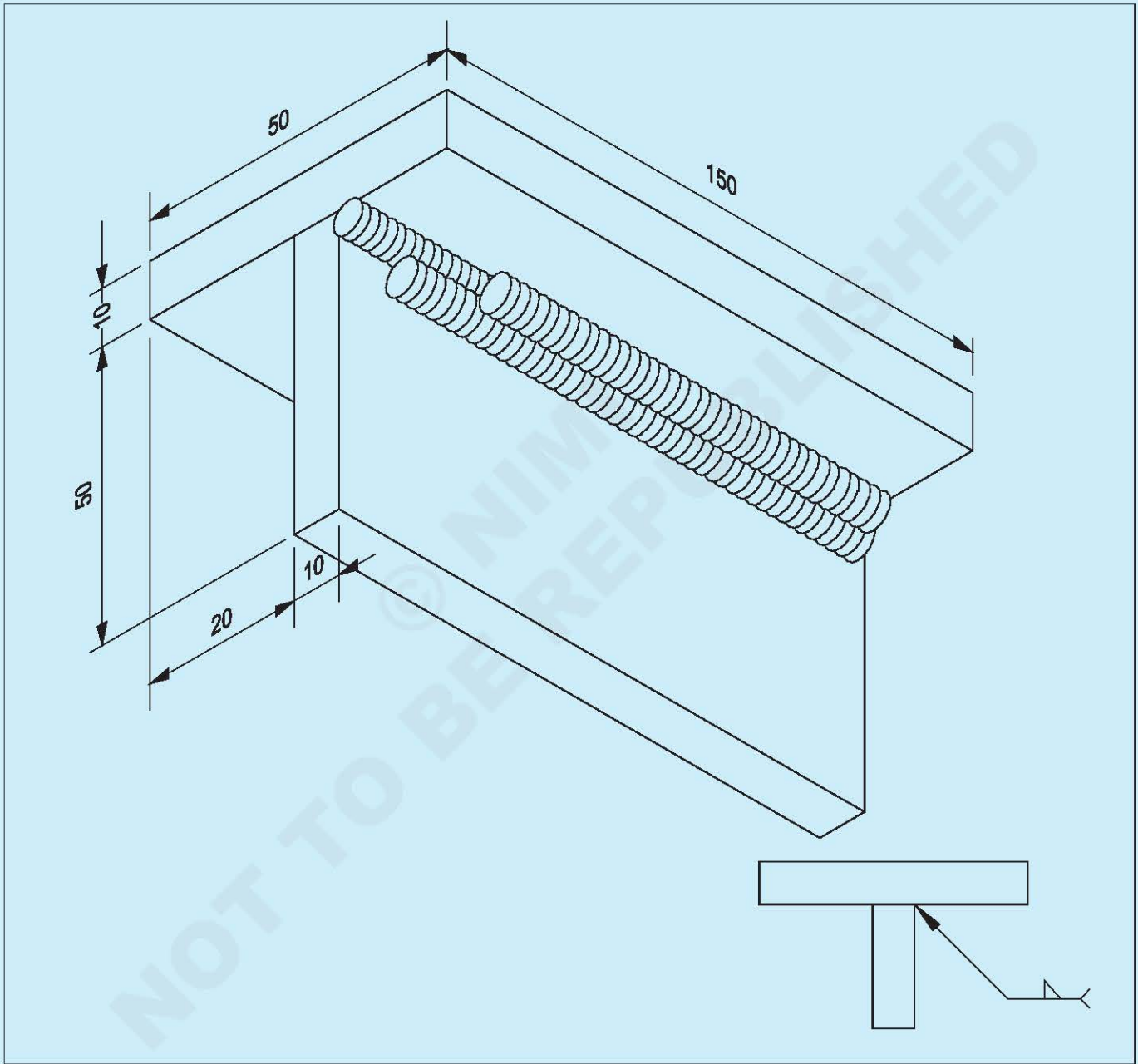
WI.20N1346J8

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Fillet - "T" joint on MS plate 10mm thick in over head position (4F)-(SMAW-19)

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

- **prepare and tack weld the job as per drawing**
- **deposit root, 2nd and weaving bead on overhead position**
- **clean and inspect the weldment for surface defects.**



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2	150 ISF 10 - 50	-	Fe 310 - W	-	-	1.3.47
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	FILLET TEE JOINT M.S PLATE 10mm THICK IN OVERHEAD POSITION.				TOLERANCE ±1	TIME
					CODE NO. WL20N1347E1	

Job Sequence

- Prepare and clean the job pieces.
- Set and tack the job pieces at both ends of the Tee joint in flat positions.

Tack the work pieces in outside edges so as to avoid starting defect.

- Set the job in overhead position and adjust its height.

Wear protective clothing i.e. helmet, hand sleeves, apron etc.

- Set a current of 110 amps for a 3.15mmø M.S. electrode.
- Connect the electrode holder in positive pole in the case of a DC machine.
- Deposit root run (first bead) deep in the root of the joint using a 3.15 mm ø electrode.
- Remove the slag and deposit second and third run with a 3.15 mm electrode. (Refer to Skill Information.)
- Remove the hot job by using a tongs.
- Clean the weldments and inspect the surface defects.

Skill Sequence

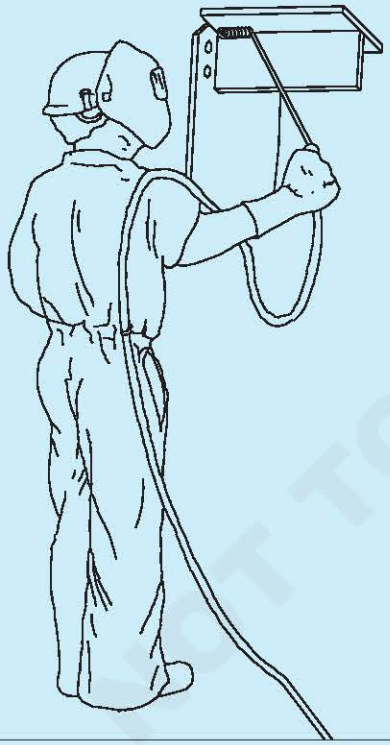
Fillet 'T' joint on MS plate 10mm thick in over head position

Objective: This shall help you to
- **prepare and weld fillet 'T' joint on MS plate 10mm thick in over head position.**

Job setting

Set the job in overhead position on the positioner. (Fig 1)

Fig 1



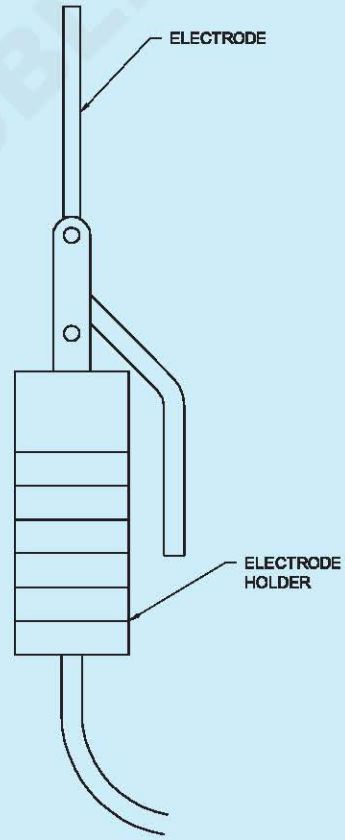
Fix the electrode as shown in Fig 2.

Start the bead at the left side. (Fig 1)

Use a 30° work angle off the vertical plate as shown in Fig 3.

Work angle is the angle between the electrode and the job surface.

Fig 2



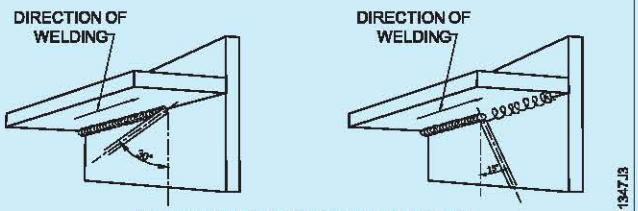
Use a drag angle of approximately 10-15° to the direction of the weld.

Drag angle is the angle between the electrode and the line of weld.

Maintain a short arc all the time.

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Fig 3



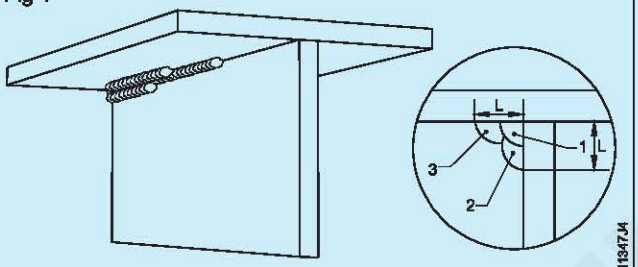
FILLET WELD IN THE OVERHEAD POSITION

WL20N1347.13

When multi-passes are used the second pass should be placed between the first pass and the vertical plate so that the second bead overlaps the first pass, (Fig 4) by about 2/3rd of its width.

The third bead should cover the top horizontal plate and about two-third of bead two. The leg lengths "L" of the weld should be equal. (Fig 4)

Fig 4



T-JOINT IN AN OVERHEAD POSITION

WL20N1347.04

Welding in the overhead position is not difficult if you remember to keep the puddle flat and small.

If the molten metal becomes too fluid and tends to sag, whip your electrode away quickly from the crater and allow the metal to solidify.

Do not attempt to deposit too much weld metal at one time.

All the slag must be removed and clean the bead before you deposit the next run.

The process is quite hazardous because of flying spatters and the possibility of molten metal from the puddle dropping on to the operator. By maintaining a short arc length and rapid electrode manipulation this difficulty may be overcome to a great extent.

The discomfort of the cable can be minimized by dropping it over the shoulder if you are welding in a standing position as shown in Fig 1 or over the knees if in a sitting position.

Inspection: Remove the slag from the weld and inspect the joint for surface and external defects.

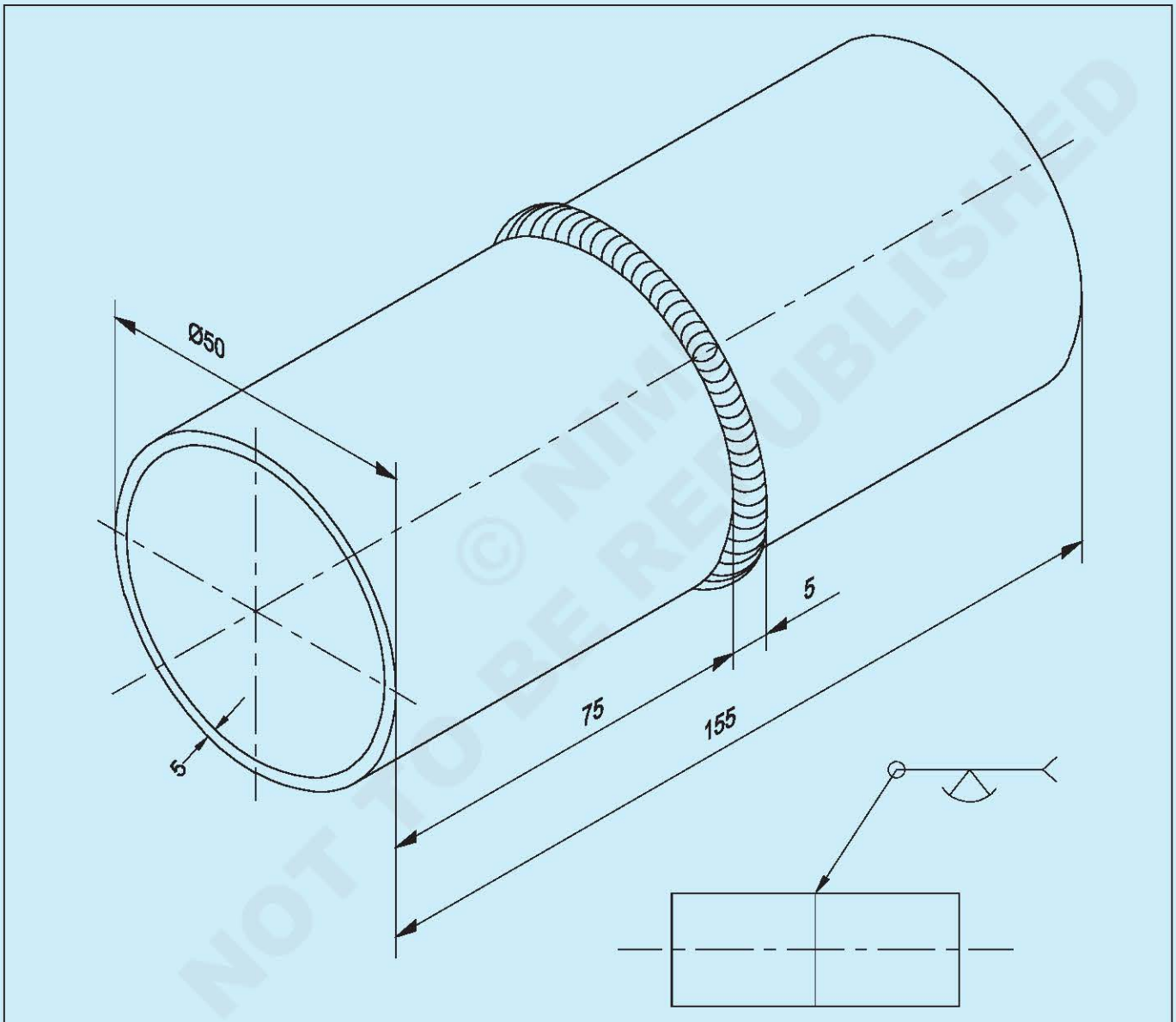
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Exercise 1.3.48

Pipe welding butt joint on MS pipe ø50mm and 5mm wall thickness in 1G position (SMAW-20)

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

- **cut and bevel the pipe as per drawing**
- **tack pipes for butt welding**
- **Deposit root, second and weaving run by rotation method**
- **clean the job and inspect for defects.**



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2	Ø50 x 5 - 75	-	Fe 310 - W	-	-	1.3.48
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PIPE WELDING. BUTT JOINT ON M.S. PIPE Ø 50mm x 5mm WALL THICKNESS IN 1G POSITION (SMAW-20)	TOLERANCE ±1	TIME
		CODE NO. WL20N1348E1	

Job Sequence

- Cut the pipes to the given size.
- File pipe ends to be at right angle to the pipe axis.
- Grind the edges to 30 to 35° bevel maintaining 1.5 to 2.9mm root face.
- Remove the burrs and rust from the pipe ends.
- Arrange the 2 pipes to form as a butt joint.
- Use a fixture or V profile of an angle iron to align pipes.

Wear protective clothing.

- Switch 'on' the machine and select a 3.15 mm ø electrode for tacking and the root run and set a 110 amps current.
- Put 4 tacks at regular intervals adjusting 3 mm root gap between the pipes using spacers.
- Ensure that each tack ends with a key hole.
- Check and ensure that the pipes are in line after tacking.
- Set 110 amp for a 3.15mmø electrode for root run.
- Deposit the root run in flat position by without rotating the pipe.
- Welding using the keyhole technique ensures root penetration.
- Remove slag from the root thoroughly.
- Deposit the second and third run using a 3.15 mm ø electrodes i.e. the same as for the root run.
- Clean and inspect the joint.

Skill Sequence

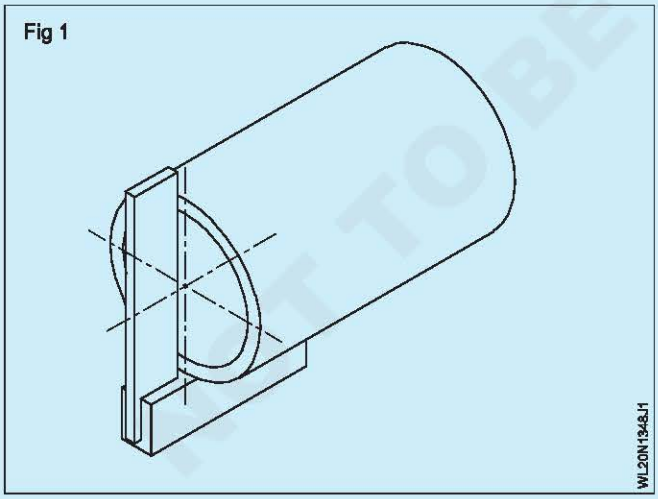
Pipe welding butt joint on MS pipe ø50mm and 5mm wall thickness in 1G position

Objective: This shall help you to
- **prepare and weld butt joint on MS pipe in (IG) position.**

Cut the pipes to the given size by a hacksaw.

Check the squares of the pipe end by using a try square. (Fig 1) and file the pipe end so that it is square with the pipe axis.

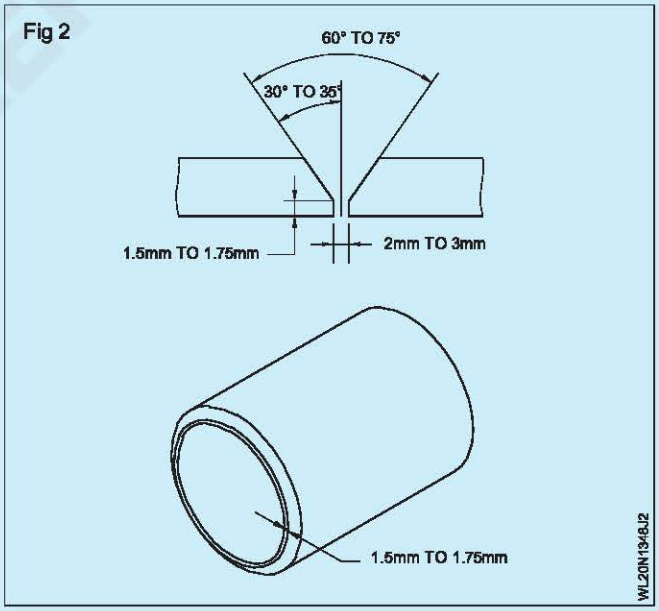
Fig 1



Prepare 30 to 35° bevel on one end of each pipe, leaving 1.5 to 1.75 mm root face by grinding or by filing. (Fig 2)

Switch 'on' the machine and adjust 110amp current for 3.15 mm ø medium coated M.S. electrode (B.I.S code ER4211). Use DCEN polarity.

Fig 2



Before tacking, align the pipes on V profile of an angle iron with 2 mm root gap (Fig 3) and tack them as shown in Fig 4. Check the gap using a 2 mm rod.

Place the electrode in the holder, as in Fig 6. Use a 90 degree angle or a 45 degree angle away from the end of the holder.

Position yourself so that you are at a 90 degree angle to the pipe. Be sure you are comfortable.

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Fig 3

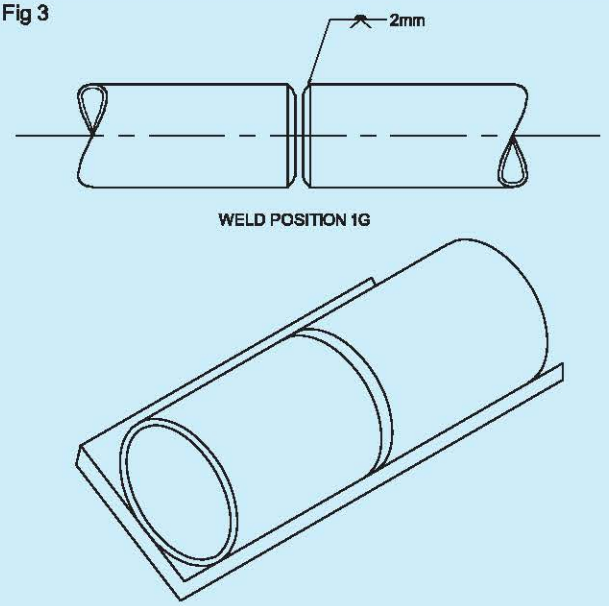
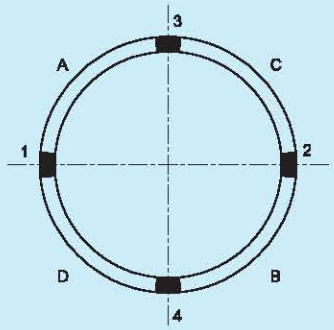
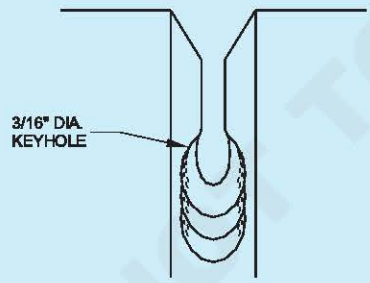


Fig 4



Strike the arc, on the bevel, at approximately 3 o'clock. Carry it down to 4 o'clock. Pause long enough for the root faces to melt away and for a keyhole to form Fig 5. Then reverse your electrode direction.

Fig 5



To run the first pass uphill, utilize the whipping method, as in welding plate in the vertical position. Use an electrode at a push angle of 5 to 15 degrees upward, as in Fig 6. Whip upward, taking care not to damage the surface of the pipe on either side of the V groove. Stop when you reach 1 o'clock, as shown in Fig 6. Clean thoroughly.

Turn the pipe toward you one quarter of a turn. Then proceed in the same manner until the first pass is completed. Be sure to start the next electrode slightly below the crater.

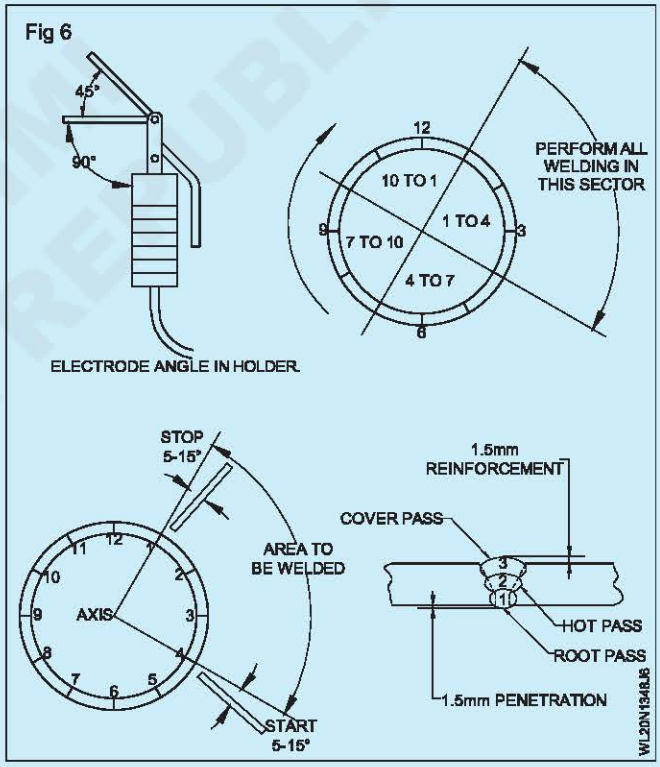
The second pass (hot pass) and third pass (cover pass) can be welded using 3.15mm electrode with either the triangle motion or the alternate weave, as in vertical plate welding. Take care to pause at the sides of the joint. Burn out any entrapped slag and fill in any undesirable undercut.

The sequence of beads is shown in Fig 6. Adhere to the maximum root and face reinforcement shown.

When you make the connection on completing the pass, be sure to overlap slightly. Break the arc by slowly drawing it away from the puddle.

Clean and inspect the joint for surface defects.

Fig 6



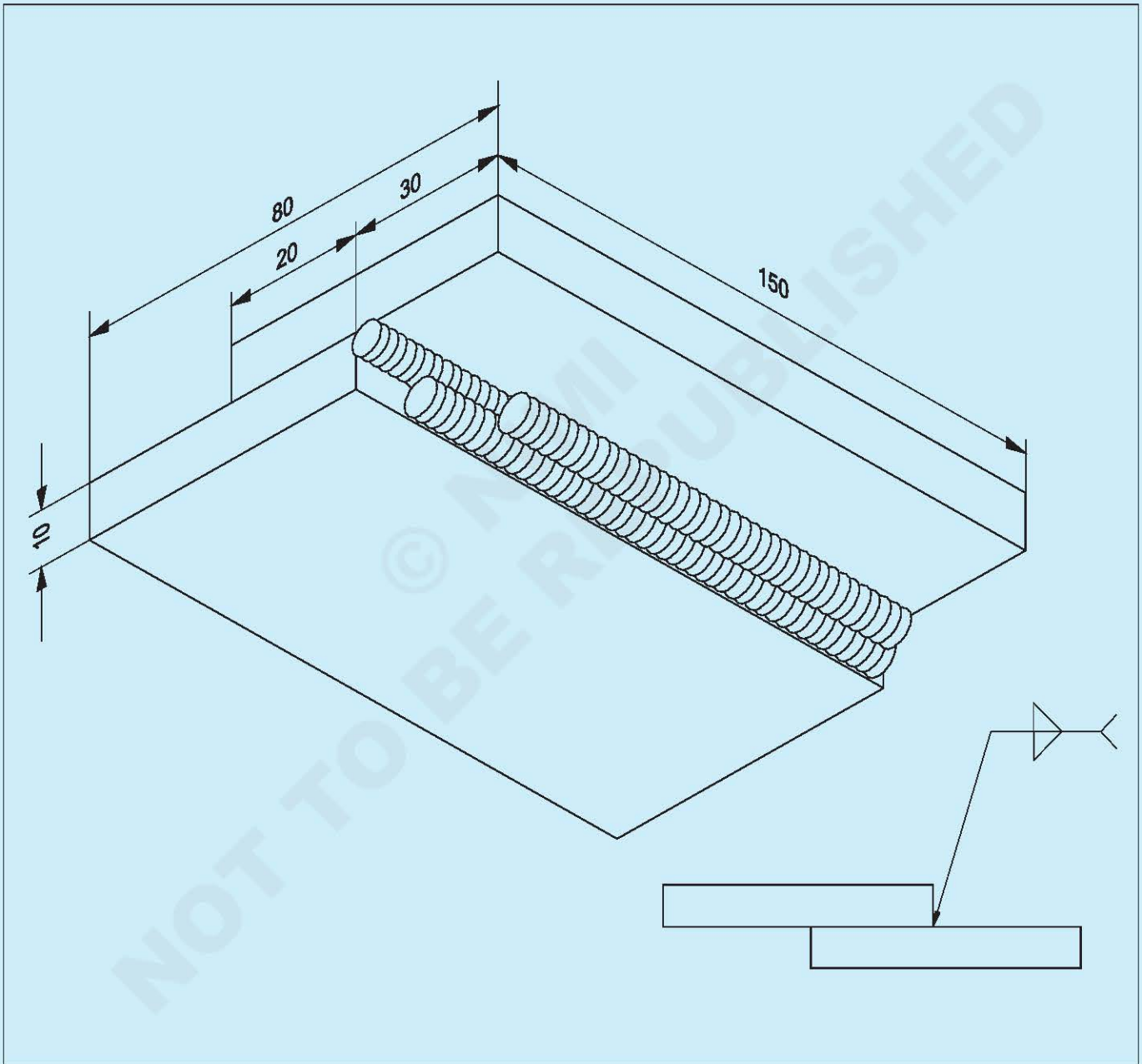
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Exercise 1.3.49

Fillet - lap joint on MS plate 10mm thick in over head position (4G) - (SMAW-21)

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

- **prepare, set and tack weld the job as per drawing**
- **deposit root, second and weaving run in OH position**
- **clean and inspect the job for surface defects.**



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2	50 ISF 10 - 150	-	Fe 310 - W	-	-	1.3.49
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	FILLET LAP JOINT ON M.S. PLATE 10mm THICK IN OVERHEAD POSITION.	TOLERANCE ±1	TIME
		CODE NO. WL20N1349E1	

Job Sequence

- Mark the plate and cut to given size.
- Prepare the square edges.
- Set the lap joint without gap and tack the plate on both ends.
- Clamp the job for overhead lap welding.
- Select 3.15øMM M.S electrode and set the current.
- Hold the electrode at an angle of 45° to the plate surface and an angle of 15° to the perpendicular to the line of weld.
- Lay the first bead at the root without weaving the electrode.
- Clean the slag using a chipping hammer.
- Deposit 2nd and 3rd run using stringer beads.
- Deslag, clean and inspect the joint.

Skill Sequence

Fillet lap joint on MS plate 10mm thickness in over head position

Objective: This shall help you to
• prepare and weld tap joint on MS plate over head position.

Preparation and job setting

Mark and cut the plate to the given size by gas cutting.

Clean the surfaces of the plates and file to square edge.

Set lap fillet without gap and tack the plates at both ends.

Keep the lapping distance as 20mm.

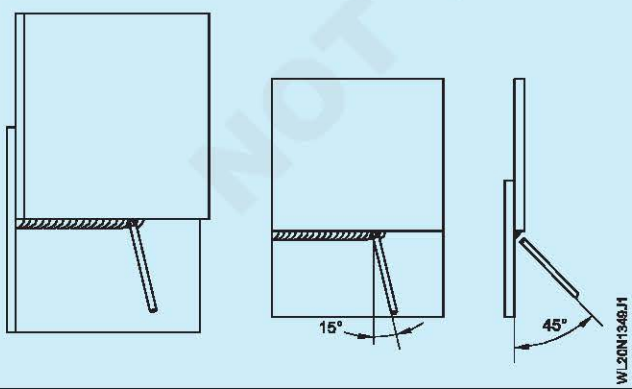
Use PPE

Clamp the job for overhead welding.

Select a M.S. electrode 3.15 mm ø and set 110 amps current.

Hold the electrode so that it bisects the angle between the edge of the top plate and the surface of the bottom plate, and is inclined slightly away from the crater, say 15°. (Fig 1)

Fig 1



Lay the first bead at the root of the joint with a short arc without electrode weaving.

Remove the slag from the bead using a chipping hammer and clean with a wire brush.

Use a M.S. electrode 3.15 mm ø and deposit the 2nd run with 110 amps. current, between the 1st bead and the surface of the plate, maintaining a short arc. The electrode angle is the same as the one mentioned for root run.

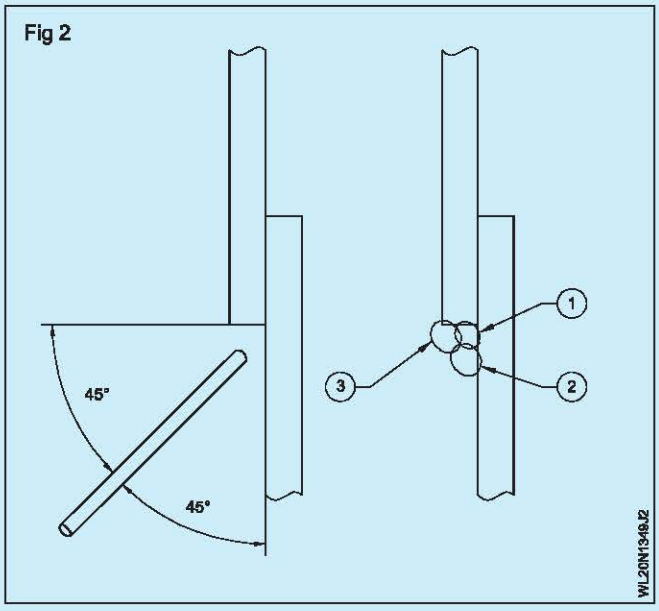
Deslag the second bead thoroughly.

Use a 3.15 mm electrode and set 110 amps current.

Deposit the 3rd bead in between the first bead and the bottom edge of the top plate (Fig 2) with a short arc and with an electrode angle of 45° to the surface of the plate to avoid the edge melting off the top plate.

Clean the weld thoroughly and inspect for defects, like undercut, porosity, uneven ripples and the melting off of the edge plate.

Fig 2



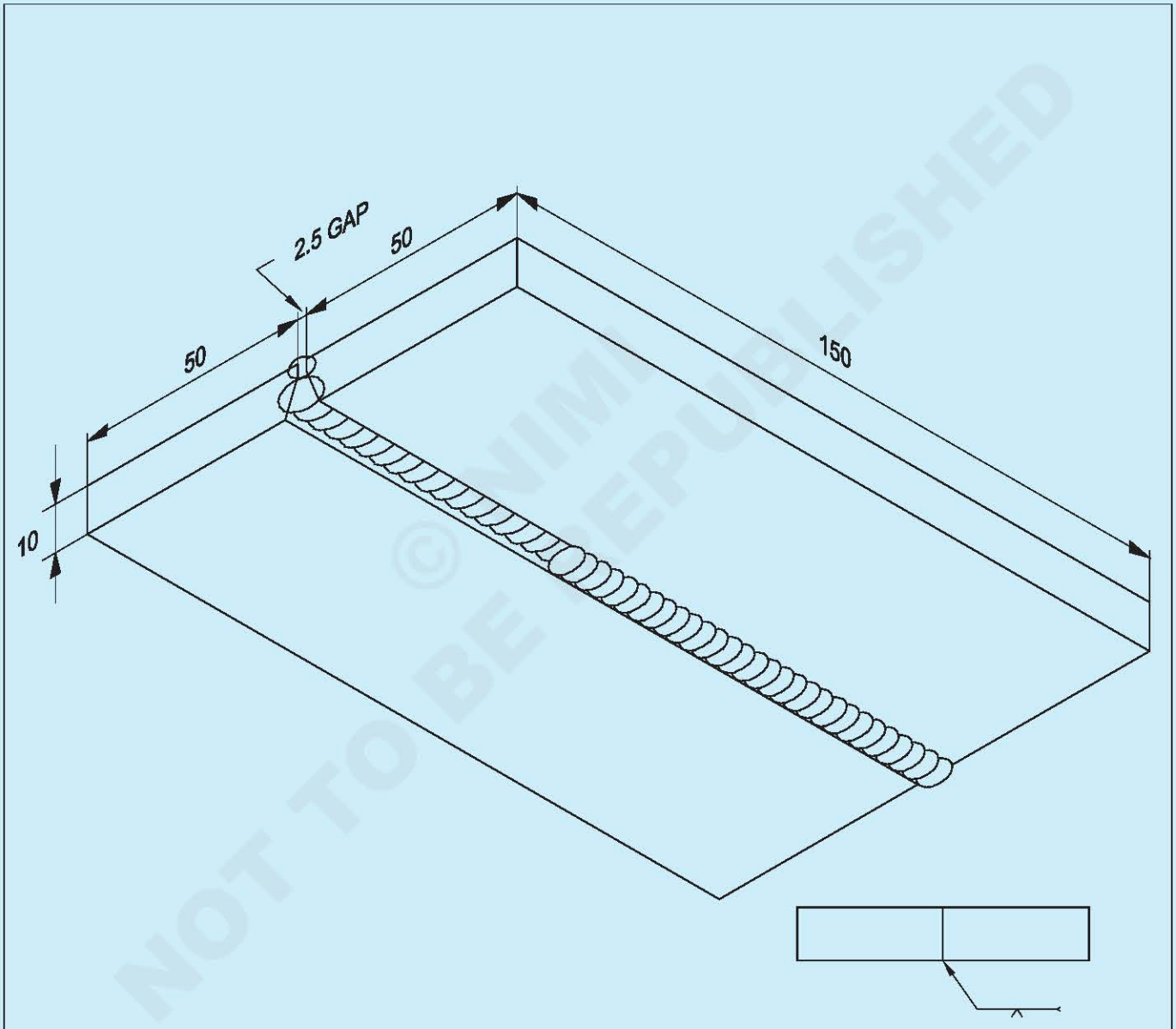
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Single "V" butt joint on MS plate 10mm thick in over head position (4G)-(SMAW-22)

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

- **select electrode, current, polarity and arc length**
- **preset and tack the beveled plate with root gap**
- **place the joint in overhead position**
- **deposit root run, 2nd run, 3rd run**
- **Clean the weldment and inspect for surface defects.**

Scan the QR Code to view the video for this exercise



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2	50 ISF x 10 - 150	-	Fe 310 - W	-	-	1.3.50
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	SINGLE 'V' BUTT JOINT ON M.S. PLATE 10mm THICK IN OVERHEAD POSITION.				TOLERANCE ±1	TIME
					WL20N1350E1	

Job Sequence

- Prepare the plates to size as per drawing.
- Clean the beveled plate.
- Use spacers, maintain 2.5 mm root gap, tack one end and adjust the gap and tack the other end.
- Preset the plates 3° to take care of distortion as done.

Ensure safety apparels are worn.

- Arrange the work piece in overhead position.
- Select a 3.15ø mm M.S. electrode and set 110 amps current.
- Weld the root run with short arc with uniform welding speed, so that a uniform root penetration can be obtained.
- Chip the slag and inspect the weld.

Use a pair of tongs to hold hot jobs.

Use a chipping hammer and wire brush for cleaning.

Use chipping goggles for protection of eyes.

- Deposit second covering run with a weaving motion.
- Use a 3.15 mm electrode with 110 amps current.
- Deposit the third covering run similar to the second run.

Skill Sequence

Single 'V' butt joint on MS plate 10mm thick in over head position

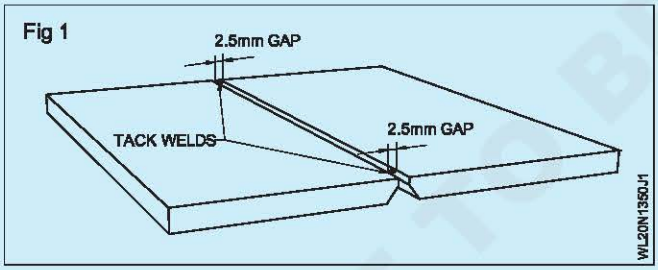
Objective: This shall help you to
- **prepare and weld single 'V' butt joint on MS plate 10mm thick in over head position.**

This type of joint is used very extensively for welding huge structures as in rail coach, ship building industries and earth moving equipment manufacture and for welding big structures and huge pipes at side.

Setting and tacking

Set the pieces as single V butt joint with 2.5 mm root gap. (Fig 1) Tack at both ends.

Fig 1



Use a 3.15 mm ø M.S. electrode and set a current of 100° amps.

Preset the plates

Fix the work piece in the overhead position. (Fig 2)

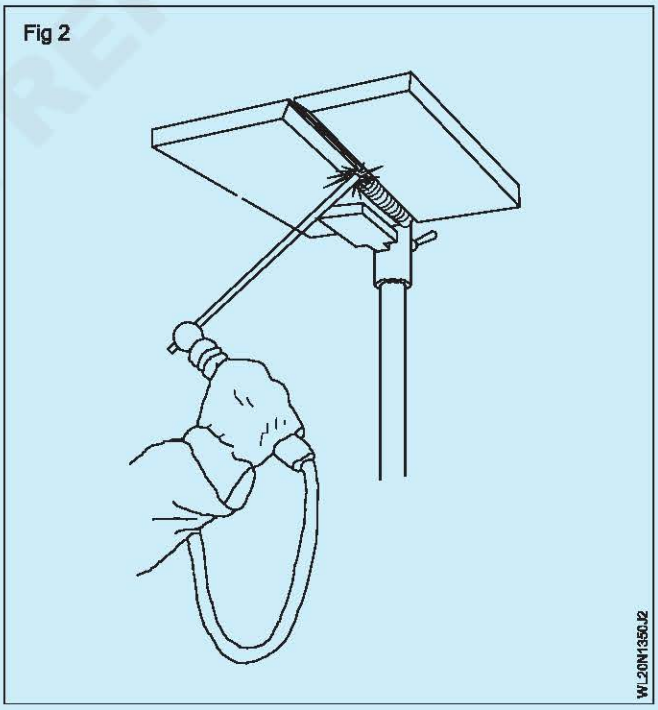
Adjust it to a suitable height.

Use a light welding cable to reduce the load on your arms.

Weld root run

The electrode should be kept as near as possible and square to the surface of the plate and at a small angle to the direction of the weld. (Fig 3) Keep the electrode well up in the gap and control the 'keyhole' to get a small reinforcement on the weld on the root side. (Figs 3 and 4)

Fig 2



Keep a short arc length. (Fig 4)

Control the slag. The slag must not drop into or flood the weld pool.

Weld up to the end of the work piece, chip off the slag after cooling and inspect the weld.

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Fig 3

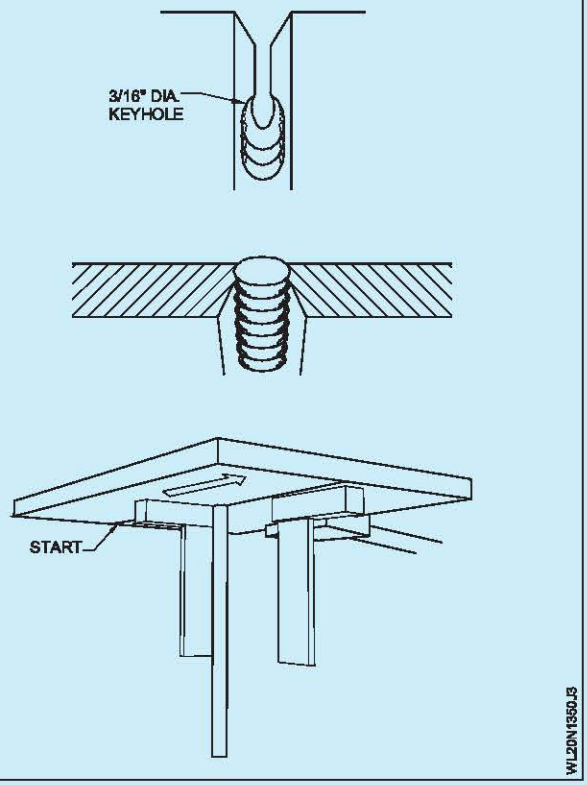
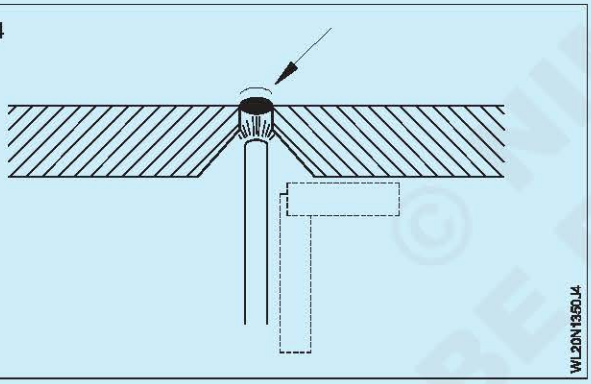


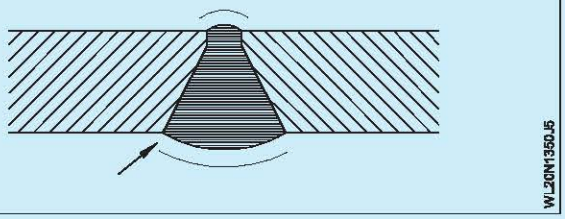
Fig 4



Weld second and third passes

Select a 3.15 electrode and set 100 amps current. Use weaved beading technique. The electrode should be moved across the face of the weld. (Fig 5)

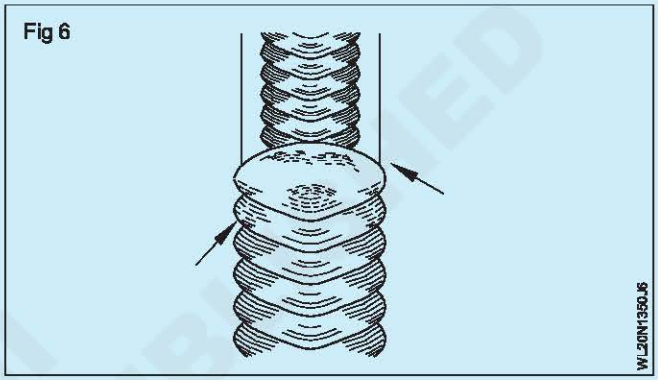
Fig 5



Do not deposit too much metal in the center of the bead causing it to sag in the center.

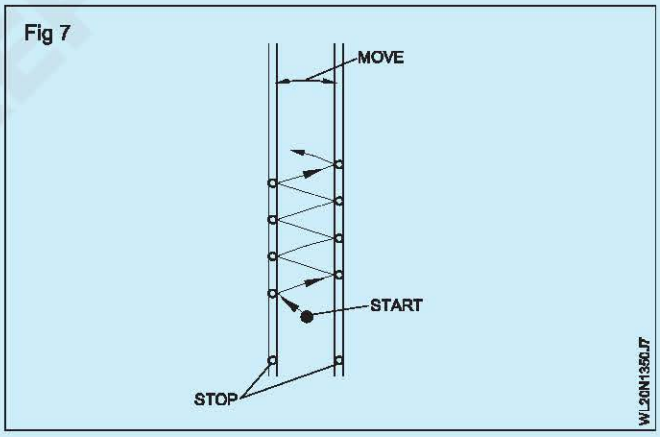
The side-to-side movement should be kept within the required weld size. (Fig 6)

Fig 6



Stop a while at the sides of the weld to prevent undercut. (Fig 7)

Fig 7



Chip off the slag and inspect the weld.

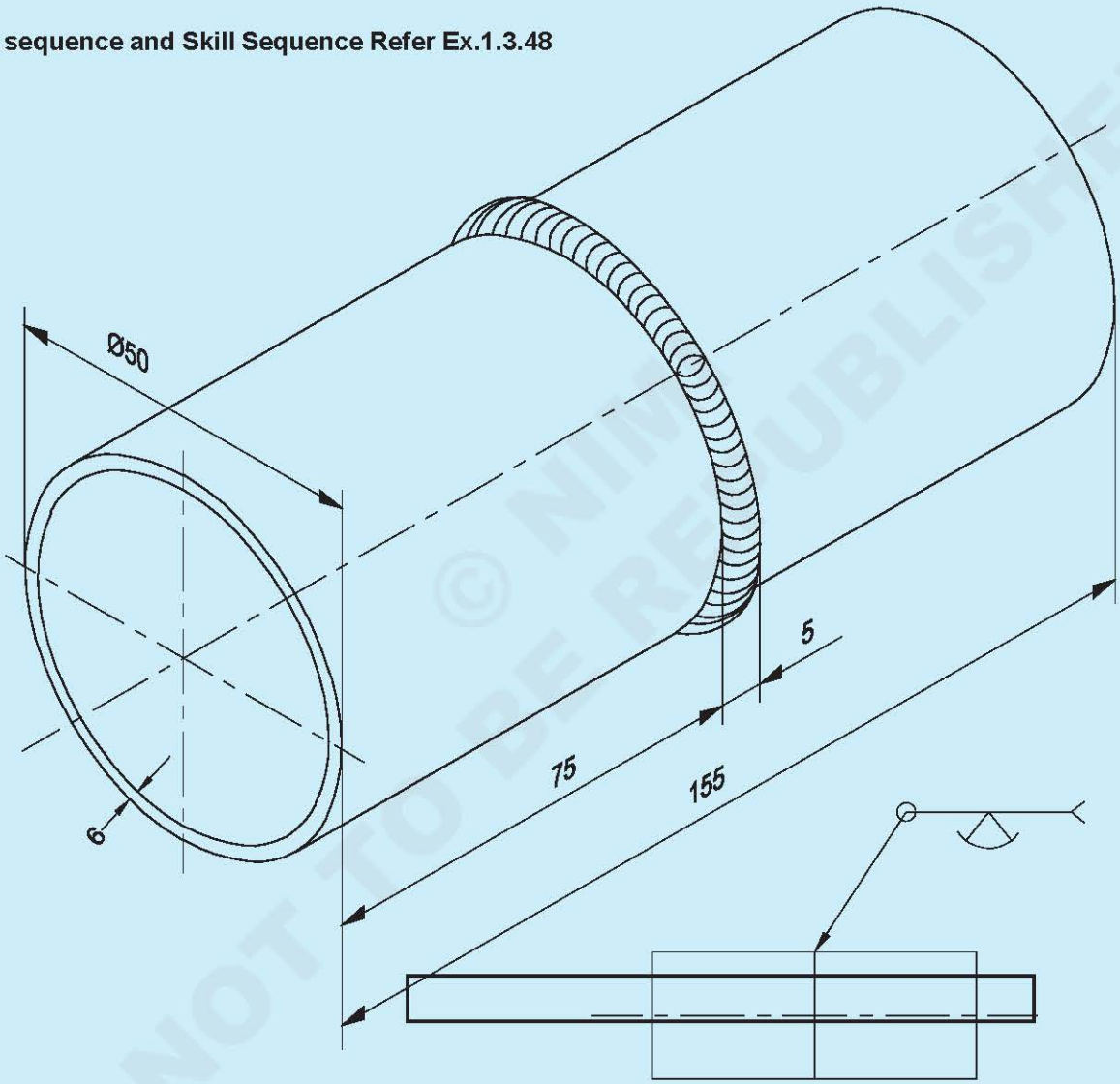
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Pipe butt joint on MS pipe ø50mm wall thickness 6mm (1G Rolled) position (SMAW-23)

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

- **cut and bevel the pipe as per drawing**
- **tack weld for butt welding**
- **make root 2nd and 3rd weaving run by rotation method**
- **clean the job and inspect for defects.**

Job sequence and Skill Sequence Refer Ex.1.3.48



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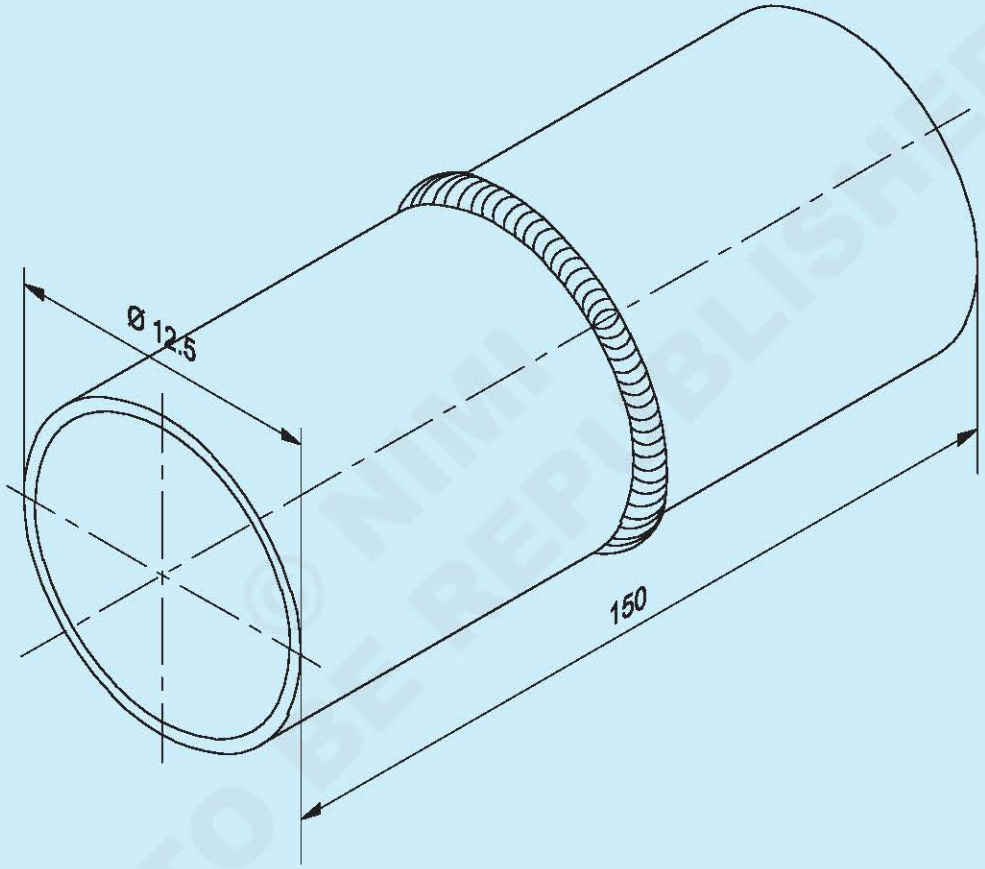
2	Ø50 x 6 - 75	-	Fe 310 - W	-	-	1.3.51
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PIPE BUTT JOINT ON M.S. PIPE Ø 50mm x 6mm WALL THICKNESS IN 1G (ROLLED) POSITION	TOLERANCE ±1	TIME
		CODE NO. WL20N1351E1	

Butt joint of copper pipe 1/2" by brazing process by induction welding machine OAW-17

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

- **to braze copper pipes with induction**
- **to replace flame operation of 12.5mm copper pipe mm.**
- **deposit root 2nd and 3rd run in flat position**
- **clean and inspect the defects**



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2	Ø12.5 x 6 - 75	-	COPPER	-	-	1.3.52
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	BUTT JOINT OF COPPER PIPE 1/2" BY BRAZING PROCESS -INDUCTION WELDING MACHINE (OAW-17)	TOLERANCE ±1	TIME
		CODE NO. WL20N1352E1	

Job Sequence

- Keep parameter of induction welding machine power is 10K.W frequency 10k.
- Sample is held in position by press clamp.
- Brazing alloy is applied.
- Hand held "U" blaze gun is manually applied to the joint.
- Initially heat the tube around 4.5sec and brazing time is appearing to be 7 sec.
- With precession of tuning of process 5 to 6sec can be achieved.

Heating provides:

Strong durable joints. (Fig 1)

Fig 1



Selective and precises heat zone, resulting in less part distortion and stress. (Fig 2)

Fig 2



Skill Sequence

Induction welding machine

Objective: This shall help you to

- **prepare the pipe butt joint on MS pipe wall thickness position.**

Material: Copper tubing 3/16' (4.76) OD, 1/8" (3.18mm) II) and slightly larger

Stainless steel Teflon coated mandrel 1/8" (3.18 mm) diammeter

Temperature: 350° f (177 °C)

Frequency: 352 kHz

Equipment power of 6k W induction heating system, equipped with a remote work head containing two 33 F capacitors (for a total of .66F)

Induction heating coils designed and developed specifically for this application.

Process for the butt joint two tubes of the same diameter with differing degrees of hardness are used. The tubes are slipped onto the Teflon coated mandrel and a short length of shrink tubing is placed over the tubes. Hot air is blown over the shrink tubing to gently heat it. The assembly is placed in the center of a three tum pancake coil and heated for 8 seconds.

Advantages of Induction heating arc:

- Heating of the mandrel is from the inside out providing a smooth finish on the outside of the assemblies.
- Precise, repeatable application of heat.
- Ambient temperature factors do not affect the process
- No over heating

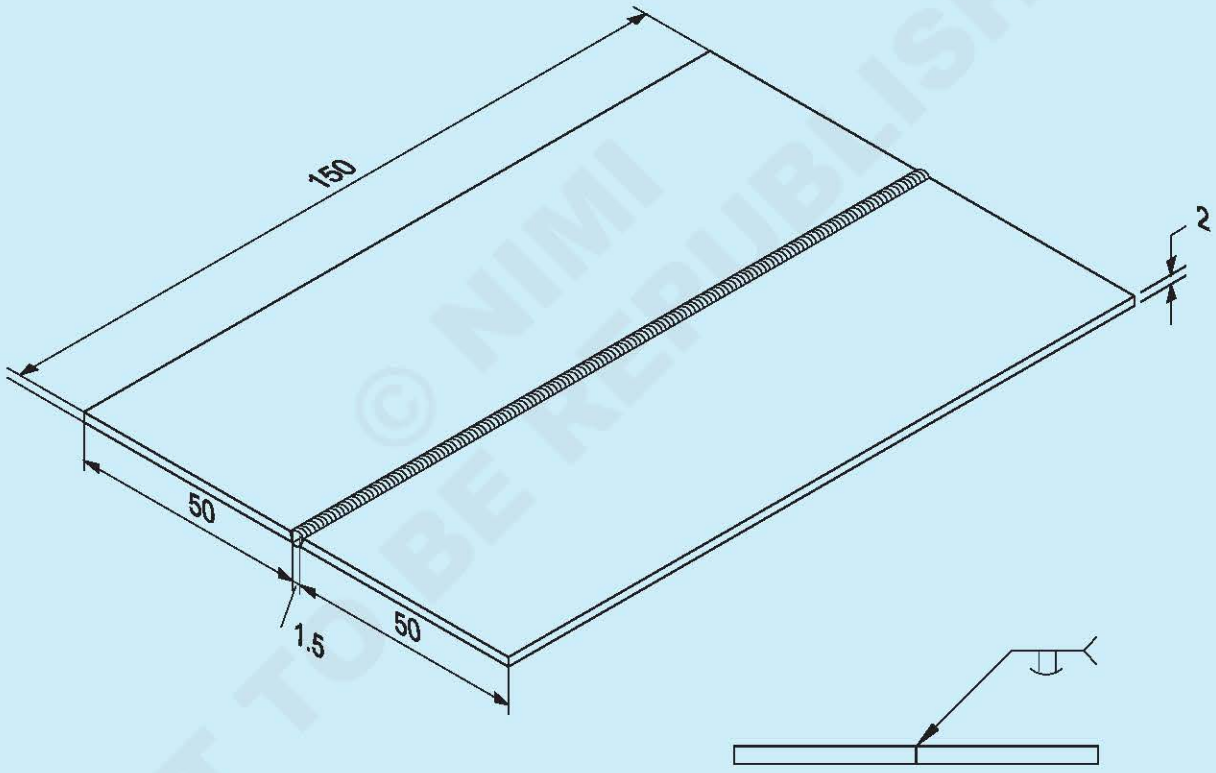
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Exercise 1.3.53

Square butt joint on stainless steel sheet 2mm thick in flat position (1G) (SMAW-24)

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

- **prepare square edges on stainless steel sheets as per drawing**
- **select suitable stainless steel filler rod, nozzle, gas pressure and flux**
- **set a perfect neutral flame and tack weld**
- **weld the square butt joint using leftward technique**
- **clean the joint and inspect for weld defects.**



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2	150 x 50 x 2	-	X 04 Cr19 Ni9	-	-	1.3.53
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	SQUARE BUTTJOINT ON STAINLESS STEEL SHEET 2mm THICK IN FLAT POSITION.(1G)-(SMAW-24)	TOLERANCE ±1	TIME
		CODE NO. WL20N1353E1	

Job Sequence

- Prepare the stainless steel sheet as per dimensions.
- Clean the edges of the sheets.
- Select the nozzle No. 5 for 1.6mø ccms filler rod.
- Select the stainless steel flux and apply on both sides of the edges of the joint.
- Set and align the stainless steel sheet as square butt joint.
- Set perfect neutral flame.
- Tack-weld at every 50mm length of the butt joint.
- Weld the joint using leftward technique.
- Clean the joint and inspect the weld for defects.

Skill Sequence

Square butt joint on stainless steel sheet 2mm thick in flat position

Objective: This shall help you to

- **prepare and weld square butt joint on stainless steel sheet 2mm thick in flat position.**

Refer Exercise.No. 1.2.25

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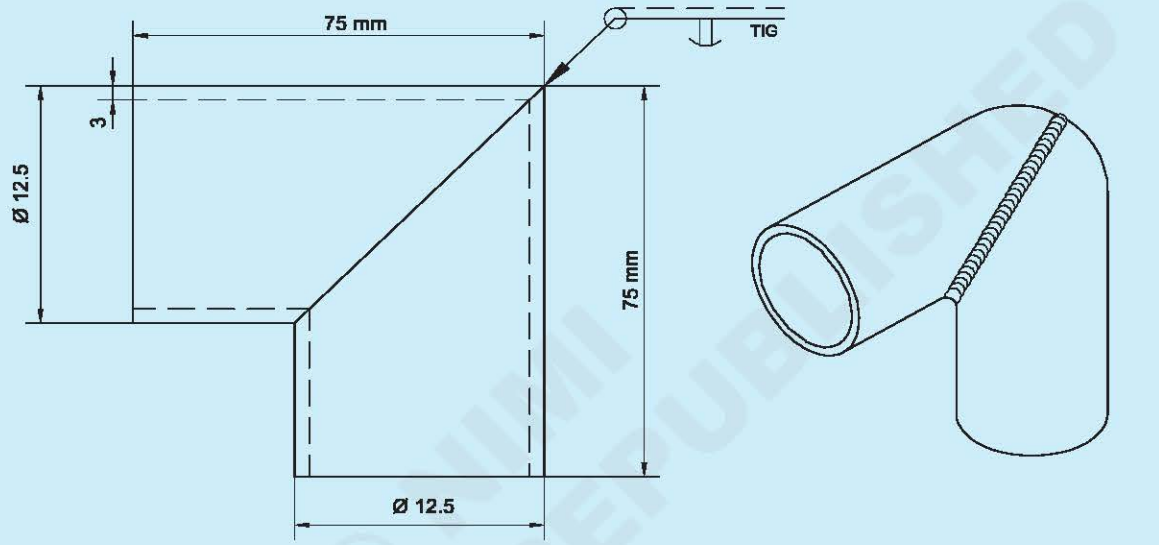
Exercise 1.3.54

Corner /Tee joint of copper pipe of 1/2" and of length 75mm (OAW-18) and Braze tee joint on copper tube 1/2" and of length 75mm

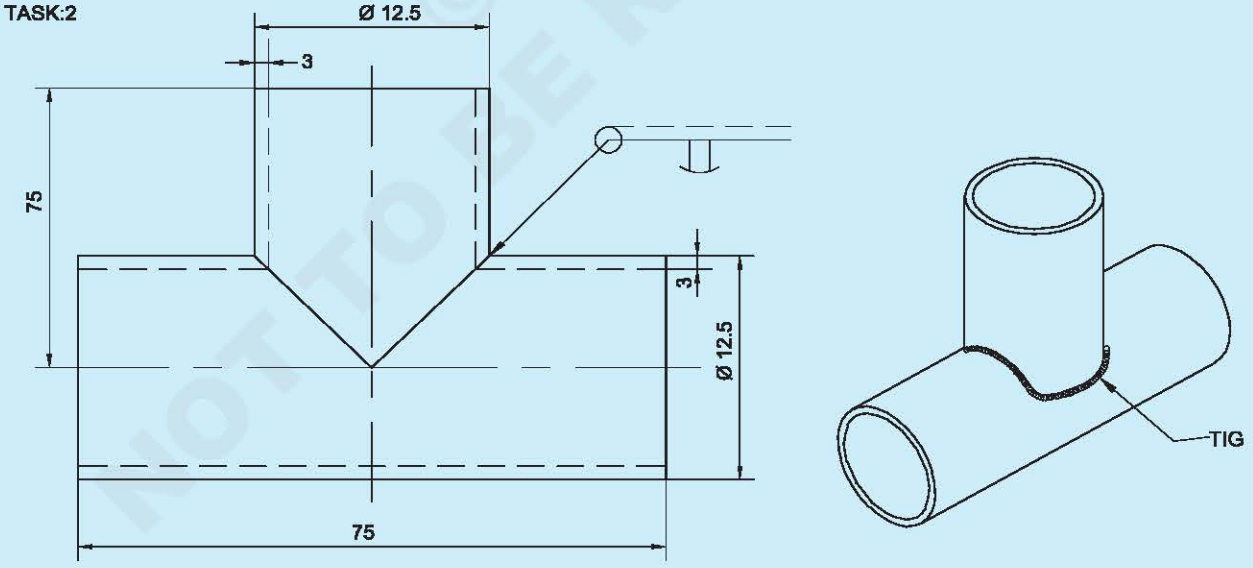
Objectives: At the end of this exercise you shall be able to

- **draw the development of corner and Tea joint**
- **prepare the jobs as per drawing**
- **braze corner and Tee joint**
- **clean and inspect the surface defects.**

TASK:1



TASK:2



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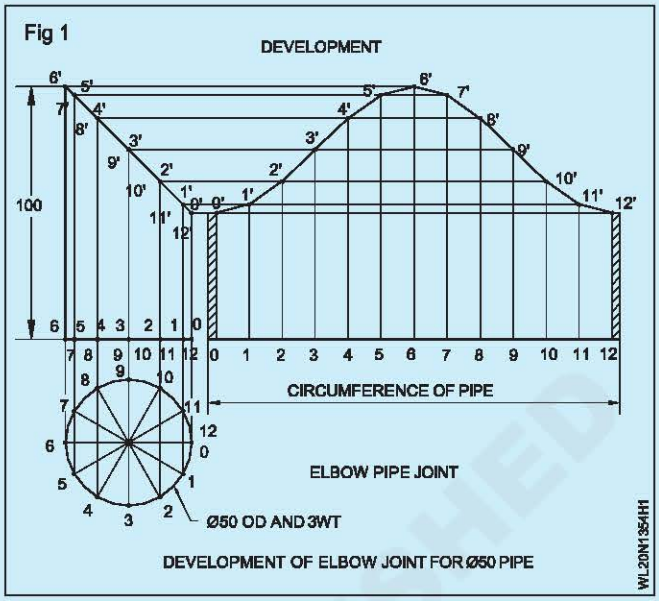
2	Ø12.5 x 75mm		COPPER PIPE	CUDPA - IS 2378		1.3.54
4	1/2" - 75mm		COPPER TUBE			1.3.54
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**BRAZE CORNER/TEE JOINT ON COPPER PIPE OF 1/2" OF LENGTH 75mm (OAW-15)**	TOLERANCE	TIME
	CORNER/TEE JOINT OF COPPER TUBE OF 1/2" OF LENGTH 75mm - COPPER (OAW-18)	WL20N1354E1	

Job Sequence

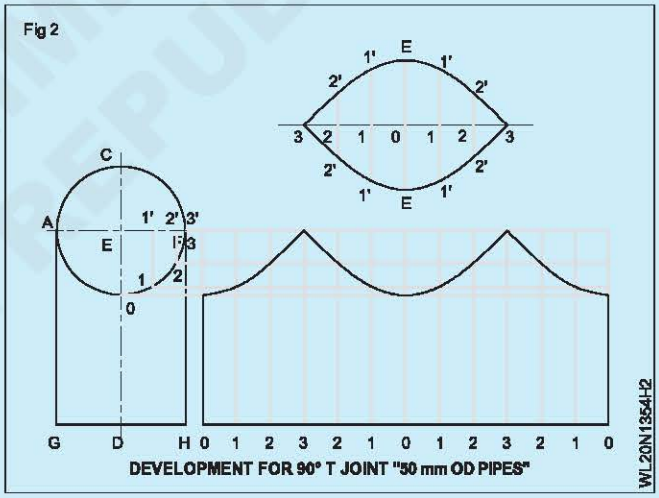
TASK 1: **Draw the development of corner and Tea joint**.

- Cut the tubes of gives size
- Draw the development for corner joint
- Mark the development on the types and cut accordingly.
- Deburr the cutting edges by filling
- Clean the surface of tube
- Set and aligned the tube valves to and angle 90° at
- Braze the joint without root gap to control distortion and to keep the joint in alignment
- Inspect the joints for surface defects



TASK 2: **Draw the development of corner and tea joint**

- Cut the pipes to the given size
- Breach pipes in copper may be produced by cutting to the marked outline.
- After cutting to the length remove any burrs on the pipe by filling.
- Ensure the correct size at the pipe
- Prepare development for 90° branch
- Mark the development on the pipe and cut accordingly
- Clean the surface at the pipe
- Set and align the branch pipe with main tube at an angle of 90°
- Brazed joint without root gap to obtain penetration.
- Braze tee joint on copper tube ½ on length 75mm 19-rolling position.



- One difficulty encountered with tube brazing is the distortion or mis alignment at the tubes after brazing is completed.
- One difficulty encounter with corner brazing is distortion causing the corner angle reduced from 90°

Skill Sequence

Braze tee joint on copper tube

Objective: This shall help you to

- **braze tee joint on copper tube 1/2 on length 75mm 19-rooling position.**

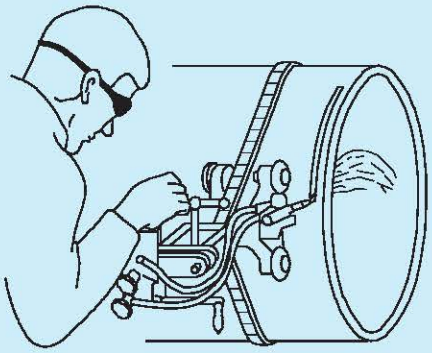
One difficulty encountered with all pipe and tube welding is the distortion or misalignment of the pipes/tubes after welding is completed. One, very frequently used method to prevent or reduce distortion is to clamp the pipes or tubes in a fixture while welding and allow it to cool before removing the clamps.

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Tube welding is similar to thin sheet metal welding except the weld joint is a three dimensional curve, as in pipe welding. Also, since the root of the weld is not accessible and because the inner surface is in contact with flowing fluids, the penetration standards are high. Two common tube welding faults are too much penetration and lack of penetration. These faults must be repaired before the tubing can be used.

In pipe welding other than butt joint - it is very essential to get a development and prepare the template for the appropriate joints.

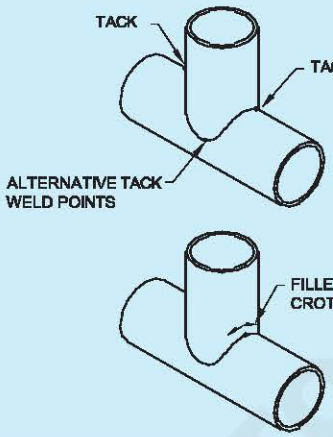
Fig 3



ROTATED PIPE-CUTTING HEAD

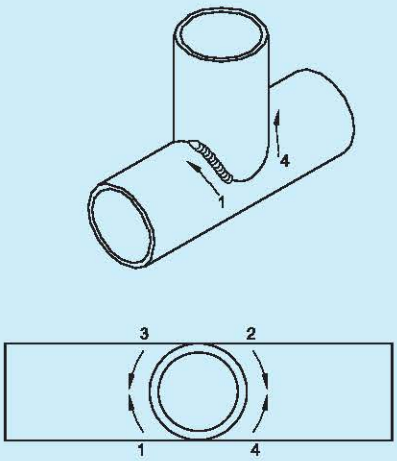
WLN2285H3

Fig 5



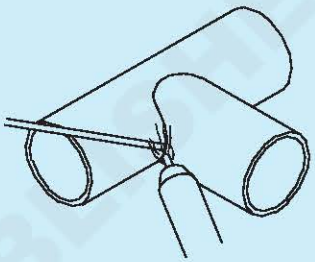
WL20N1354H5

Fig 6



WL20N1354H6

Fig 7



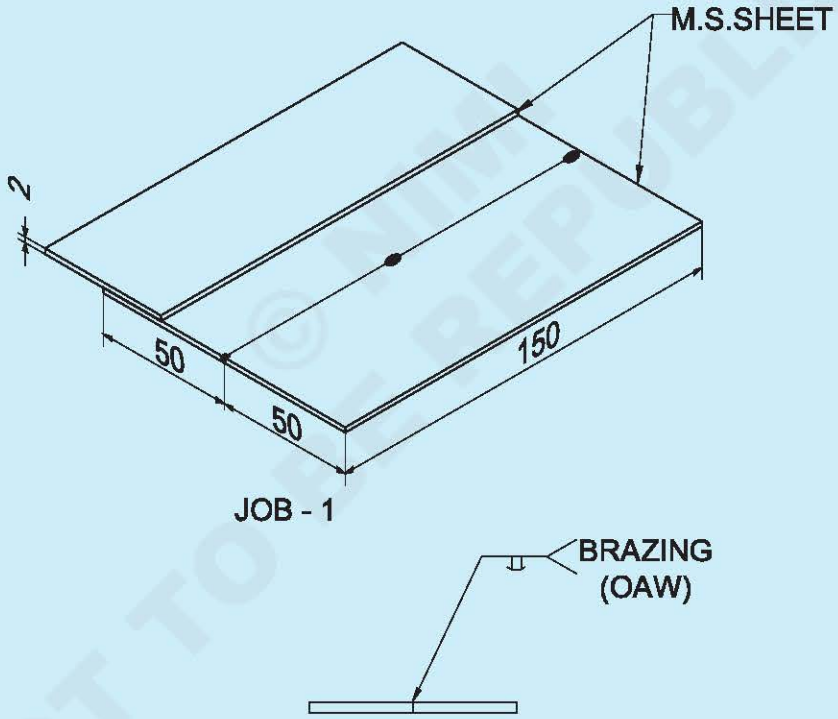
WL20N1354H7

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Square butt and lap joint on M.S. sheet 2mm thick by brazing in flat position (OAW-19)

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

- **prepare the jobs as per drawing**
- **select nozzle filler rod and flux**
- **set oxidizing flame and tack weld**
- **deposit bead by using leftward technique**
- **clean and inspect for surface defects.**



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3	ISST 50 x 2 - 150	-	Fe310 - W	-	-	1.3.55
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
		CODE NO. WL20N1355E1	

Job Sequence

- Cut the sheets as per drawing and file the edges to be joined square.
- Clean the joint area.
- Set the sheets as a square butt joint without root gap
- Select nozzle, filler rod, gas pressures, flux.
- Set oxidizing flame.
- Use leftward technique.
- Preheat the sheets and joint area to about 800°C.
- Dip the hot filler rod in flux and melt the filler rod into the joint ensuring proper wetting conditions.
- Avoid application of too much heat into the joint.
- Finish the joint in one run only.

Skill Sequence

Brazing of square and lap joint on MS sheet of 2mm thick

Objective: This shall help you to
- **prepare and brazing of square and lap joint on MS sheet of 2mm thick.**

Brazing of MS sheet (Job-1)

Oxidizing flame is used to avoid evaporation of zinc while brazing. Fig 1

The blow pipe and filler rod is held at angles as shown in Fig 1.

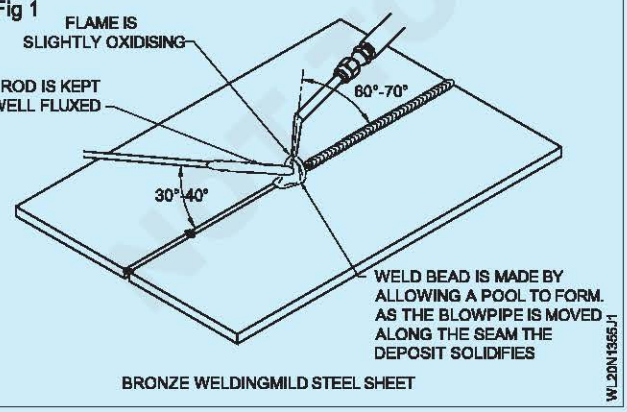
A No. 3 size nozzle with 0.15 kg/cm^2 pressure for both gases is used as the base metal is not melted, but heated to around 800°C.

A 1.6mmø silicon bronze filler rod is used which helps free flow of molten filler metal.

Direct the flame to the joint edges and tack weld at the ends and center of the joint. Fig 1.

Preheating the sheets to the correct temperature helps in proper wetting/spreading of the filler metal into the joint to get good bonding. Fig 1

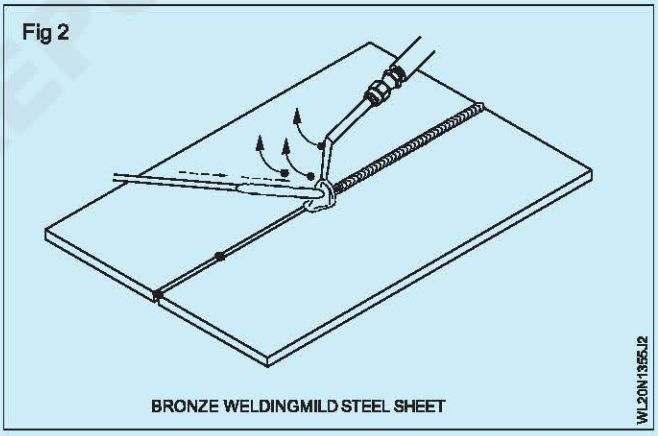
Fig 1



The flame has to be directed only on the melting filler rod or the weld deposit in order to prevent oxidation or over-heating of MS sheet.

After establishing the molten pool, the flame is withdrawn slightly (Fig 2) to permit the deposited metal freeze partially. Again reintroduce the filler rod to melt further deposit. Observe the brazed area carefully to ensure proper bonding is obtained and a uniform weld size is achieved.

Fig 2



To avoid crater at the end of the weld the filler rod is continued to be added into the molten pool at the finishing point and the flame is withdrawn.

It is essential to remove any unused and residual flux on the finished weld to avoid corrosion later on.

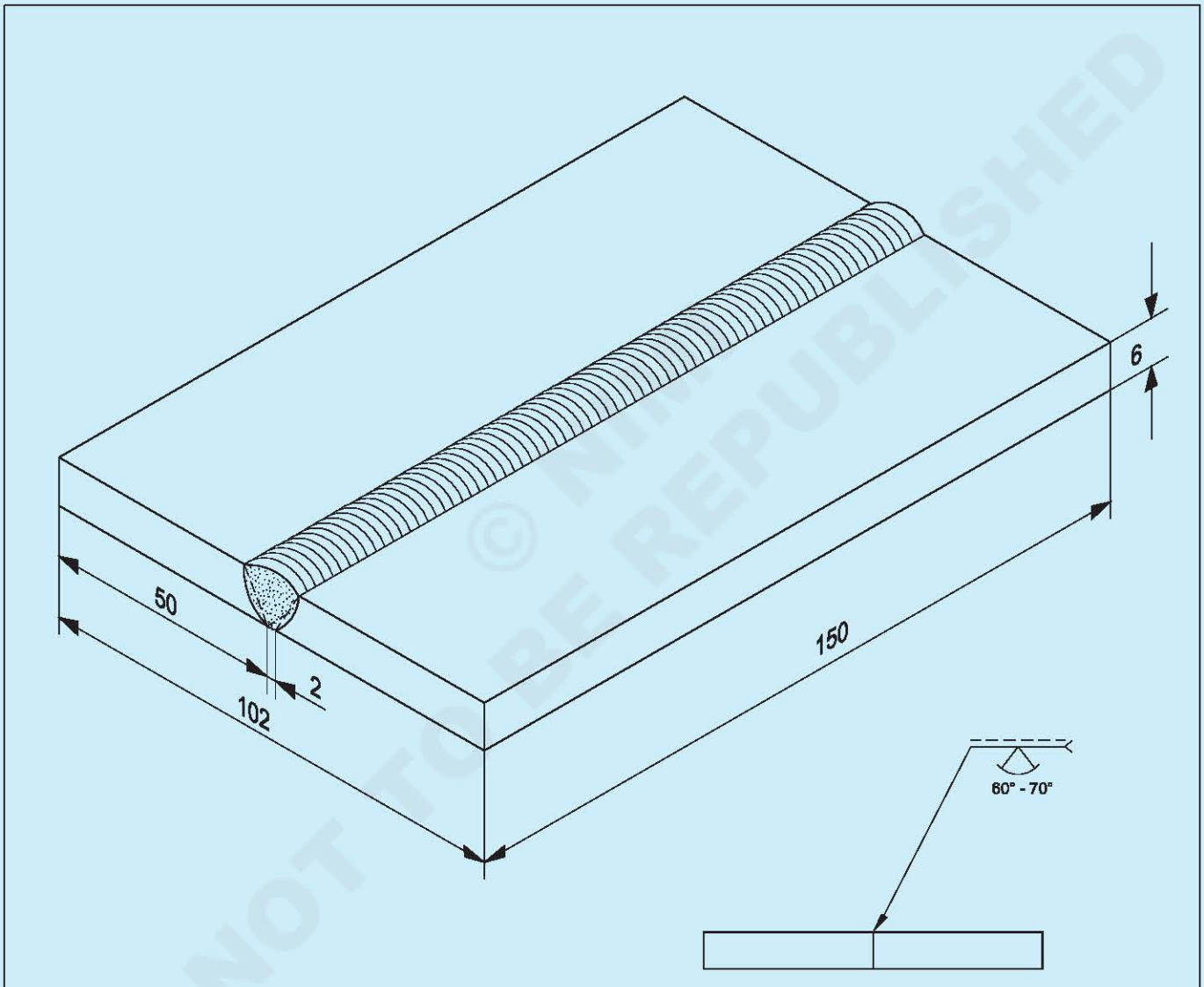
Check the joint for proper bonding of filler metal with the base metal and proper root penetration by the filler metal. Check for weld defects like surface porosity, etc.

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Single "V" butt joint on cast iron plate 6mm thick in flat position (1G) (SMAW-25)

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

- **prepare the edges, set the cast iron plates and tack weld**
- **preheat and post heat the joint**
- **select the electrode and current**
- **deposit root run, second and third runs without crack**
- **inspect the joint for defects.**



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2	150 x 50 x 6	-	FG 15	-	-	1.3.56
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	SINGLE VEE BUTT JOINT - ON CAST IRON PLATE	TOLERANCE ±1	TIME
		CODE NO. WL20N1356E1	

Job Sequence

- Bevel the edges to 30° angle by grinding (or) filing maintain root face to 2mm.
- Keep the plates in alignment in flat position maintain a root gap of 2mm.
- Select low hydrogen type E7016 (or) E7018 electrode 3.15mm size and use DCEP polarity i.e., connect the electrode cable to the positive terminal of the machine.
- Follow necessary safety precautions.
- Preheat the job to 300°C using an oxy-acetylene torch and check the temperature using a thermos chalk and tack weld on both ends using low hydrogen electrode.
- Keep the tack welded joint in flat position.
- Deposit the root run using ø3.15mm low hydrogen M.S. electrode ensuring root penetration.
- Clean the root run. Deposit 2nd and 3rd run using slight weaving and digging motion.
- Maintain minimum interposes temp 200°C throughout and also peen the weld bead by ball peen hammer to remove internal stress concentration for every run.
- Post heat the job if required and cover it in dry sand or ash to allow to cool slowly.
- Clean the weld and inspect it for cracks, proper fusion and other surface defects.

Skill Sequence

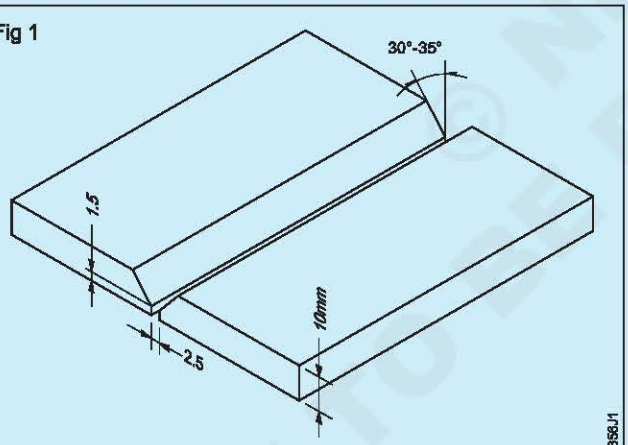
Single "V" butt joint on cast iron plate 6mm thick in flat position

Objective: This shall help you to

- **prepare the 'V' joint on cast iron plate thick in flat position.**

Bevel the edges: Bevel the edges to 30° angle by machining or filling. Maintain the root face 1.5 mm (Fig 1) avoid sharp edges as it may get chipped off if not handled properly.

Fig 1



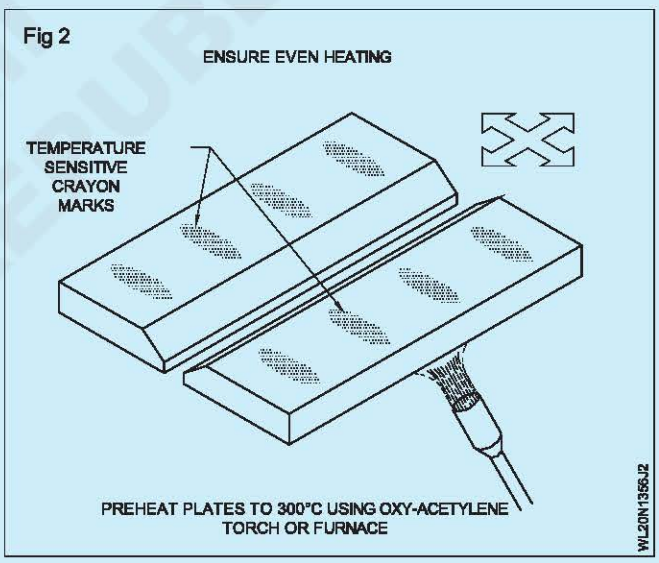
PREPARE EDGES BY FILING, GRINDING OR MACHINING AND SET PARALLEL 2.5mm APART

Set and tack weld: Keep the job parallel in flat position and maintain the root gap 2.5 mm.

Preheat the job: Preheat the job at 300°C by using an oxy-acetylene flame. (Fig 2) Check the temperature by using a thermos chalk. (Figs 3a & 3b) Tack weld on both ends. (Fig 4)

Deposition of runs: Select a M.S. electrode (low hydrogen) 3.15 mm dia. and set the current at 130-140 amps with DCEP. (Electrode +ve) Deposit root run with electrode angle of 80° to the line of weld with medium arc length. AVOID SHORT ARC.

Fig 2



PREHEAT PLATES TO 300°C USING OXY-ACETYLENE TORCH OR FURNACE

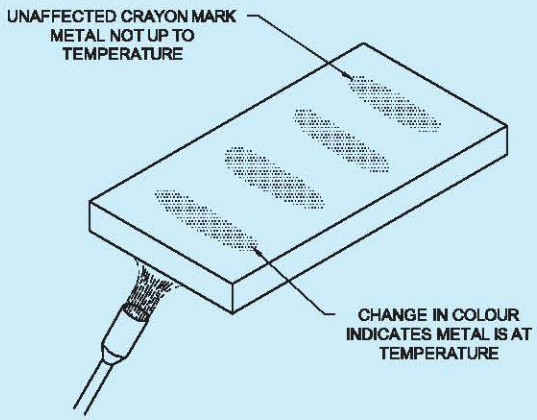
Clean the root run by a wire brush. Deposit the second the by using a 3.15 mm dia. electrode with slightly weaving motion and keep the electrode angle 80° to the line of weld. Move the electrode with a digging action. Since fluidity of cast iron is less, to make the molten metal to flow into the joint easily the electrode has to be given a digging action.

Clean the second run by a wire brush.

Deposit the third run by using a 3.15 mm dia. electrode with a slight weaving motion. Keep the electrode angle at 80° to the line of weld. Peen the welded bead by a ball peen hammer to remove internal stresses. Post heat the job to preheating temperature. Keep the job under dry sand or ash and allow to COOL SLOWLY. Clean the weldment by using a wire brush.

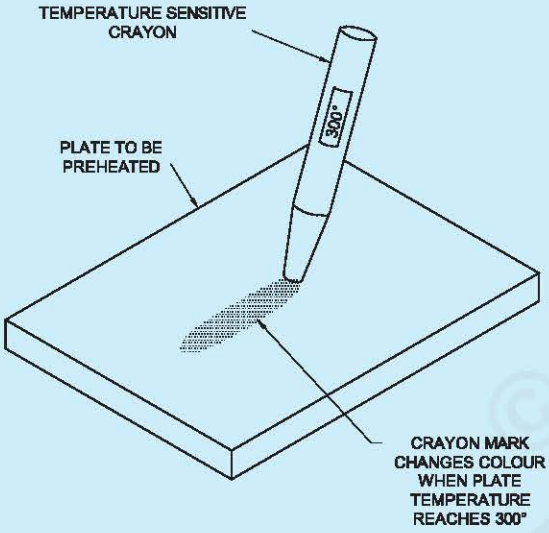
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Fig 3



USE OF TEMPERATURE SENSITIVE CRAYON
FOR TEMPERATURE MEASUREMENT

(3a)

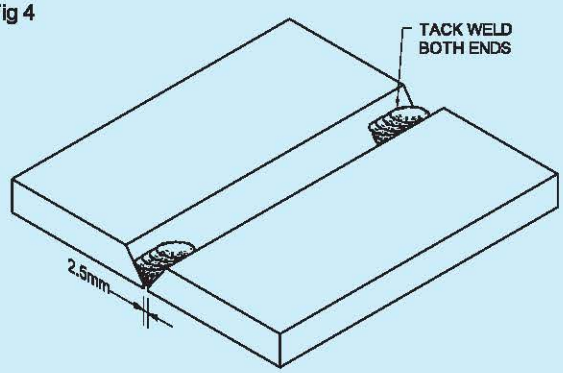


TEMPERATURE SENSITIVE CRAYON

(3b)

WI_20N1358J3

Fig 4



PREPARED PLATES SET UP FOR A SINGLE-V BUTT JOINT

WI_20N1356J4

The use of low hydrogen electrode and the preheating, post heating, peening and slow cooling are essential to avoid cracks in the cast iron joint.

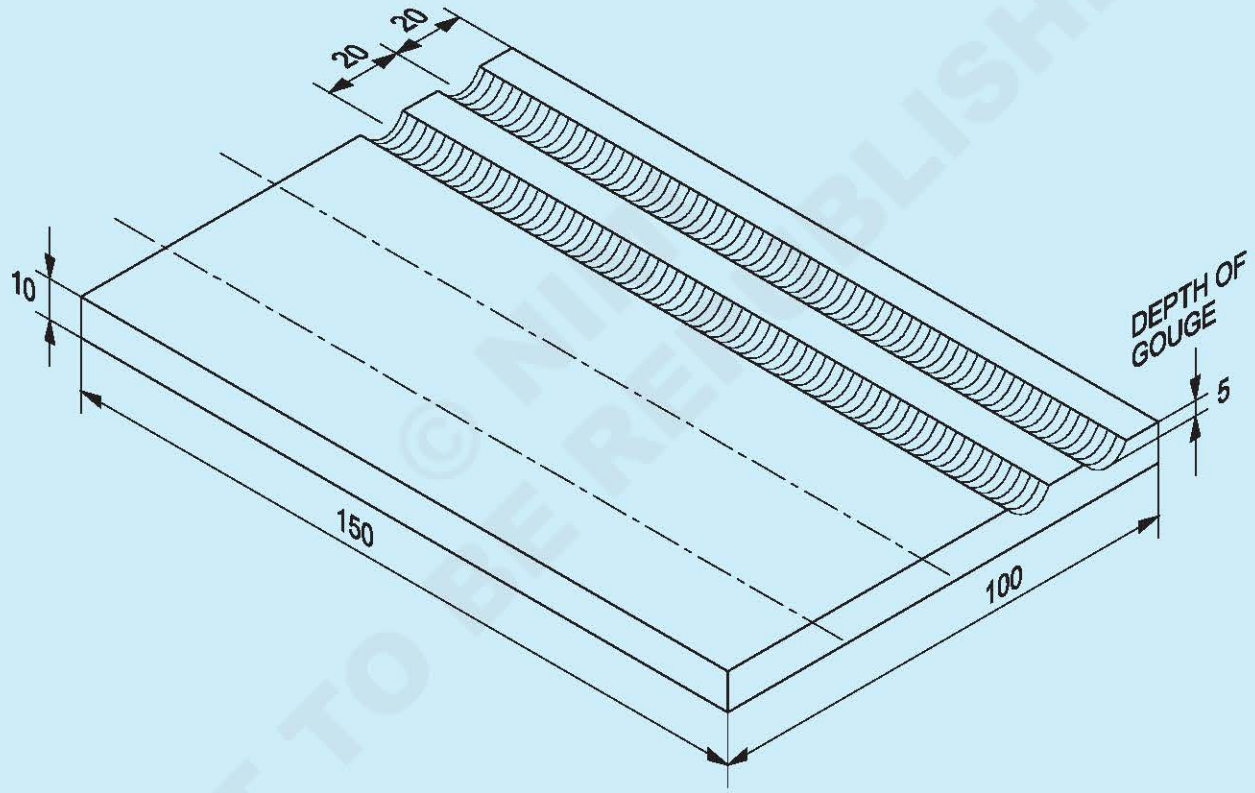
Inspect the welds: Inspect the welds for proper fusion, cracks and other surface defects.

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Arc gouging on MS plate 10mm thick (AG-01)

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

- **select the electrode and set the current as per requirements**
- **start and maintain gouging action**
- **clean and inspect the gouging.**



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1	100 ISF 10 - 150	-	Fe310 - W	-	-	1.3.57
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	ARC GOUGING ON M.S.PLATE 10mm THICK IN FLAT POSITION.	TOLERANCE ±1	TIME
		CODE NO. WL20N1357E1	

Job Sequence

- Mark and cut the pieces as per the given size.
- Mark and punch the straight line.
- Keep the plate in down hand position.
- Use 4mm dia electrode for 10mm thick plate and select DC electrode negative (DCEN).
- Set 300 amps current for both AC or DC machines and select DCEN if DC is used.
- Start from edge of the plate keeping a slant angle.
- When molten metal is established reduce the angle further to gouge and remove surface metal.
- While gouging is in progress remove molten metal and slag away from the arc and gouged groove.
- Move the electrode fast and control the gouging action.
- Complete the operation and clean the gouging surface.
- Inspect the groove for smoothness, even depth and uniformity.

Skill Sequence

Arc gouging on MS plate 10mm thick

Objective: This shall help you to
- **prepare and arc gouging on MS plate.**

Prepare the pieces: Mark and cut the pieces as per given sizes by gas cutting. Clean the surfaces. Mark and punch a straight line.

Position the plate down hand or flat.

Select the electrode and set the current.

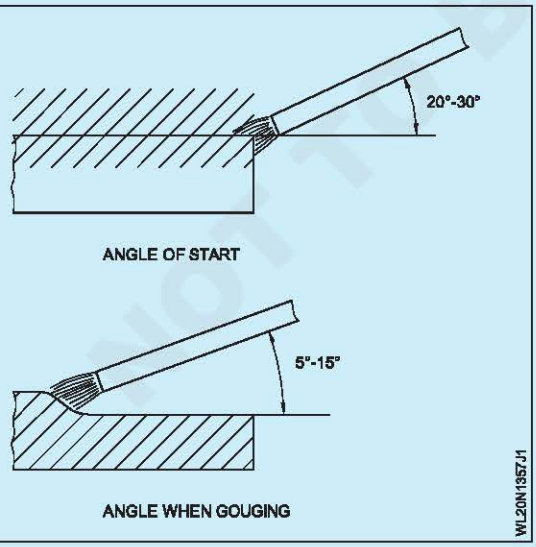
Select a 4 mm dia. gouging electrode for a 10 mm thick plate.

Set 300 amps current in AC or DC m/c and if DC is used set the (straight polarity) electrode negative (DCEN).

Gouging the plate: Point the electrode towards one end of the edge with an angle of 20°-30° and 90° to the rear surface of the plate. (Fig 1)

Strike the arc.

Fig 1



Wear a respirator while gouging.

As the molten pool is established, lower the electrode holder and reduce the angle between 5°-15° from 20°-30°.

Move the electrode along the line of marking from the right to the left side of the plate without side movement.

While gouging is in progress push the molten pool and slag away from the arc and the gouged groove.

Due to rapid fusion because of the arc, heat, move the electrode fast and control the gouging operation.

Ensure that the angle of slope is not too steep, and avoid grooving too deeply.

Use safety boots and leg guards to protect the legs.

Maintain the angle and travel of electrode constant so as to obtain a groove of uniform width and depth.

Clean the gouging surfaces.

Inspect the gouging.

Check the smoothness, depth and uniformity of gouging.

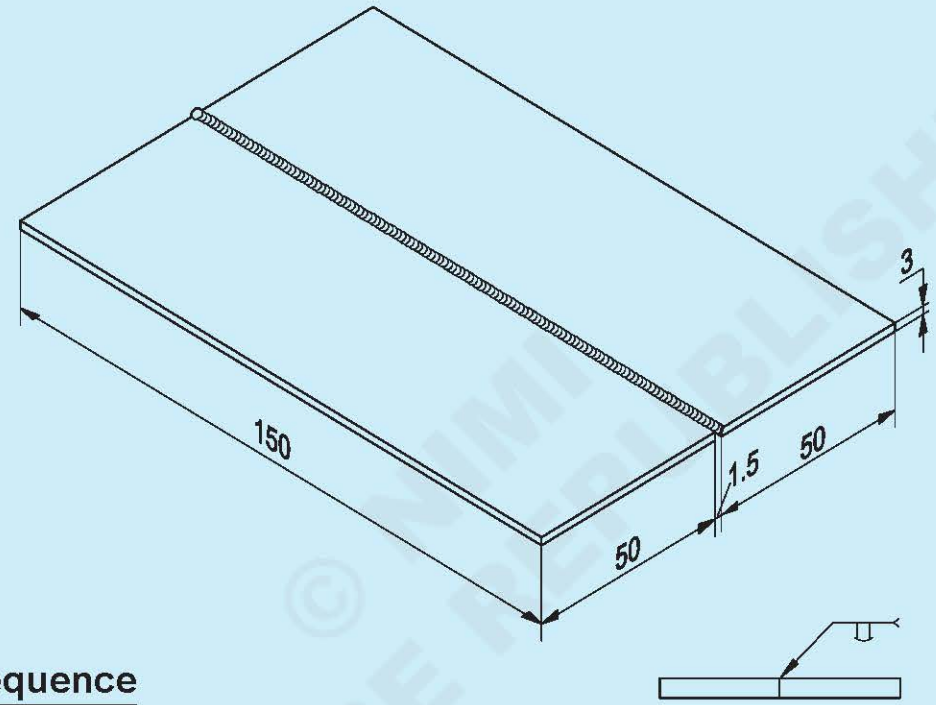
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Exercise 1.3.58

Square butt joint on aluminium sheet 3mm thick in flat position (OAW-20)

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

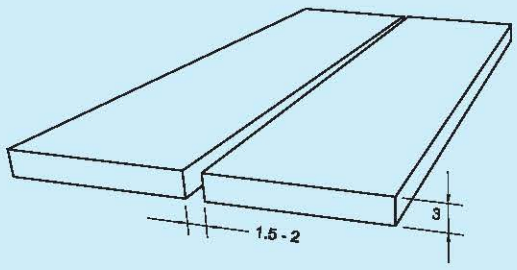
- **set the sheets with root gap as per drawing**
- **select filler rod, gas nozzle, gas, pressures and flux and flame**
- **tack weld preheat the job**
- **Deposit single run by using leftward technique**
- **inspect for weld defects.**



Job Sequence

- Prepare aluminium sheet as per dimension with square edges.
- Clean the surface and edges of the sheets to remove the surface oxide and other impurities using.
- Don't grind aluminium sheets in a grinding machine.
- Apply the pasty flux on the butting edges.
- Set the sheets with 1.5 mm - mm root gap. (Fig 1) As the thermal expansion of aluminium is more, the root gap can be set such that it increases at about 1mm per 100mm length of the joint for butt welds.

Fig 1



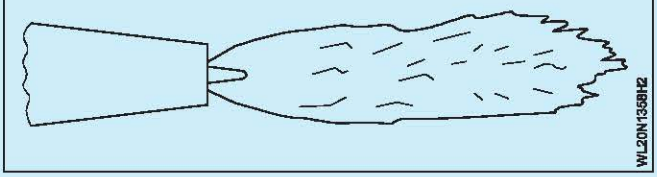
2	150 x 50 x 3	-	AL.199990-IS:737	-	-	1.3.58
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	SQUARE BUTT JOINT ON ALUMINIUM SHEET 3mm IN FLAT POSITION.	TOLERANCE ±0.5	TIME
		CODE NO. WL20N1358E1	

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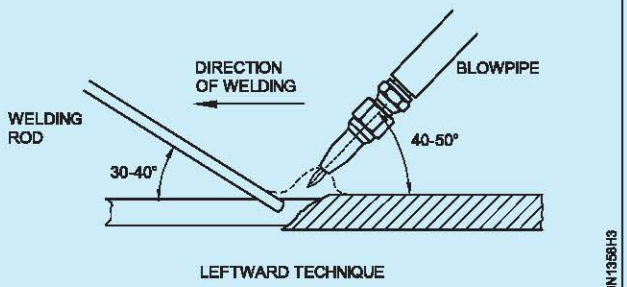
- Fix nozzle No. 5 on the blow pipe and adjust gas pressure of 0.15 kg/sq.cm^2 for both gases.
- Adjust a strict neutral flame. (Fig 2)

Fig 2



- Use silicon aluminium filler rod 3 mm ø and apply the pasty flux on the filler rod.
- Tack-weld at both ends of the joint and at the center.
- Preheat the job to a temperature of 150° - 180°C to reduce the effect of expansion during welding using the blow pipe flame itself.
- Start welding by the leftward technique by holding the blowpipe at an angle of 40° to 50° and the filler rod at an angle of 30° - 40°. (Fig 3)
- Do not remove the filler rod end from the outer envelope of the flame till the welding is over.

Fig 3



- Clean the weld by washing in a 10% sulphuric acid solution.
- Again wash the weld by rinsing in hot or cold water.
- No traces of flux should remain on the weld. It will cause corrosion, after completion of the weld.
- Inspect for weld defects.
- As the end of the joint is approached, reduce the blow pipe and filler rod angle and raise the inner cone. This is done to avoid burn through of the joint.

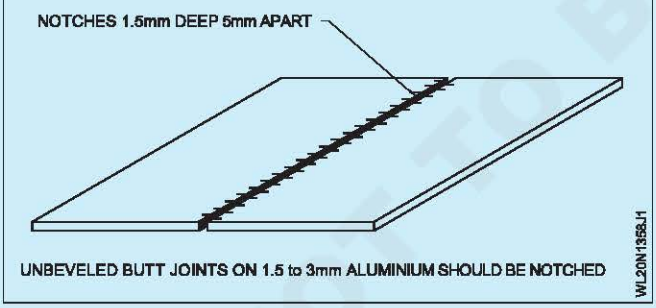
Skill Sequence

Square butt joint on aluminium sheet of 3mm thick

Objective: This shall help you to
- **prepare and weld square butt joint on aluminium sheet of 3mm thick.**

While preparing square edges make notches on the edges to be joined. Fig 1

Fig 1

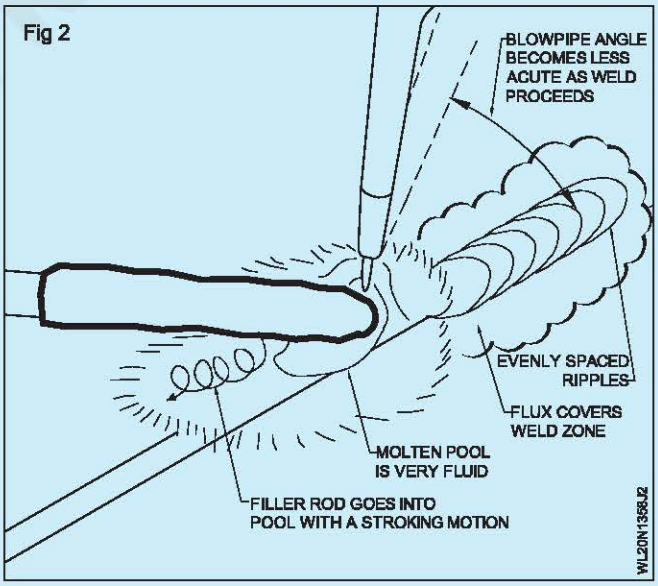


Since setting a strict neutral flame is difficult a very slight carburizing flame is set for welding aluminium.

While using leftward technique, the blow pipe angle will be reduced gradually as the welding progresses. Fig 2.

As there is no colour change when aluminium melts, watch carefully for any shrinking of oxide film on the surfaces of the base metal which indicates the starting of base metal melting.

Fig 2

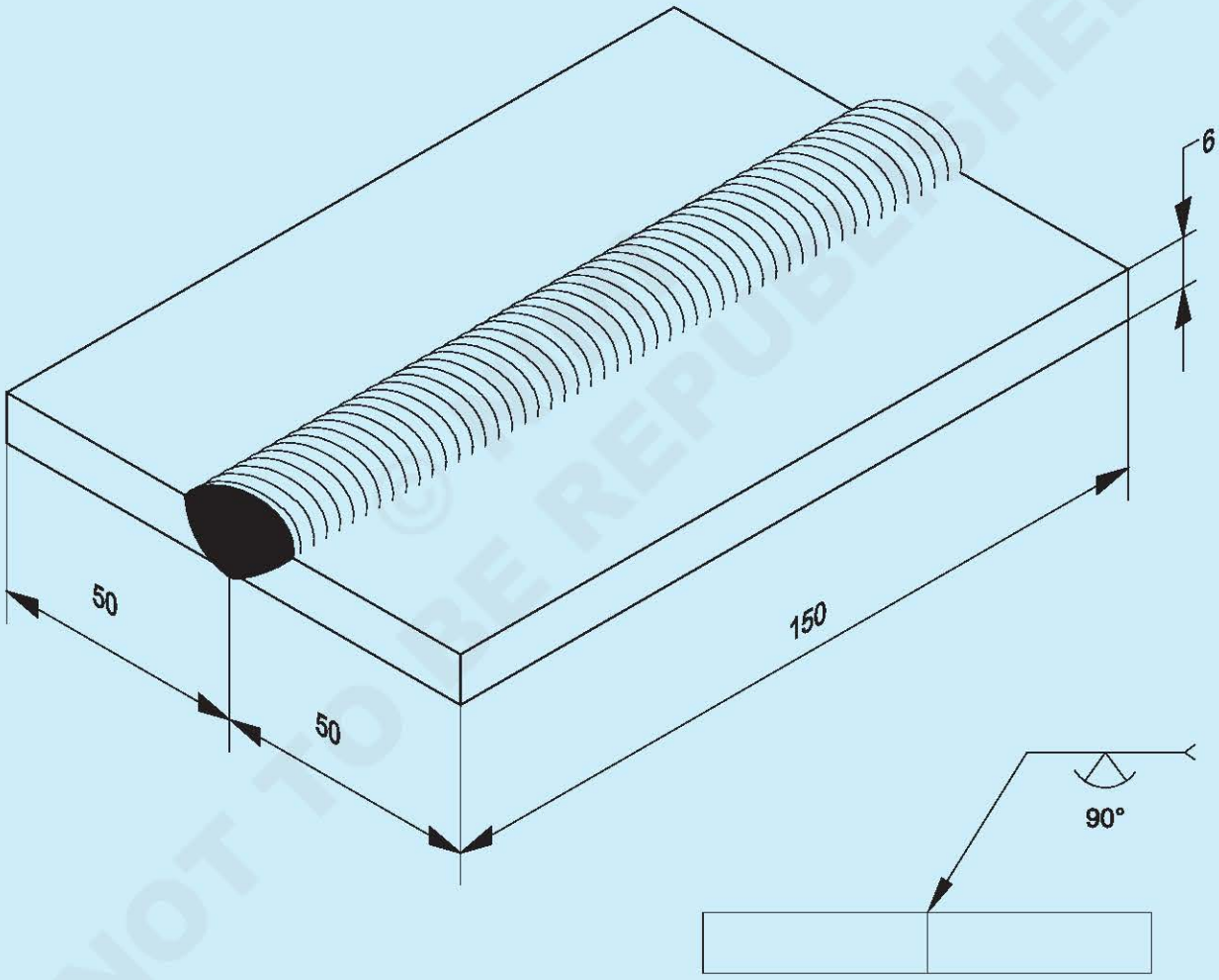


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Bronze welding of single "V" butt joint on cast iron plate 6mm thick plate (1G) (OAW-21)

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

- **prepare clean the job pieces as per drawing**
- **select the correct nozzle size and filler rod and flux**
- **set a slightly oxidized flame**
- **deposit root and 2nd run by applying after flux**
- **clean and check for defects on the weldment.**



NOT TO BE REPUBLISHED

2	150 x 50 x 6	-	FG15	-	-	1.3.59
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	BRONZE WELDING OF SINGLE 'V' BUTT JOINTON 6 mm THICK CAST IRON PLATE IN FLAT POSITION.	TOLERANCE ±1	TIME
		CODE NO. WL20N1359E1	

Job Sequence

- Clean the surface of the work piece from oil, grease, dirt and remove oxides if any by filing/grinding.
- Grind the edges of the plate to (no feather edge) form a single V of included angle of 90°. Round off all sharp edges.
- Select nozzle No.7.
- Select a silicon bronze filler rod of 3mmø for the root run and 5mmø for the 2nd run.
- Select bronze flux and 0.15 kg/cm^2 pressure for both gases.
- Ensure all safety precautions before lighting the torch.
- Set a soft oxidizing flame.
- Apply flux in powder form by dipping hot filler rod. Then tack weld on both ends of the joint with a uniform root gap of 25mm.
- Weld the root run using leftward technique and 3mmø filler rod keeping the job at 30° slope.
- Ensure wetting of weld faces by the filler metal before building up the bead.
- Heat the weld faces only to dull red color by giving circular motion to the blow pipe.

It is not necessary to melt the base metal for bronze welding of cast iron.

- Clean the root run and deposit the 2nd run using 5mm filler rod after applying flux.
- Fill the joint by filler metal to get a maximum of 1.5mm reinforcement, good ripple formation.
- Clean the joint removing any flux residue and inspect for defects.
- Heat control is important. If the heat is insufficient the bronze metal will not wet the surface or flow properly.
- Excess heat will cause the bronze metal to flow more freely and not allow it to build up.

Skill Sequence

Bronze welding of single "V" butt joint on cast iron plate 6mm thick plate

Objective: This shall help you to
- **prepare the bronze welding of single "V" butt joint on cast iron plate 6mm thick plate.**

Set the job with 30° inclinations. Keep the angle of the filler rod at 30° to 40° and give a rubbing action to the filler rod on the V.

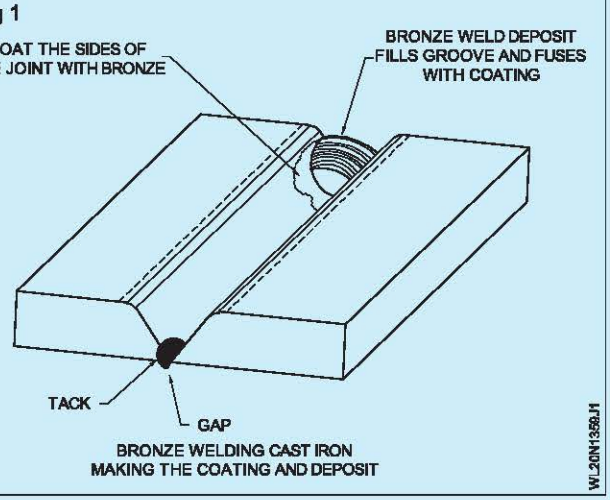
Maintain the angle of the blowpipe at 60° to 70° and give a circular motion to the blowpipe.

Deposit a root run with a 3mmø filler rod and the finishing run with a 5mmø filler rod. Dip the hot filler rod end into the powdered bronze flux frequently.

In bronze welding of cast iron the base is only heated to 650°C and it is not melted. So while depositing the root run the surfaces of the joint is coated with a layer of filler metal for about 20mm along the joint, ensuring that it is correctly bonded. Fig 1.

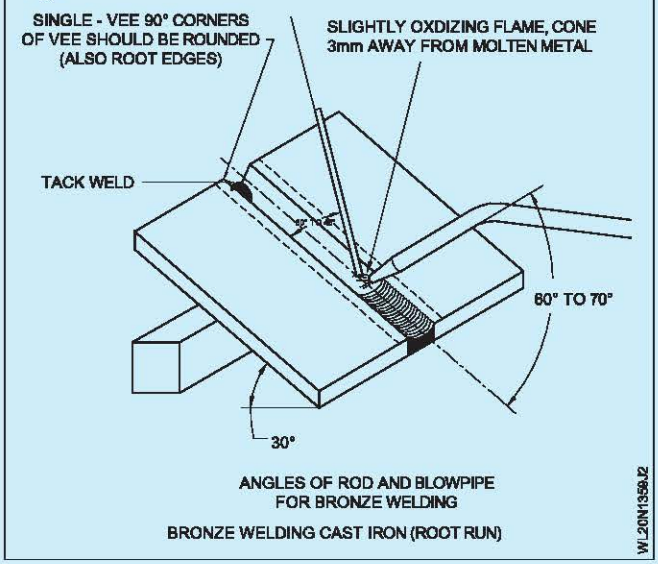
Then return to the starting point and add sufficient filler metal to produce a satisfactory weld. This method is repeated continuously until the root run is completed. Fig 2 Ensure root penetration by the filler metal and fusion between consecutive bronze filler metal deposits.

Fig 1



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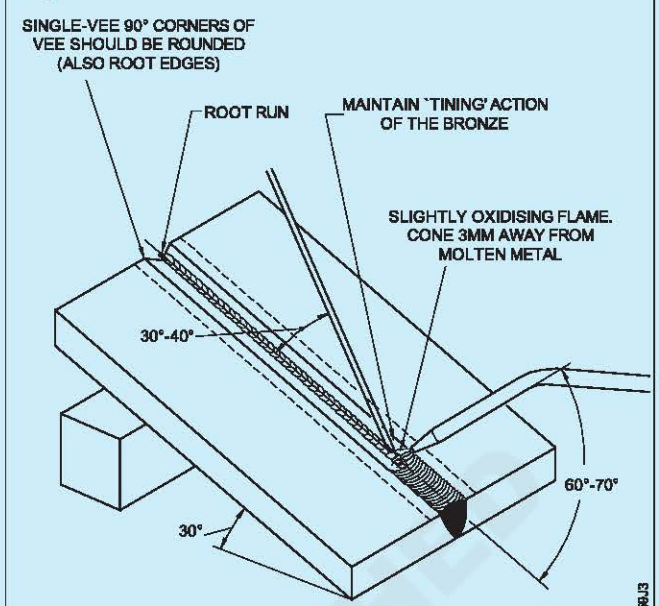
Fig 2



Weld similarly the 2nd run by using 5mmø filler rod dipped in flux with a soft oxidizing flame and get 1.5mm reinforcement and good bead up to the end of the joint. Fig 3.

Clean the bead and remove the flux residue on both sides of the joint.

Fig 3



Inspect the joint for weld defects like porosity, incomplete penetration etc.

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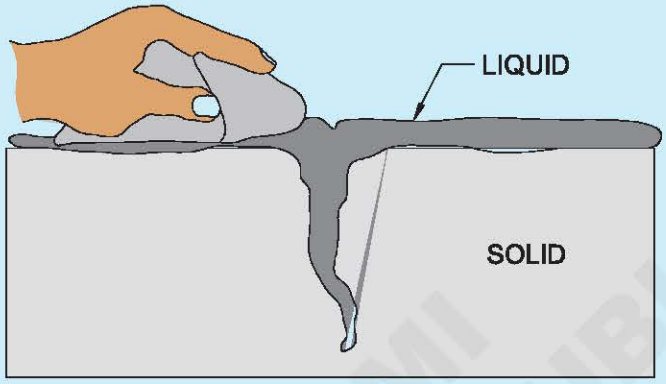
Exercise 1.3.60

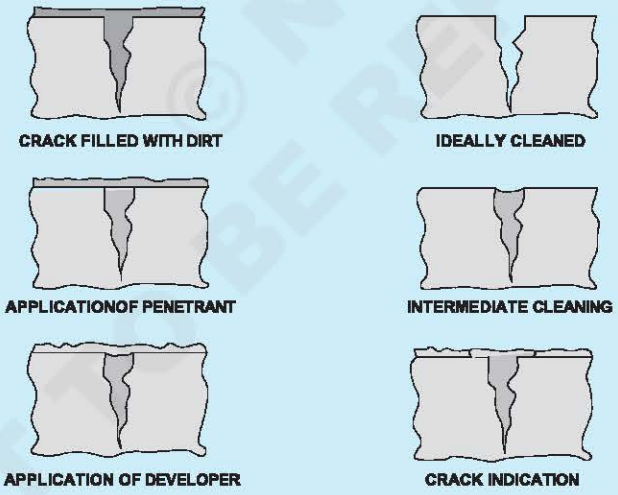
Dye penetrant test

Objectives: At the end of this exercise you shall be able to
- **inspect welded component for surface defect using**
- **state the penetration test**
- **identify the defect.**

Job Sequence

- Clean the surface of the test piece spray the colored dye on the surface
- Allow the dye to soak for about 2 to 3 minutes wash the surface with cleaner
- Dry the surface using a test cloth





- Spray the liquid developer on the surface
- Observe the colored due coming out in the shape of the defect in to the white liquid developer analyses the defect

1	WELDED MODEL		Fe 310 - W			1.4.60
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	DYE PENETRANT TEST				TOLERANCE ±1	TIME
					WL20N1460E1	

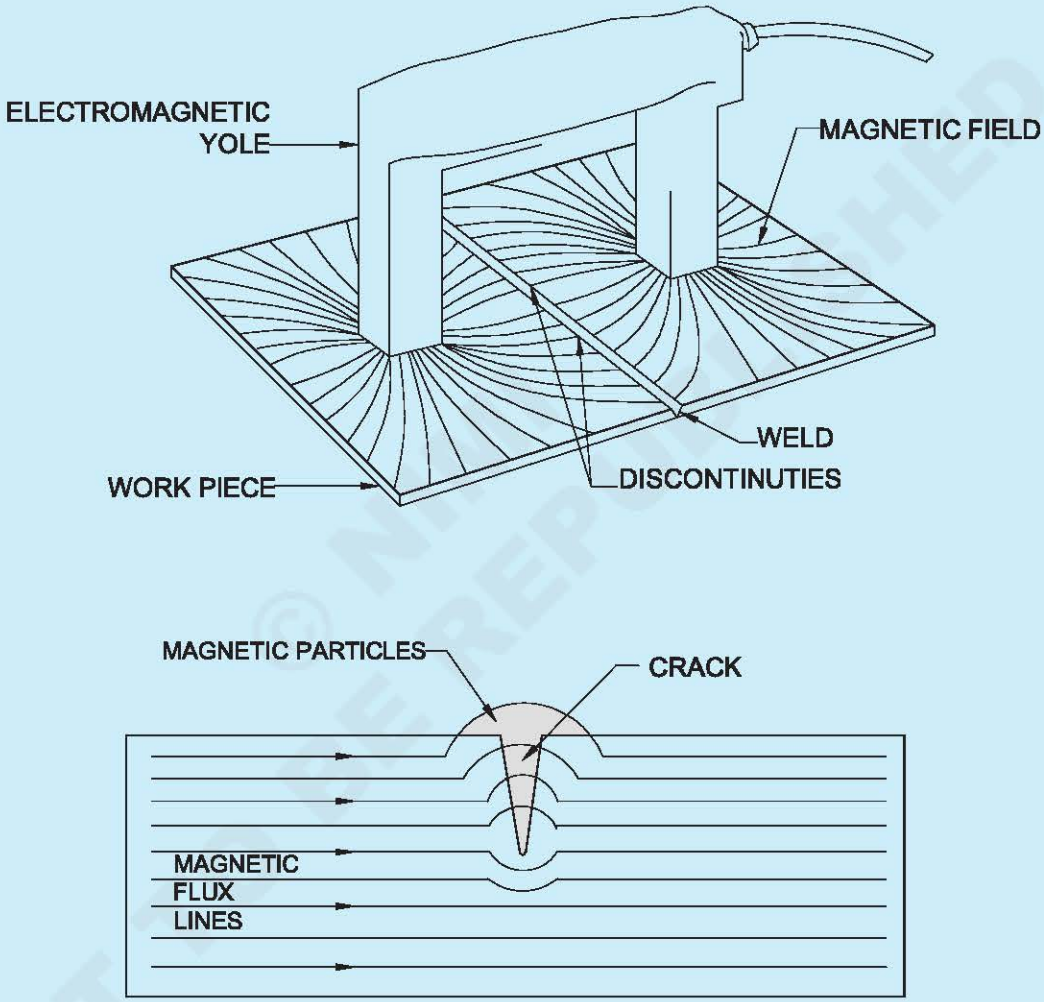
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Exercise 1.3.61

Magnetic particle test (I&T)

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

- **inspect of welded component for surface defect using magnetic practical test.**
- **locate and mark the place of defect.**



MAGNETIC PARTICLE INSPECTION

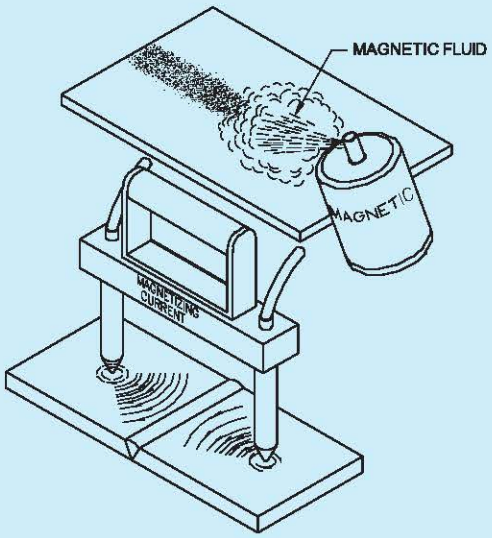
1	WELDED JOB		Fe 310 - W			1.4.61
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	MAGNETIC PRACTICAL TEST (I&T-20)				TOLERANCE ±0.5	TIME
					WL20N1461E1	

NOT TO BE REPRODUCED

Job Sequence

- Familiarize with the working of magnetic particle test unit
- Set the test piece in the MPT unit
- Spray the iron particle liquid on the surface of the component
- Switch on the power to magnetic the test piece

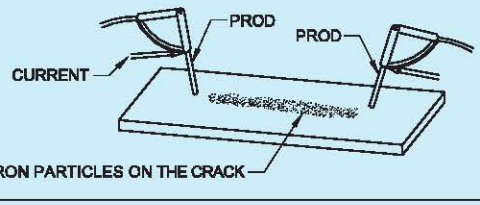
Fig 1



MAGNETIC PARTICLE TEST

- Observe the iron particles which gather at the edges of crack (or) flaw
- Locate the crack or flaw and make the area.

Fig 2



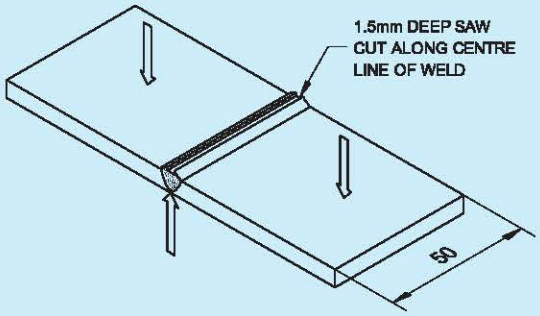
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Exercise 1.4.62

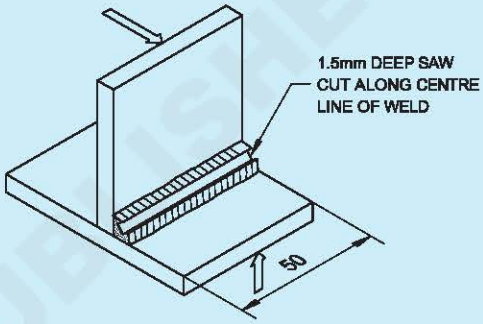
Nick-break test (I & T) 04

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

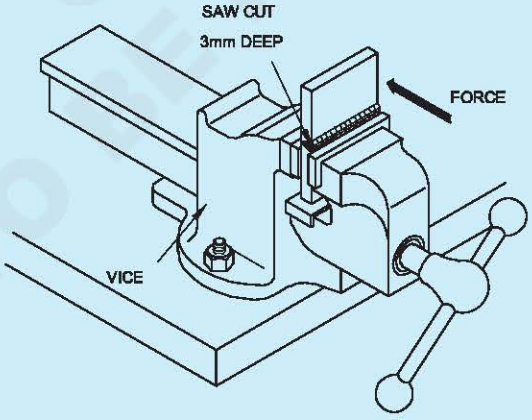
- **make saw cut on the weld bead**
- **apply the force on weld metal to break**
- **identify the internal defects.**



NICK BREAK TEST PIECE-BUTT WELD



NICK BREAK TEST PIECE-FILLET WELD



FRACTURE TEST ON BUTT JOINT

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2	WELDED JOBS		Fe 310 - W			1.4.62
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	NICK BREAK TEST				TOLERANCE ±0.5	TIME
					WL20N1462E1	

Job Sequence

1 Select welded Tee or butt joint

2 Make saw cut of about 1.5mm to 2mm depth along the centre line of the weld as per Fig 2.

3 Apply the force with hammer on the reverse of the joint as shown in the Figure 2.

4 The joint will break along the saw cut & by observing the fractured surface.

5 Identify the various defects like slag inclusion, lack of fusion, lack of penetration etc.

6 Rectify the reasons for the above defects.

Skill Sequence

Nick-break test (I & T) 04

Objectives: This shall help you to
- **identify the internal weld defects by nick break test.**

To determine the quality of weld.

Breaking open the weld length wise & then visually inspecting the exposed weld interior for any internal imperfections such as lack of side wall fusion, lack of inter-run fusion & porosity.

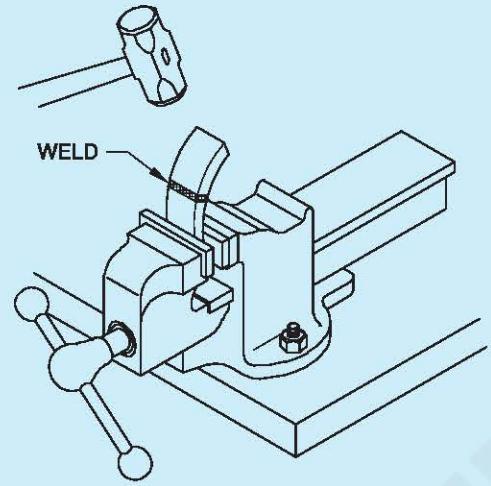
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Exercise 1.4.63

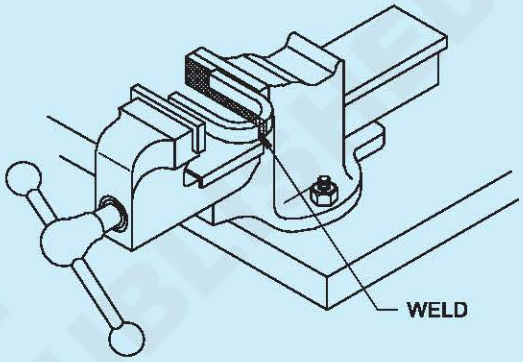
Free bend test (I & T) 03

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

- **fix the job in vice**
- **apply the force on job to bend**
- **use guided bend machine**
- **rectify the defects.**



THIS IS ONE WAY THE INITIAL BEND CAN BE MADE



FOR THE FINAL BEND, THE SPECIMEN MUST BE BENT IN A VISE

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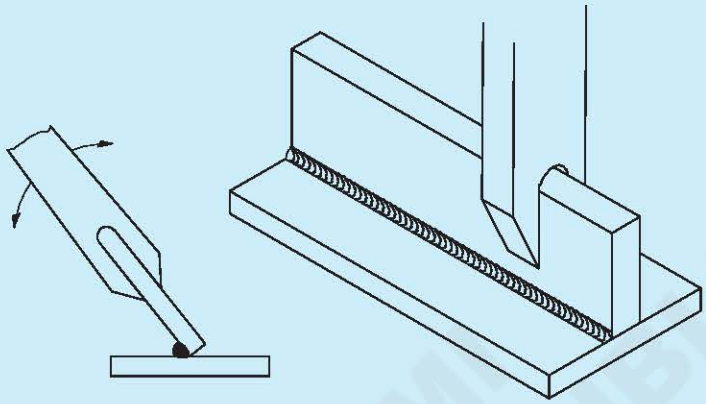
Job Sequence

- The force to initiate bending for a free-bend test be applied at, or within one width distance from, the ends of the specimen. This may be done by gipping the specimen. If the material is too stiff to respond to such force it shall be supported at the mid-length over a span of at least the specimen width while the initial force is applied near the two ends of the specimen.
- The angle of a free-bend is measured once the specimen has been removed from the bending fixture and is under no constraining force there is no radius of bend measurement required for a free-bend test.
- Free-bend-180° bend the bending is initiated and is then continued until a 180° bend is developed by applying force to bring the legs of the specimen to a parallel position
- The bending force is more severe in free bend test.
- After completing the free-bend, the surface is examined for cracks and imperfections.

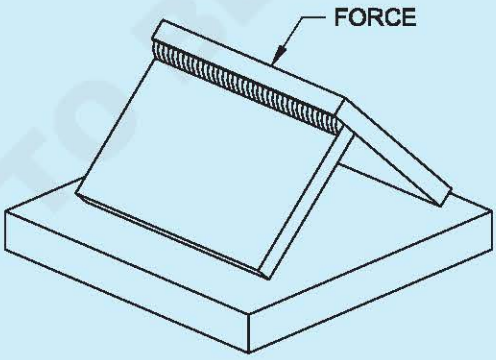
02	WELDED JOBS		Fe 310 - W			1.4.63
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	FREE BEND TEST WITH WELDED JOBS (I&T-03)				TOLERANCE ±0.5	TIME
					WLN2163E1	

Fillet fracture test (I & T) 04

Objectives: At the end of this exercise you shall be able to
- **fix the job in vice**
- **apply the force to fracture**
- **rectify the defects.**



FILLET FRACTURE TEST USING BENDING BAR



FILLET FRACTURE TEST USING HAMMER

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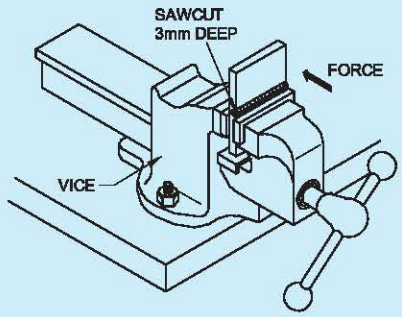
2	WELDED JOBS		Fe 310 - W			1.4.64
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**FILLET FRACTURE TEST (I&T-06)**				TOLERANCE ±0.5	TIME
					WL20N1464E1	

Job Sequence

1 Select job pieces of one side welded fillet tee, lap or but joint also.

2 Fix the jobs in bench vice as per Fig 1.

Fig 1



FRACTURE TEST ON BUTT JOINT

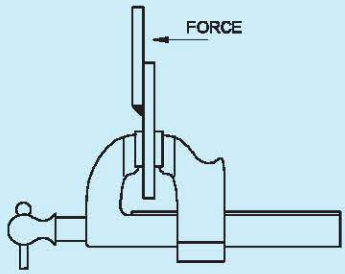
WL20N1464H1

3 Use bending bar to bend or fracture the joint as per Fig 2

4 Observing the fractured surface

5 Select another welded job

Fig 2



FRACTURE TEST ON LAP FILLET

WL20N1464H2

6 Apply the force on job.

Observing the fractured surface various defects like

- Lack of fusion
- Slag Inclusion
- Blow holes or porous weld

7 Rectify the defects.

Skill Sequence

Fillet fracture test (I & T) 04

Objectives: This shall help you to

- **identify the weld defects by fillet fraction test.**

Examination of fractured weld

The fractured weld may exhibit and show the following internal defects in following figure

- Lack of fusion
- Incomplete penetration
- Slag inclusion
- Blow holes or porous weld.

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C G & M
Welder - Gas Metal Arc Welding

Exercise 1.5.65

Introduction to safety equipment and their use etc. GMAW-011

Refer the Exercise 1.1.02

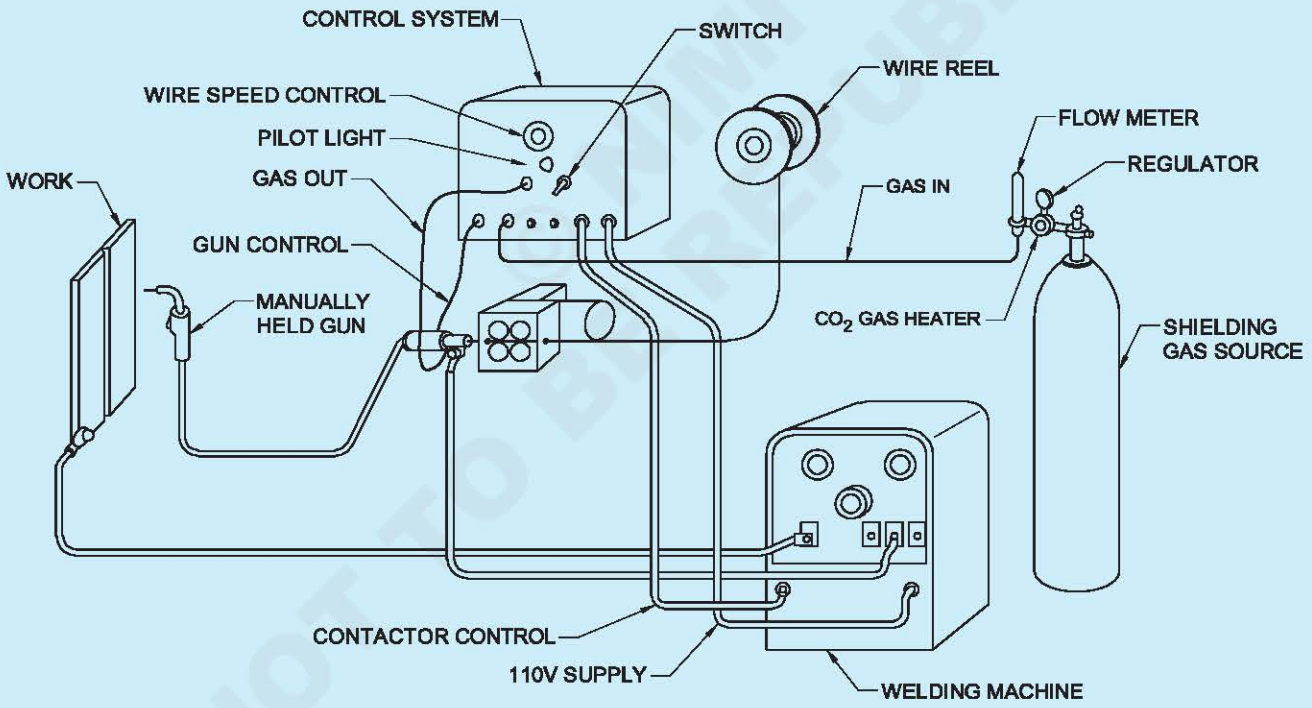
C G & M
Welder - Gas Metal Arc Welding

Exercise 1.5.66

Setting up of GMAW welding machine & Accessories and striking an ARC GMAW-02

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

- **identify and set the GMAW welding machine with accessories**
- **describe the welding techinids of GMAW and stroking an arc.**



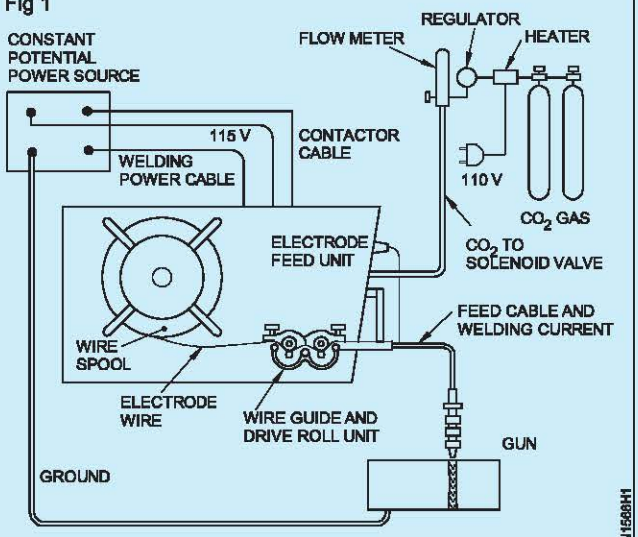
DIAGRAMMATIC VIEW OF A COMPLETE GAS METAL ARC WELDING (GMAW) OUTFIT

NOT TO BE REPUBLISHED

						1.5.66
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	**SETTING UP OF GMAW MACHINE & ACCESSORIES**				TOLERANCE ±1	TIME 15h
					CODE NO. WL20N1566E1	

Setting up of the GMAW 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 OF THE GMAW 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 & 3).

Fig 2

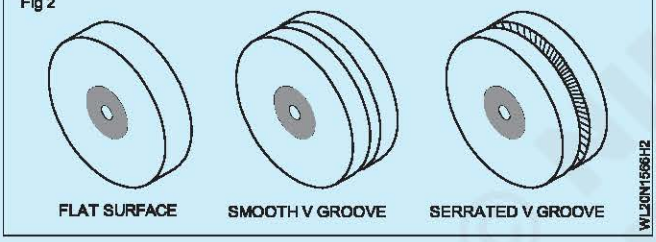
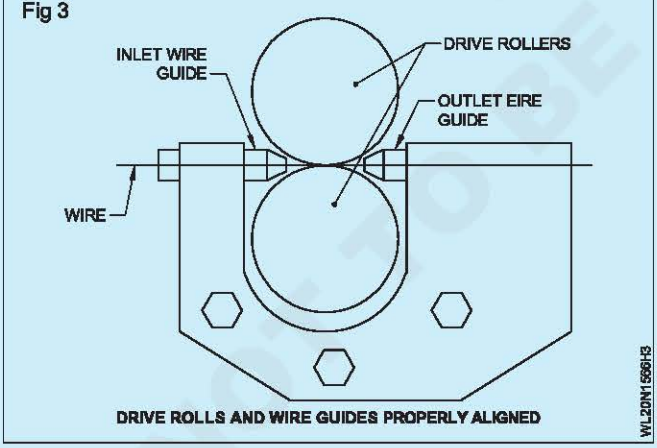


Fig 3



DRIVE ROLLS AND WIRE GUIDES PROPERLY ALIGNED

The roller should not be over tightened 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)

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 welding machine after the machine is connected to the 3 phase supply mains.

Fig 4

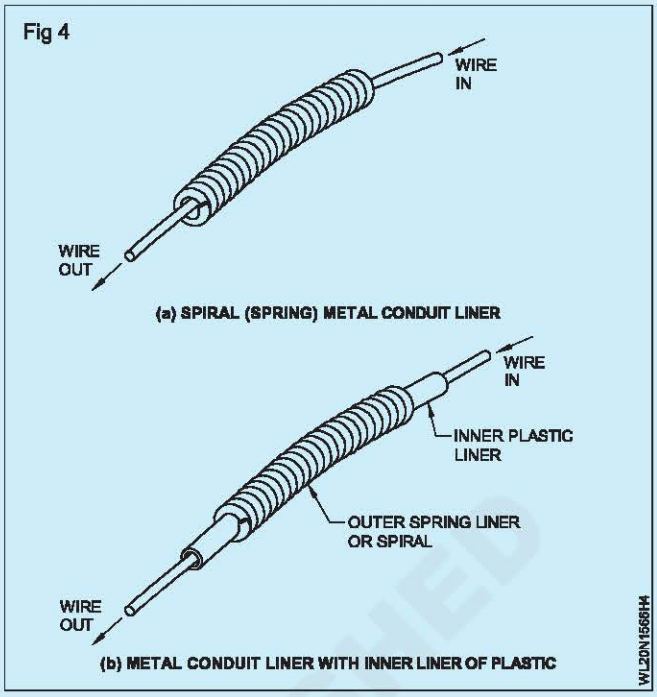
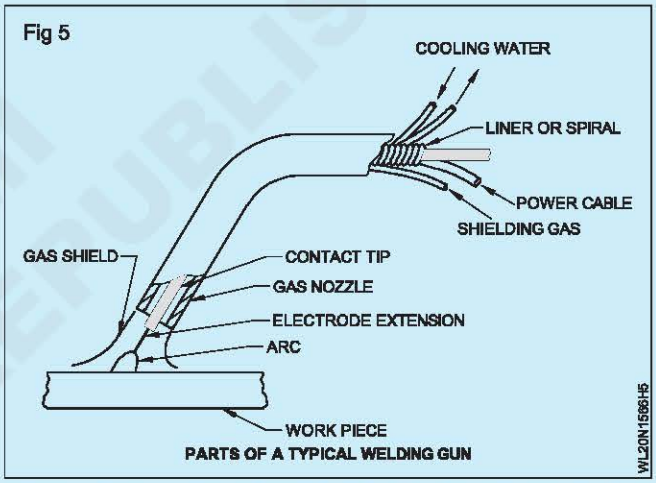


Fig 5



PARTS OF A TYPICAL WELDING GUN

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 turbulences and in turn contaminates weld.

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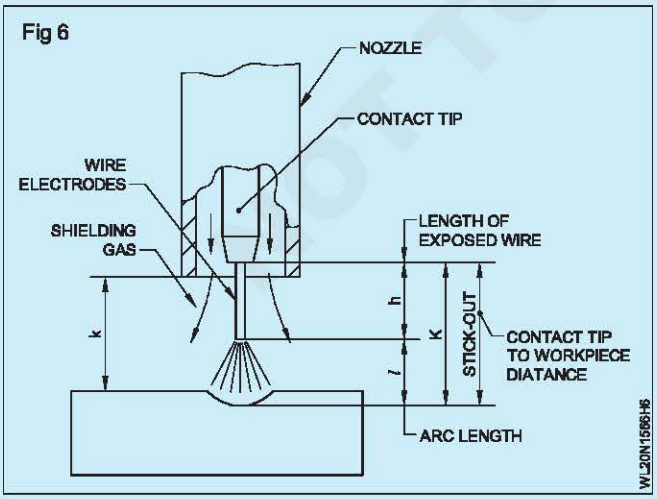
Setting up arc voltage, stick out and wire feed rate for dip transfer

Setting the current level by selecting proper wire feed rate: For this exercise of depositing straight line 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) ± 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.

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 7

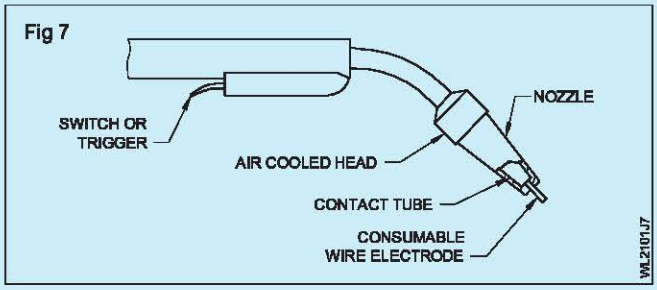
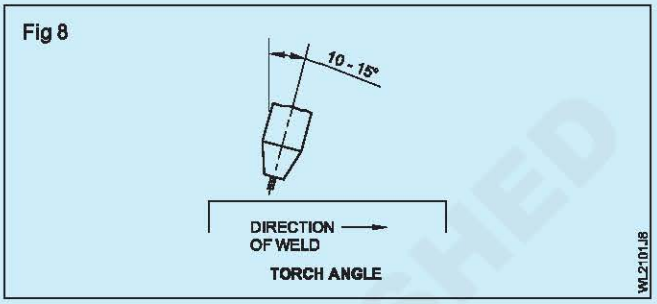


Fig 8



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

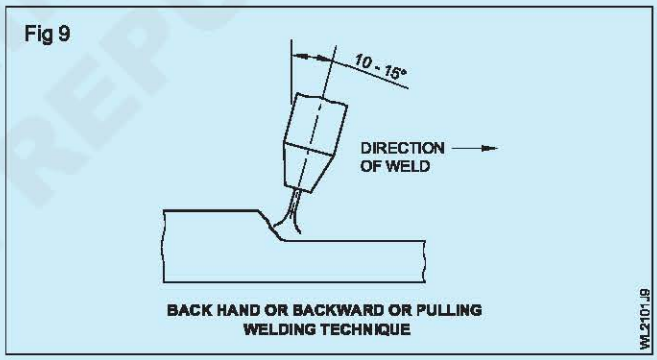
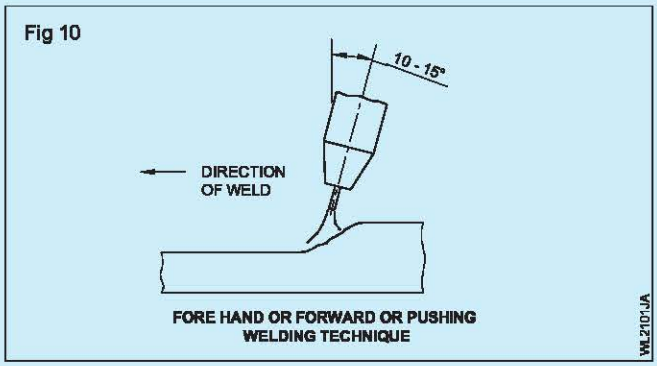


Fig 10



Make sure the contact tip looks good (not elongated or melted) and it is tightened to the diffuser. 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.

NOT TO BE REPUBLISHED

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.

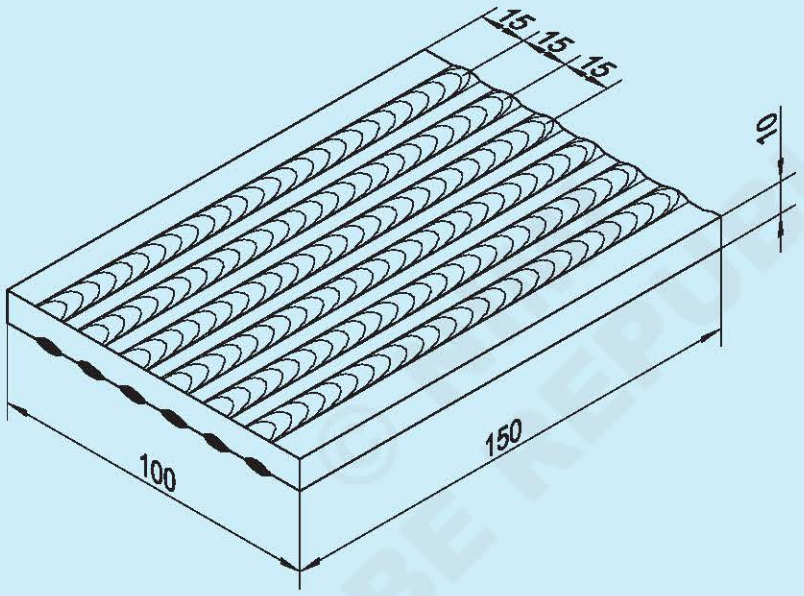
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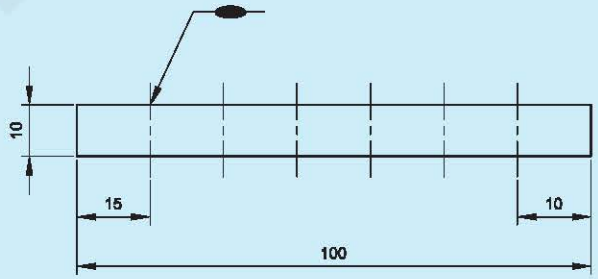
Exercise 1.5.67

Depositing straight line beads on MS plate 10mm in flat position by GMAW-02

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

- **prepare the job as per drawing**
- **set the GMAW machine and set welding parameter**
- **deposit straight line bead in flat position.**
- **clean and inspect the held defects**





NOT TO BE REPUBLISHED

1	100 ISF 10 - 150		Fe 310			1.5.67
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

SCALE NTS	DEPOSITING STRAIGHT LINE BEADS ON M.S.PLATE IN FLAT POSITION BY (GMAW-02)	TOLERANCE ±1	TIME
		CODE NO. WL20N1567E1	

Job Sequence

1 Prepare the job to size as per drawing.

2 Clean the job surface with carbon steel wire brush.

3 Mark parallel lines on the job surface as per drawing and punch the lines.

4 Set the workpiece (job) on the work table in Flat position.

5 Fix the 0.8mm diameter wire, lock it up and pull the wire through the guide tube, rollers, spiral and contact tip of the torch.

6 Start the welding machine. Connect the torch to the positive (DC +ve) terminal (DCRP) of the machine.

7 Connect the CO_2 gas heater to the electrical supply 5-10 minutes before starting of the weld.

8 Set the arc voltage at 19-21 volt as required for Dip Transfer mode.

9 Set the Gas Flow Rate at 8-10 LPM (Litres Per Minute).

10 Set the wire feed rate so as to get 90-100 amp by striking the arc.

11 Use DIN 11 or 12 black/green filter glass on Hand Shield for above current setting.

12 Wear the protective clothing as required.

13 Switch over to weld mode as indicated in the machine.

14 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.

15 Deposit the bead on punched lines of the job from one end to other.

16 Remove spatters with chipping hammer and clean the joint using carbon steel wire brush.

17 Self-inspect the weld bead for finish and defects.

Skill Sequence

Depositing straight line beads on MS plate 10mm in flat position by GMAW-02

Objectives: This shall help you to
- **prepare and practice straight line beads on MS plate.**

Preparation and setting of the job: Prepare a M.S plate piece of size 150 x 100 x 10mm thick.

Mark straight lines with punch marks spaced at 15mm.

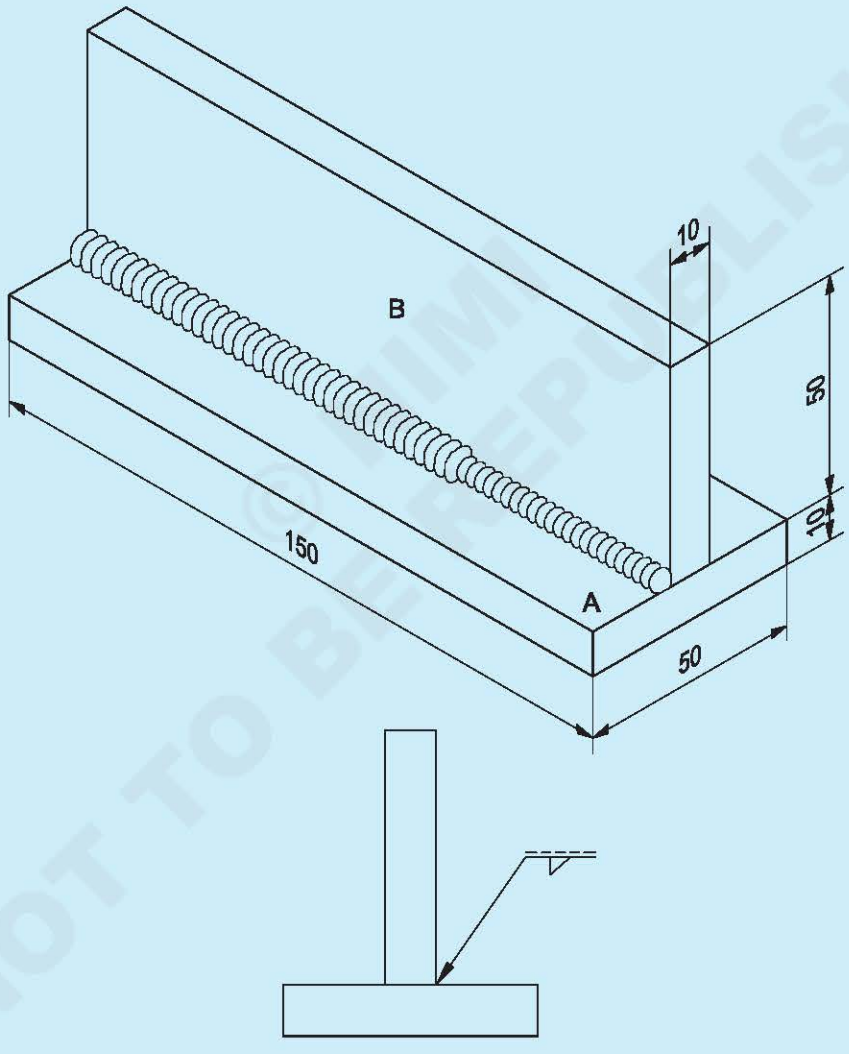
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Exercise 1.5.68

Fillet weld Tee joint on MS plate 10mm thick in flat position by dip transfer 1F (GMAW 03)

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

- **prepare and set the job as per drawing**
- **set up the GMAW machine and parameters**
- **maintain stickout and take weld.**
- **deposit root and covering run**
- **clean and inspect surface defects.**



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2	50 ISF 10 - 150		Fe 310 - W			1.5.68
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 BY DIP TRANSFER 1F (GMAW-03)				TOLERANCE ±1	TIME
					WL20N1568E1	

Job Sequence

1 Cut the plates by gas cutting as per drawing.

2 Grind the gas cut edges to square.

3 Use plain goggles while grinding and welding googles while gas cutting.

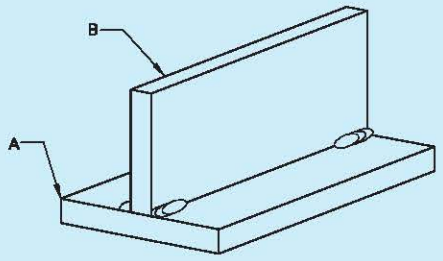
4 Deburr and clean the surface of the wire brush and filing.

5 Set the plate B on the plate A in the form of tee as per drawing.

6 Wear protective clothing's.

7 Tack weld (min 10mm length) on both ends of the tee joint as shown in the Fig 1.

Fig 1



SETTING AND TACKING A TEE JOINT

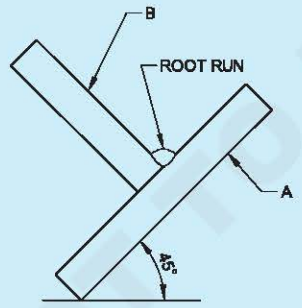
WL20N1568H1

8 Keep the tack welded job in the channel at degree from the horizontal plane so that the welding can be done in flat/down hand position

9 Connect the torch to positive terminal of the machine

10 Weld the root run of the joint by using 0.8mm dia. Mild steel filler wire and using stringer bead welding technique Fig 2

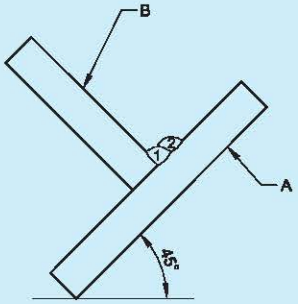
Fig 2



WL20N1568H2

11 Set 90 to 100 amps current/ corresponding wire feed rate 19 to 2 Arc and deposit the root run

Fig 3



WL20N1568H3

12 Ensure proper root penetration and even fusion of plate A and B with suitable welding gun / torch angle and Arc travel speed.

13 Clean the root run using steel wire brush.

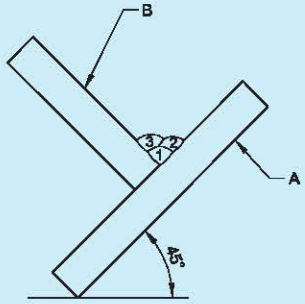
14 Deposit the 2nd run using stringer bead as shown in Fig 3 covering the bottom plate A and 2/3 of the width of the root run. Adopt the same welding parameters under techniques used for the root run.

15 Ensure the undercut in bottom plate is avoided and a leg length of plate thickness 10mm is obtained.

16 Clean the second run by using steel wire brush

17 Deposit the third run similar to second run except that the deposit covers the vertical plate B, the root run and the second run Fig 4

Fig 4



WL20N1568H4

18 Ensure under cut on the vertical plate is avoided and a leg length of 10mm is obtained

19 Clean the welded joint by steel wire brush

20 Use tongs while handling the hot job.

Skill Sequence

Fillet weld Tee joint on MS plate 10mm thick in flat position by dip transfer 1F (GMAW 03)

Objectives: This shall help you to

- **prepare and weld fillet 'Tee' joint on MS plate in flat position.**

While tack welding plates A and B for the Tee joint I, the angle between them is to be kept initially as shown in Fig 1 (i.e a distortion allowance of 1° per run) so as to control the angular distortion which ultimately settles to 90° after welding.

For the lap fillet joints 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.

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° to the surface Fig 2.

Fig 1

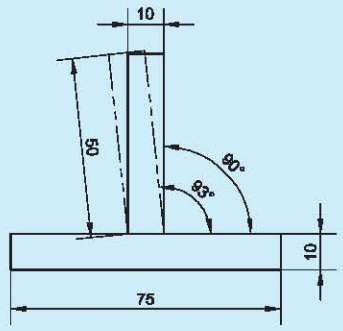
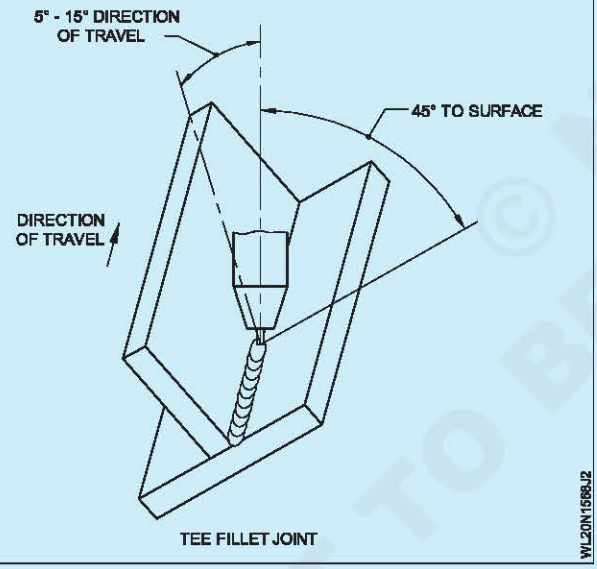


Fig 2



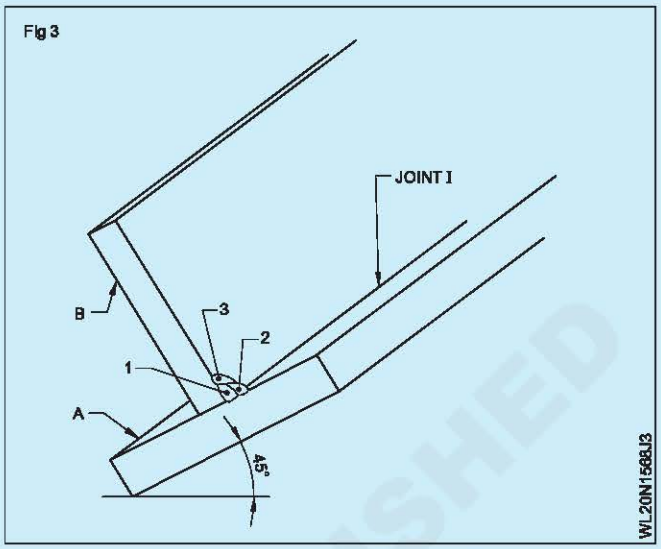
Since GMA welding process does not have the ability to remove many impurities, it is very important to clean the mill scale, rust, paint, oil or grease from the plate surface.

For welding the joints in flat (down hand) position it is convenient to use the channel to position the joints. This will permit the tack welded job to be kept at 45° angle with the horizontal plane.

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.

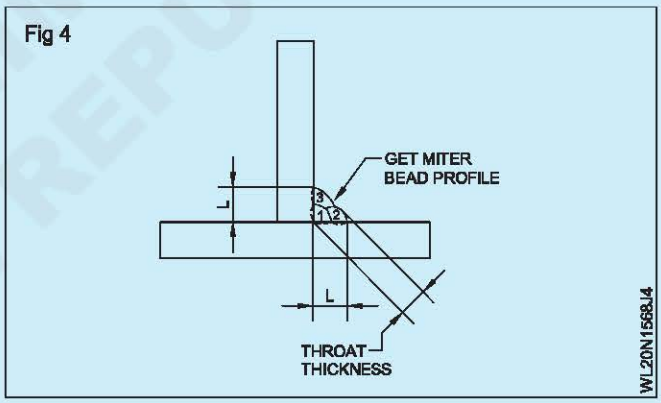
The bead placement for the 2nd and 3rd stringer bead are made as shown in the Fig 3. This is done to ensure that a

Fig 3



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 4



Maintain a uniform travel speed for the torch to get the required bead reinforcement, height and appearance.

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 unestabilished 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.

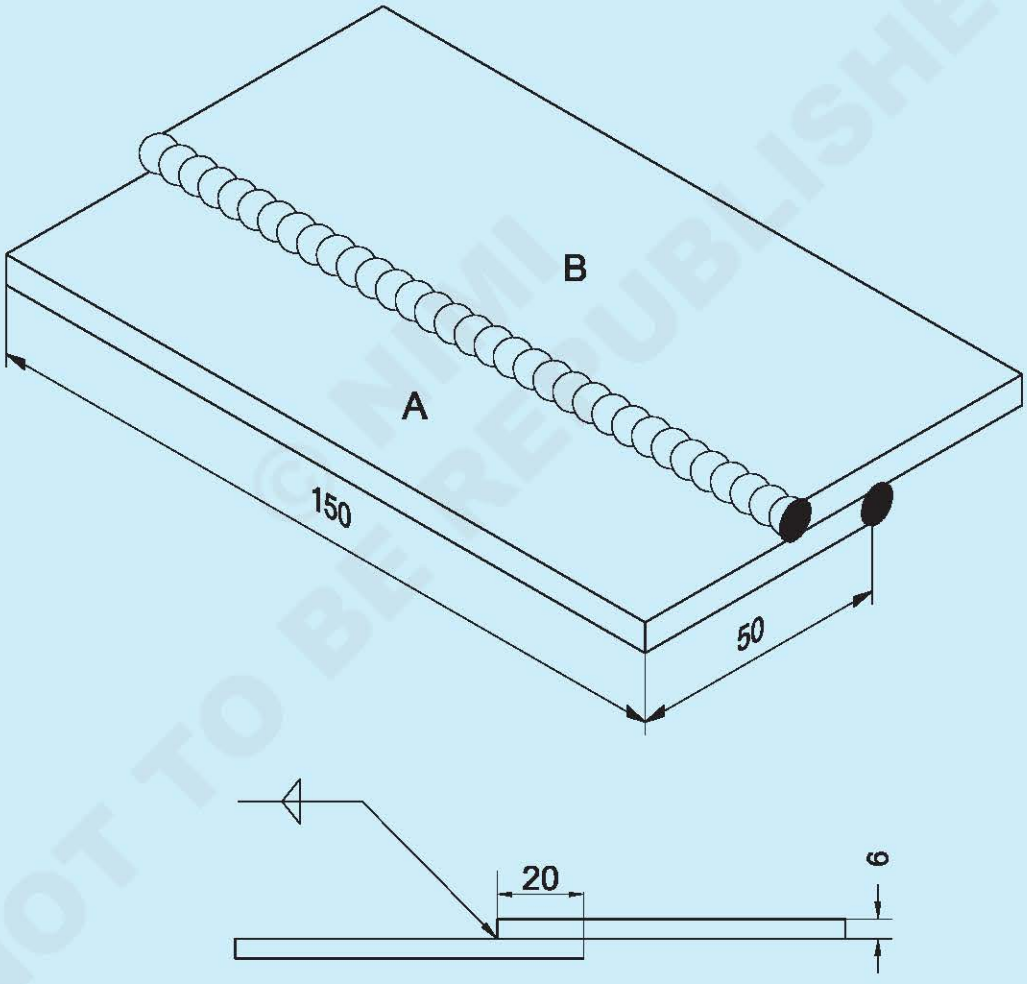
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Exercise 1.5.69

Fillet weld - Lap joint on MS sheet 3mm thick in flat position by dip transfer 1F (GMAW - 03)

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

- **prepare the sheets to size as per drawing**
- **set and tack weld the plates as per drawing**
- **set the lap joint in flat position**
- **deposit the bead with appropriate amount of filler metal**
- **clean and inspect for surface defects on the weld.**



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2	ISST 50 x 3 - 150		Fe 310 - W			1.5.69
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

SCALE NTS	LAP JOINT ON MS SHEET 3mm THICK IN FLAT POSITION BY POSITION BY DIP	TOLERANCE ±1	TIME
		WL20N1569E1	

Job Sequence

1 Cut the sheet by shearing machine as per drawing.

2 Grind and file the edges of sheets to square.

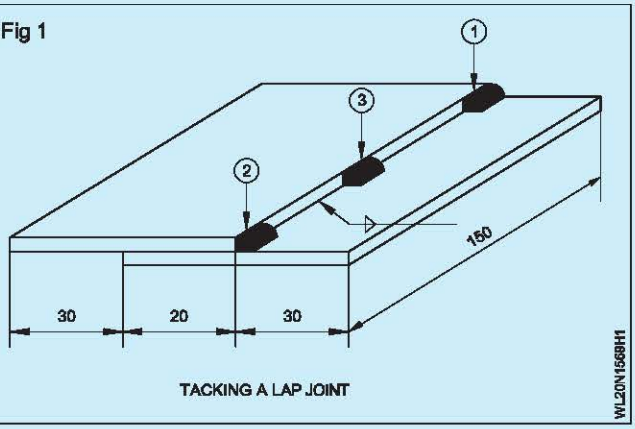
3 Deburr and clean the surface of the plates by carbon steel wire brush and filling.

4 Set the plate A on the plate B in the form of lap as per drawing.

5 Wear protective clothing's.

6 Connect the torch to the positive terminal of the machine.

Fig 1



TACKING A LAP JOINT

7 Set 90-100A current/corresponding wire feed rate, 19 to 2 arc voltage and deposit the run using Dip transfer mode.

8 Tack weld (min. 3mm length) on both ends of the lap joint as down in Fig 1.

9 Keep the tack welded jig in the channel at 45 degree from the horizontal plane so that the welding can be done in flat / down hand position.

10 Weld the lap joint by using 0.8mm dia copper coated mild steel filler wire and using stringer bead welding technique.

11 Ensure good leg length and even fusion of plates.

12 Avoid under cut

13 Ensure the edges of the plate is not melted off due to excessive weaving

14 Ensure there is no undercut at the other toe of the lap weld on plate

15 Clean the bead by steel wire brush

16 Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile.

Skill Sequence

Fillet weld - Lap joint on MS sheet 3mm thick in flat position by dip transfer 1F (GMAN - 03)

Objectives: This shall help you to

- **prepare and weld fillet lap joint on MS sheet in flat position.**

For the lap fillet joints no distortion allowance is recommended

Since the GMAW 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.

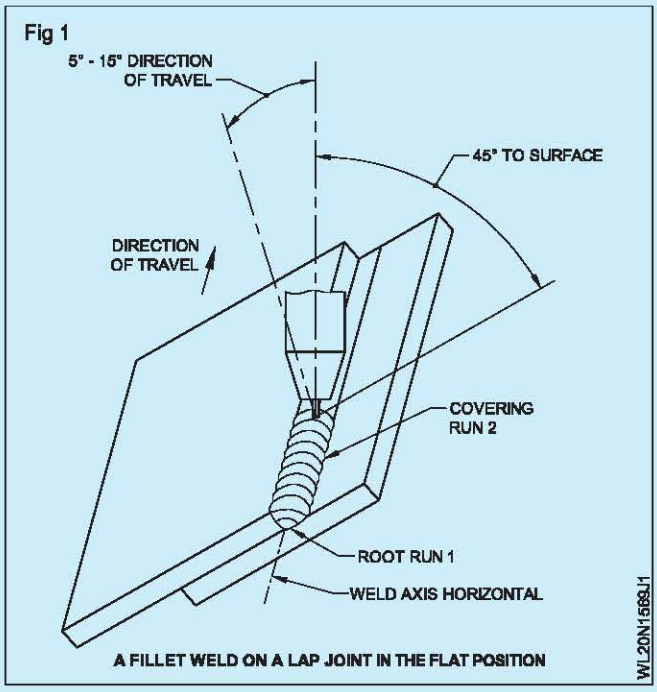
For welding the joints in flat position it is convenient to use the channel to position the joints. This weld permits the tack welded job to be kept at 45^0 angle with the horizontal plane.

The gun is held perpendicular to the joint at angle of 5 to 15 degree forward to the direction of travel as shown in Fig.1.

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 toe is properly filled with filler metal.

Maintain a uniform travel speed for the torch to get the required bead reinforcement, height and appearance. 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 Carbon-di-oxide gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

Fig 1



A FILLET WELD ON A LAP JOINT IN THE FLAT POSITION

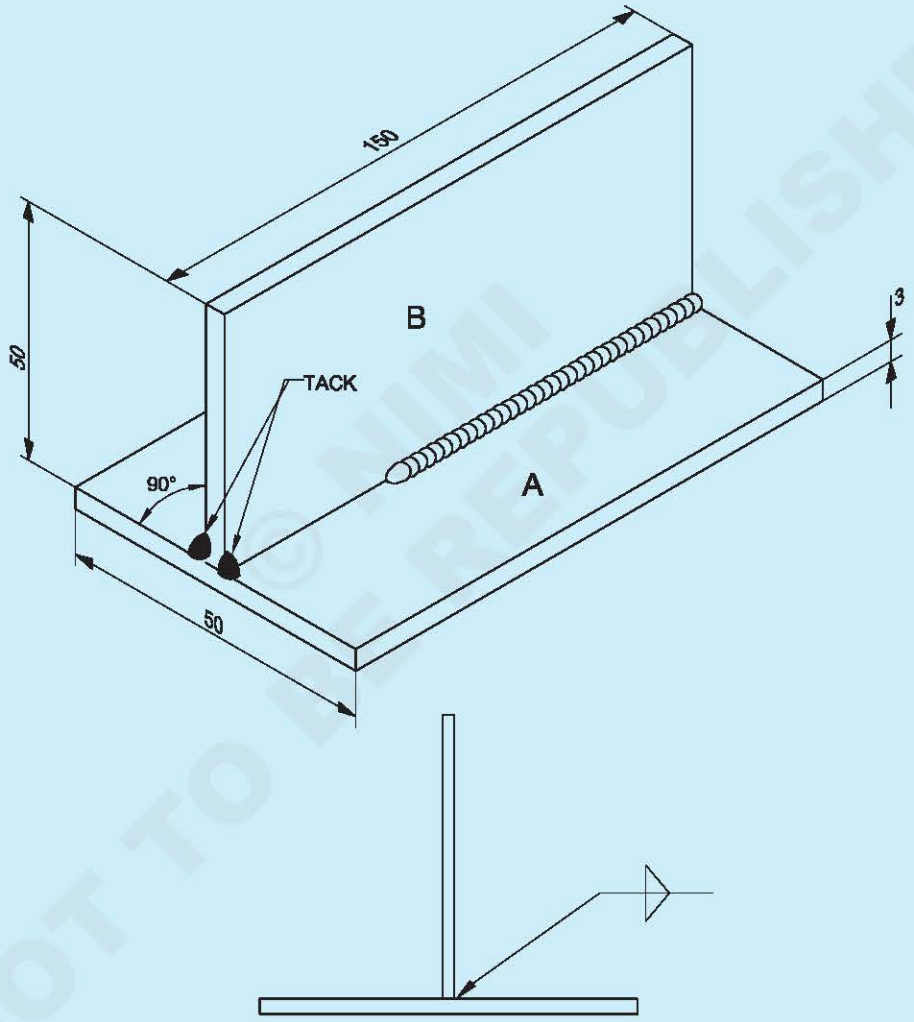
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Exercise 1.5.70

Fillet weld - 'T' joint on M.S sheet 3mm thick in flat position by dip transfer 1F (GMAW - 04)

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

- **prepare the sheets as per drawing**
- **set the 'T' joint in flat position and tack weld**
- **deposit the bead with appropriate amount of filler metal**
- **clean and inspect for surface defects on the weld.**



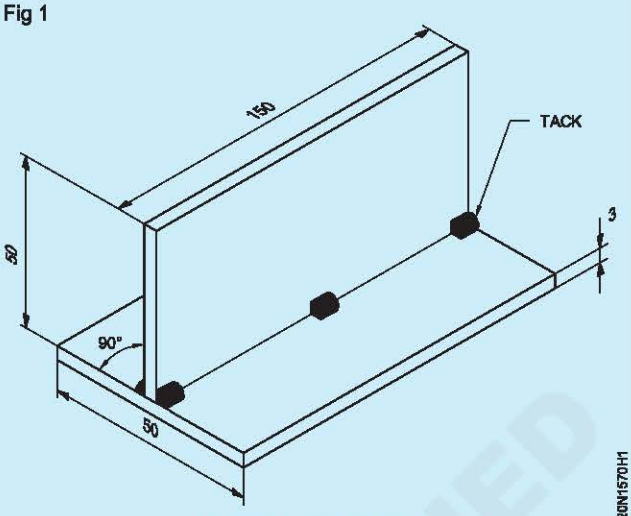
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2	ISST 50 x 3 - 150		Fe 310 - W			1.5.70
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO
SCALE NTS	**FILLET WELD TEE JOINT M.S. SHEET 3mm THICK IN FLAT POSITION BY DIP TRANSFER IF**				TOLERANCE ±0.5	TIME
					WL20N1570E1	

Job Sequence

1 Cut the sheet as per drawing.
2 Grind and file the edges of sheets to square.
3 Deburr and clean the surface of the plates by carbon steel wire brush and filling.
4 Set the plate A on the plate B in the form of Tee as per drawing.
5 Wear protective clothing's.
6 Connect the torch to the positive terminal of the machine.
7 Set 90-100A current/corresponding wire feed rate, 19 to 2 arc voltage and deposit the run using Dip transfer mode.
8 Tack weld (min. 3mm length) on both ends of the Tee joint as down in Fig 1.
9 Keep the tack welded job in the channel at 45 degrees from the horizontal plane so that the welding can be done in flat / down hand position.
10 Weld the Tee joint by using 0.8mm dia copper coated. Mild steel filler wire and using stringer bead welding technique.
11 Ensure good leg length and even fusion of plates.
12 Avoid under cut.
13 Ensure the edges of the plate is not melted off due to excessive weaving.

Fig 1



TACK WELDING A TEE JOINT

14 Ensure there is no undercut at the other toe of the lap weld on plate
15 Clean the bead by steel wire brush
16 Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile.

Skill Sequence

Fillet weld - 'T' joint on M.S sheet 3mm thick in flat position by dip transfer IF (GMAW - 04)

Objectives: This shall help you to
- **prepare and deposit weld bead Tee joint on MS sheet in flat position.**

For the lap fillet joints no distortion allowance is recommended.

Since the GMAW 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.

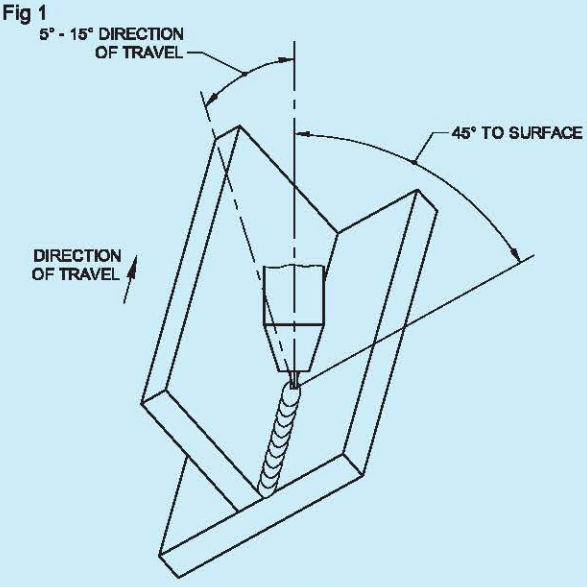
For welding the joints in flat position it is convenient to use the channel to position the joints. This weld permits the tack welded job to be kept at 45^0 angle with the horizontal plane.

The gun is held perpendicular to the joint at angle of 5 to 15 degree forward to the direction of travel as shown in Fig 1.

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 toe is properly filled with filler metal.

Maintain a uniform travel speed for the torch to get the required bead reinforcement, height and appearance. 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 unsterilised arc and the Carbon-di-oxide gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

Fig 1

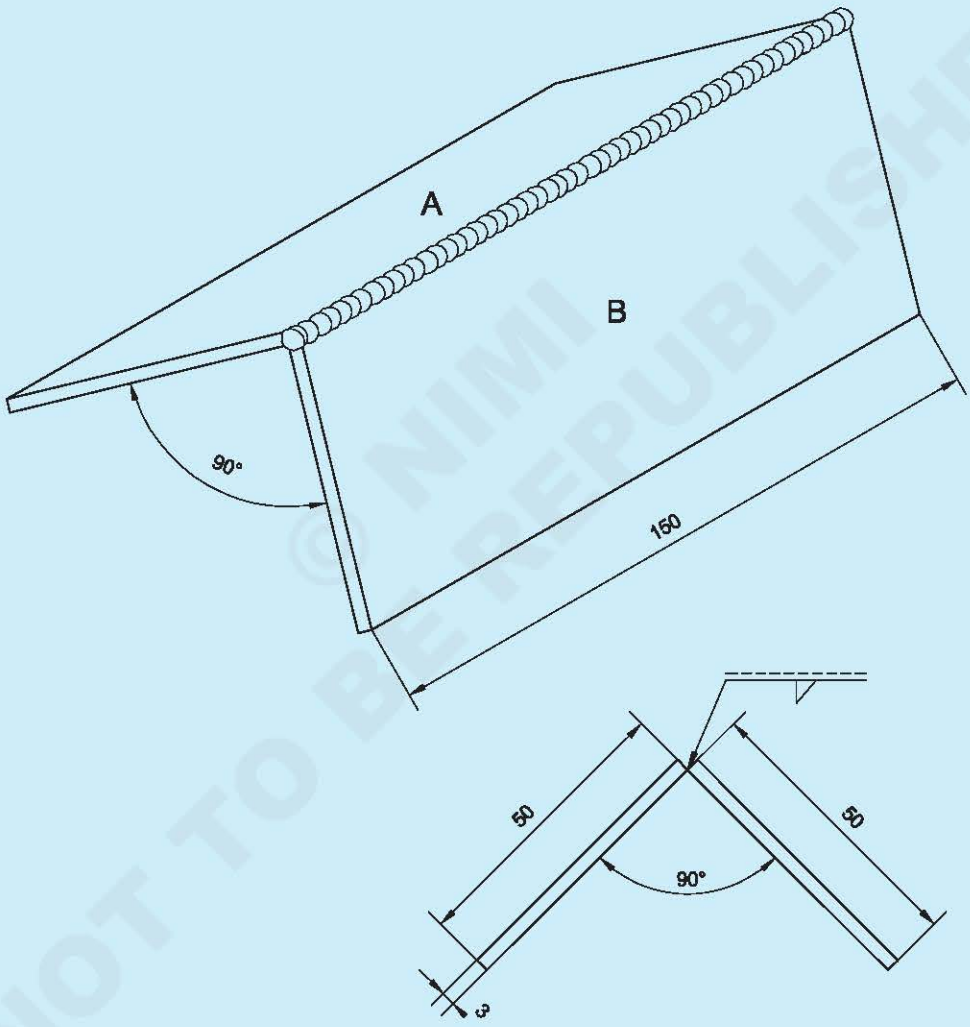


TEE FILLET JOINT

Fillet weld - Corner joint on M.S sheet 3mm thick in flat position by dip transfer 1F (GMAW - 05)

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

- **prepare the sheets as per drawing**
- **set the corner joint in flat position and tack weld**
- **deposit the bead with appropriate amount of filler metal**
- **clean and inspect for surface defects.**



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2	ISST 50 x 3 - 150		Fe 310 - W			1.5.71
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO
SCALE NTS	**FILLET WELD CORNER JOINT ON M.S.SHEET 3mm THICK IN FLAT POSITION BY DIP TRANSFER 1F (GMAW-05)**				TOLERANCE ±0.5	TIME
					WL20N1571E1	

Job Sequence

1 Cut the sheet as per drawing.

2 Grind and file the edges of sheets to square.

3 Deburr and clean the surface of the plates by carbon steel wire brush and filling.

4 Set the plate A on the plate B in the form of corner joint at 90° with specified root gap in flat position as per drawing.

5 Wear protective clothing's.

6 Connect the torch to the positive terminal of the machine.

7 Set 90-100A current/corresponding wire feed rate, 19 to 2 arc voltage and deposit the run using Dip transfer mode.

8 Tack weld (min. 10mm length) on both ends of the lap joint as shown in Fig 1.

9 Keep the tack welded job on the welding table in flat/ down hand position.

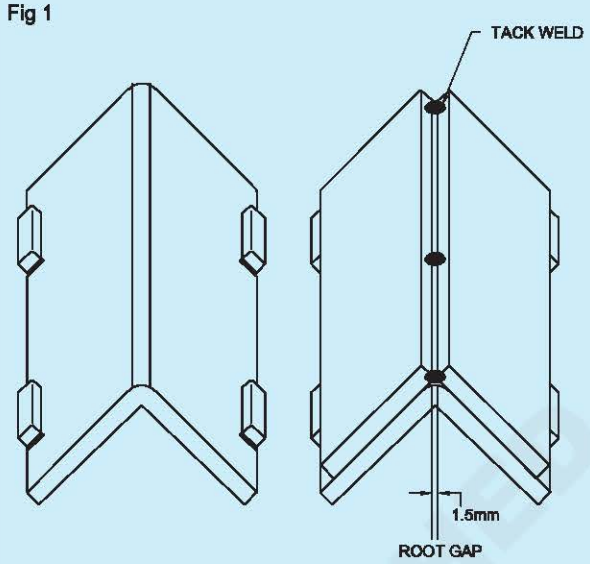
10 Deposit run in the joint by forming a key hole and obtain complete penetration and even fusion of plates.

11 Ensure good leg length and even fusion of plates.

12 Avoid under cut.

13 Ensure the edges of the plate is not melted off due to excessive weaving.

Fig 1



14 Ensure there is no undercut at the other toe of the corner weld on plate

15 Clean the bead by steel wire brush

16 Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile.

Skill Sequence

Fillet weld - Corner joint on M.S sheet 3mm thick in flat position by dip transfer 1F (GMAW - 05)

Objectives: This shall help you to

- **prepare and weld corner joint on MS sheet in flat position.**

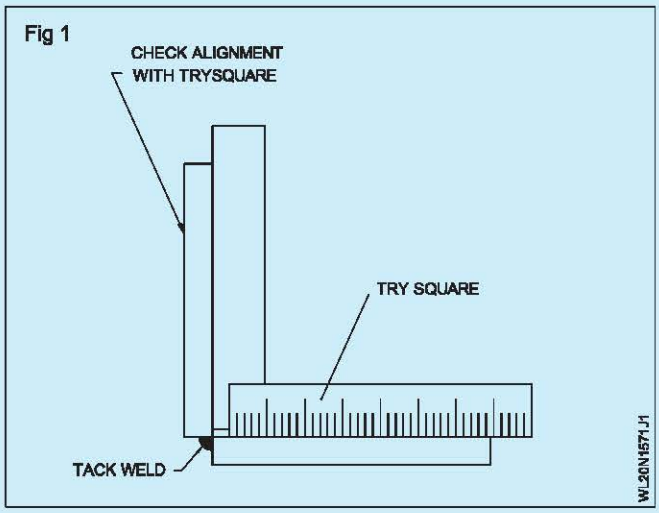
While tack welding, plates A and B for the corner joint the angle between them is to be at 90° degree. (Fig.1)

Since the GMAW 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.

Maintain a uniform travel speed for the torch to get the required bead appearance, reinforcement, penetration and height.

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 unsterilized arc and the Carbon-di-oxide gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

Fig 1



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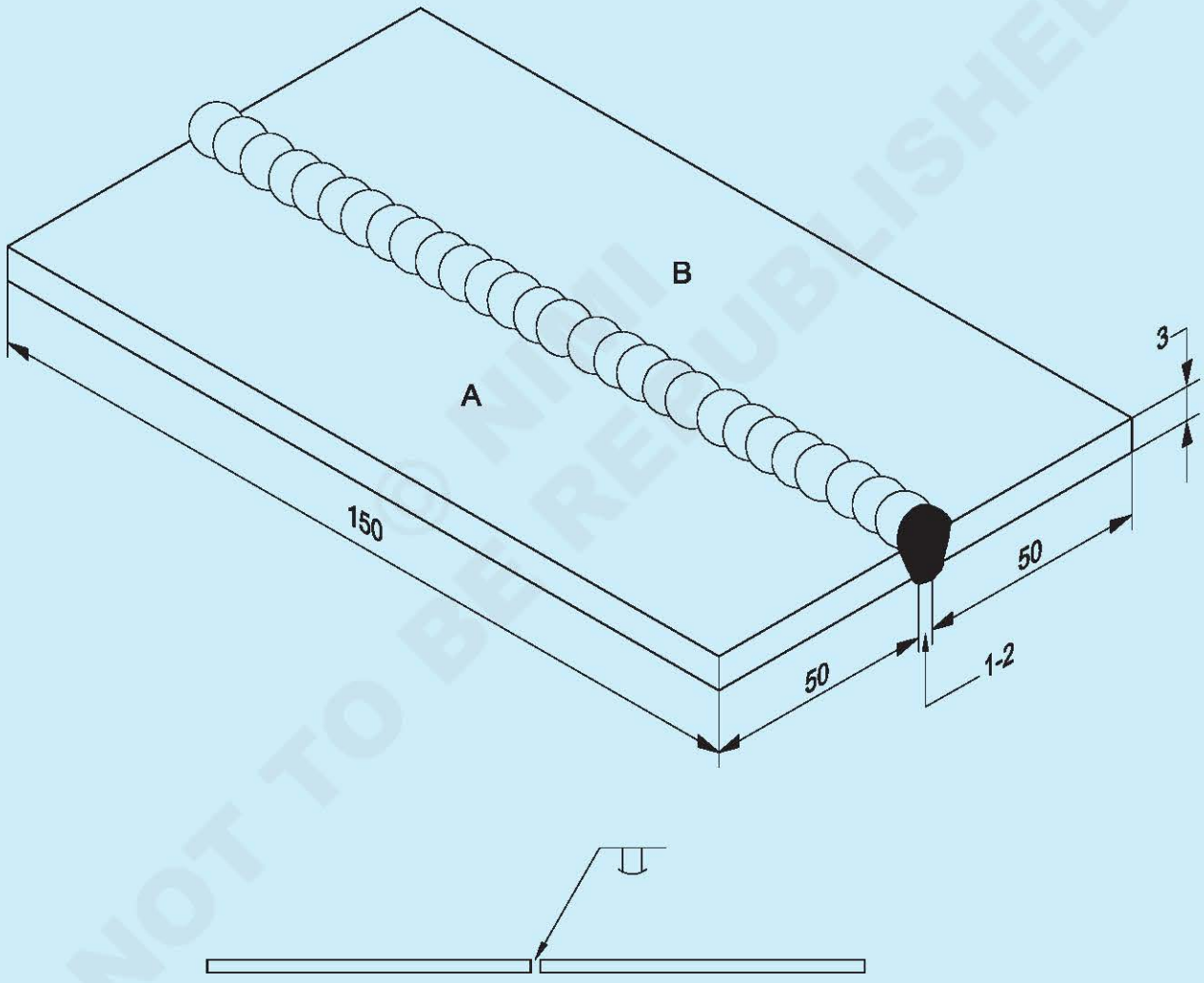
Exercise 1.5.72

Butt weld - Square butt joint on M.S sheet 3mm thick in flat position 1 G (GMAW-06)

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

- **prepare the M.S sheets as per drawing**
- **set the sheet as square butt joint with root gap and tack weld**
- **weld the square butt joint in flat position**
- **clean and inspect for surface defects.**

Scan the QR Code to view the video for this exercise



NOT TO BE REPUBLISHED

2	ISST 50 x 3 - 150		Fe 310 - W			1.5.72
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

SCALE NTS	BUTT WELD SQUARE BUTT JOINT ON M.S SHEET 3mm THICK IN FLAT POSITION	TOLERANCE ±1	TIME
		WL20N1572E1	

Job Sequence

1 Cut the sheet as per drawing.

2 Grind and file the edges of sheets to square.

3 Deburr and clean the surface of the plates by carbon steel wire brush and filling.

4 Set the plate B in parallel with A with roor gap 1 to 2mm flat position as per drawing.

5 Wear protective clothing's.

6 Connect the torch to the positive terminal of the machine.

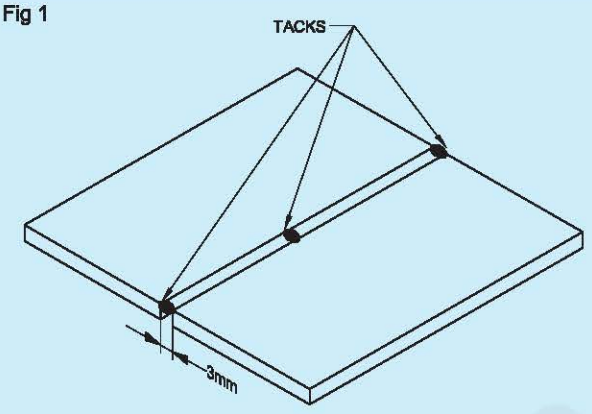
7 Tack weld (min. 10mm length) on both ends of the butt joint as dhown in Fig 1.

8 Keep the tack welded job on welding table flat / down hand position.

9 Weld the butt joint by using 0.8mm dia. Mild steel copper coated filler wire and using stringer bead welding technique.

10 Adjust the welding current to DCEP and 90-100 amperes/ corresponding wire feed rate (3-4m/min), 18 to 2 arc voltage, gas flow of 8 to 10 LPM and stick out of 8 to 10mm and deposit the run by using dip transfer mode.

Fig 1



SETTING AND TACKING

11 Deposit forming a key hole and obtain complete penetration and even fusion of plates.

12 Clean the bead by wire brush.

13 Inspect the welded joint for undercut, uneven bead formation, penetration, distortion and good bead profile.

Skill Sequence

Butt weld - Square butt joint on M.S sheet 3mm thick in flat position 1 G (GMAW-06)

Objectives: This shall help you to

- **prepare and weld square butt joint on MS sheet in flat position.**

Adjust the welding current to DCEP and 90-100 amperes/ corresponding wire feed rate, 18 to 20 arc voltage gas flow of 8 to 10 LPM and stick out of 8 to 10mm and deposit the run by using dip transfer mode while tack welding plates A and B for the butt joint the angle between them is to be at 180 degree.

Since the GMAW 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.

Maintain a uniform travel speed for the torch to get the required bead appearance, reinforcement, penetration and height.

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 unestablished arc and the carbon-di-oxide gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

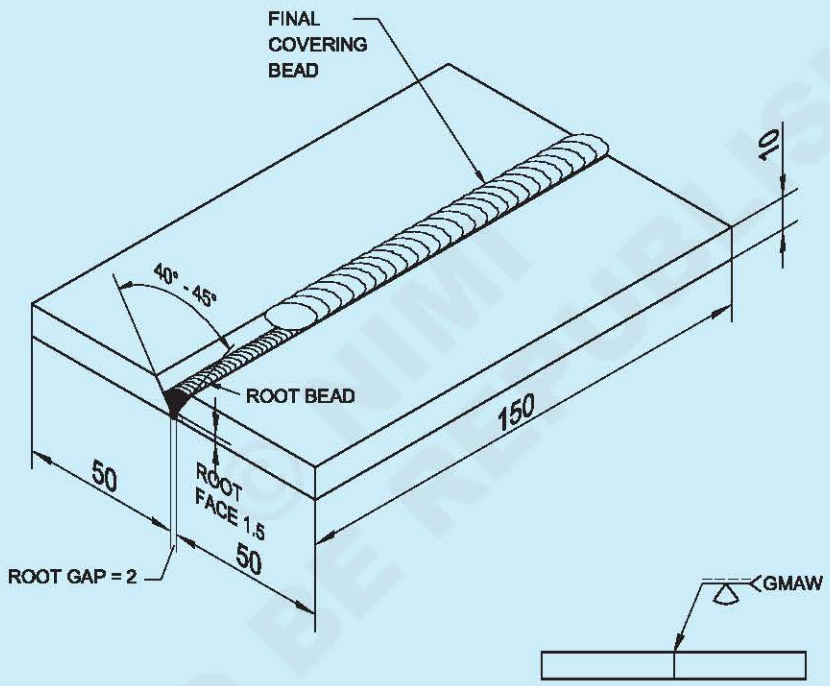
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Exercise 1.5.73

Butt weld single V Butt joint on M.S plate 10mm thick by dip transfer in flat position 1 G (GMAW - 07)

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

- **prepare the plates with beveling using gas cutting and grinding**
- **Set the root gap and tack weld**
- **deposit the root run 2nd and 3rd run using weaving technique**
- **Clean and inspect the weld defects**



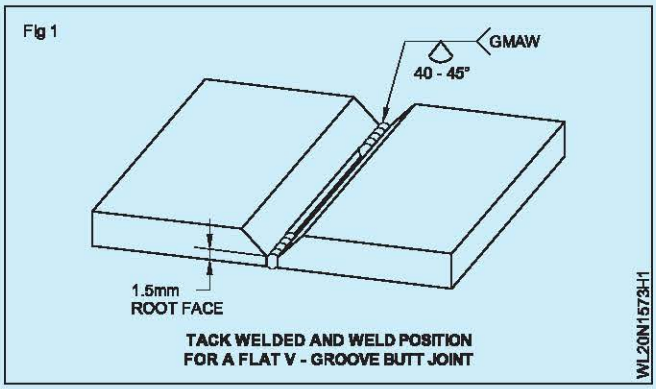
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2	50 ISF 10 - 150		Fe 310 - W			1.5.73
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

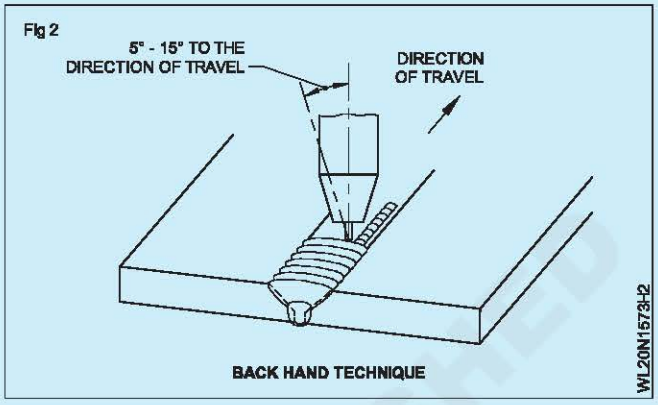
SCALE NTS	BUTT WELD SINGLE 'V' BUTT JOINT ON M.S. PLATE 10mm THICK BY DIP TRANSFER IN FLAT POSITION 1F	TOLERANCE ±1	TIME
		CODE NO.WL20N1573E1	

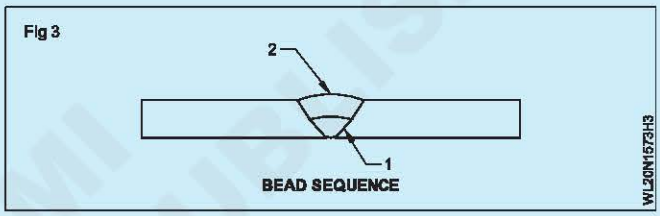
Job Sequence

- Adjust the power source and wire feeder to obtain 18 to 21 volts and 90 and 100 amperes, gas flow 8-10 LPM.
- Thoroughly clean the pieces to be joined. Pay particular attention to the top side of the plate, the sidewalls of the groove and the underside of the joint. Grind or file a 2.0mm root face on each beveled edge as shown in Fig 1.
- Tack the pieces together and position as shown in Fig 1. insert spacers wire between the root gap.



- Hold the gun perpendicular to the joint and strike the arc at the tack. Move the torch from left to right end of the joint i.e use backhand technique (Fig 2). Weave the gun from side to side. When the gun is in the center of the joint, bead to penetrate through the joint and fuse both root faces. If you allow the arc to go too far up on the puddle, your penetration will decrease and you will not penetrate the joint.
- Complete the joint using the bead sequence shown in Fig 3. Use a slight weave to help the weld flow and to fuse to the sidewalls of the groove and the previous beads.
- When you have completed the weld, cool it and examine it.





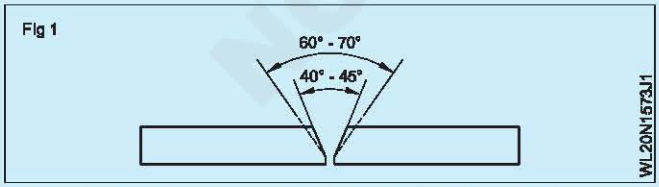
Skill Sequence

Butt weld single V Butt joint on M.S plate 10mm thick by dip transfer in flat position 1 G (GMAW - 07)

Objectives: This shall help you to

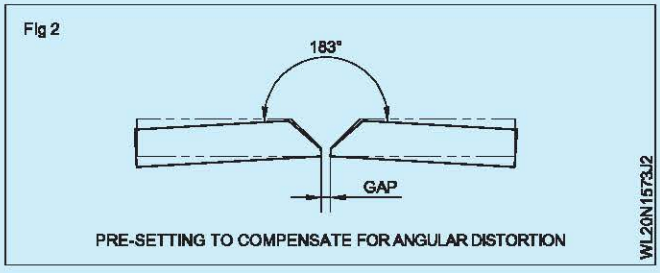
- **prepare and weld single 'Vee' butt joint on MS plate in flat position.**

For CO_2 welding (GMAW process) the plates are bevelled so that the included angle (groove angle) of the single Vee butt joint is 40 to 45° as shown in the Fig 1. This is less compared to MMAW angle which is kept at 60-70°.



To control the transverse distortion it is advisable to preset the joint to 183° for 10mm thick plates as shown in Fig 2.

Distortion may be allowed for by pre-setting the plates in the opposite way so that the weld pulls them to the desired shape. When the weld shrinks it will pull the plates to its correct position shown by dotted line Fig 2.



Maintaining the angle of the torch 5 to 15° towards the direction of travel as shown in Fig 2 in job sequence will help to get better root penetration.

Maintain a stick-out of 5 to 8mm (maximum 10mm).

Set a current of 80-90A for 0.8mm dia wire with a corresponding arc voltage of 180to 19V.

Set a gas flow rate to 8-10LPM so as to protect the weld metal from atmospheric contamination.

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Maintain a faster travel speed of 3 to 4m/min to avoid burn through during the root run. At the same time ensure to get full and even root penetration throughout.

It is very important to clean the root run by carbon steel wire brush to avoid any non-metallic inclusions during the 2nd pass/run.

Set the current to 90 to 100A and an arc voltage of 19 to 20V for the 2nd run.

Maintain a slower travel speed compared to the root run for the 2nd run. Use semicircular side to side weaving movement (crescent motion) to achieve full side wall fusion without any undercuts at either end of the bead.

Maintain a dwell time (pause) of 1 to 2 seconds to get a proper even filling at the end of the toes on either side of the bead.

Maintain a proper and even bead profile and a five reinforcement of 1 to 1.5mm.

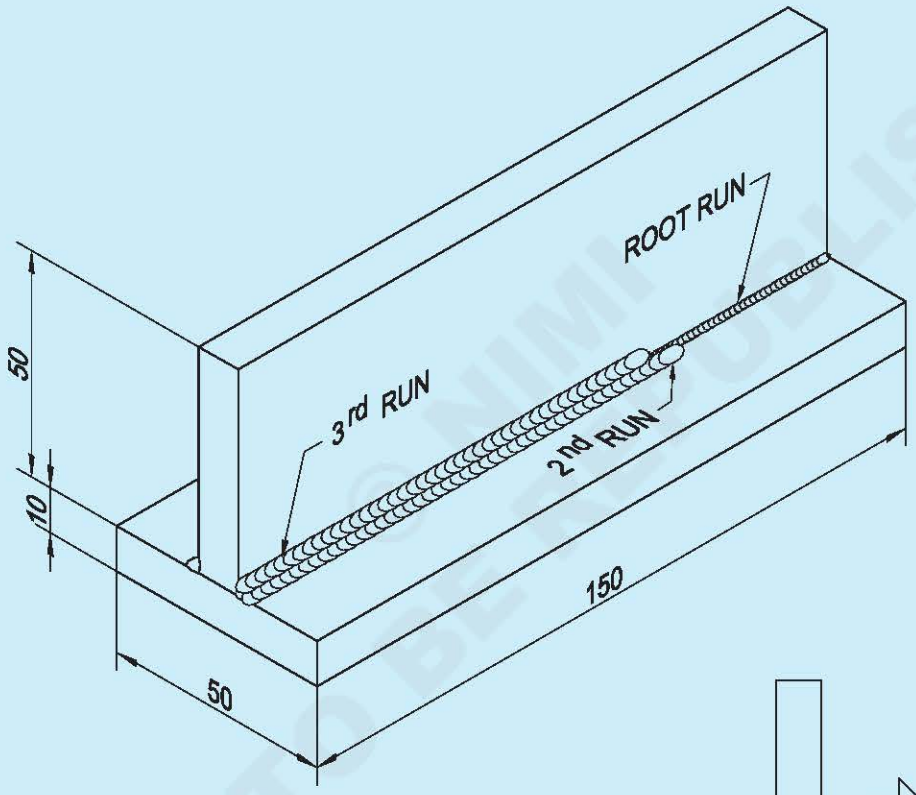
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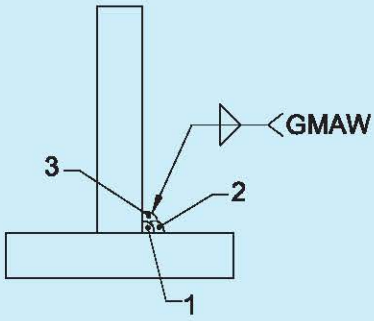
Exercise 1.5.74

Fillet weld Tee joint on M.S plate 10mm thick in horizontal position by dip transfer 2F (GMAW 08)

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

- **prepare and set the job in horizontal position**
- **set GMAW parameters and tack weld**
- **deposit root, 2nd and 3rd run using the stringer bead technique**
- **clean and inspect the weld surface**





NOT TO BE REPUBLISHED

2	50 ISF 10 - 150		Fe 310 - W			1.5.74
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

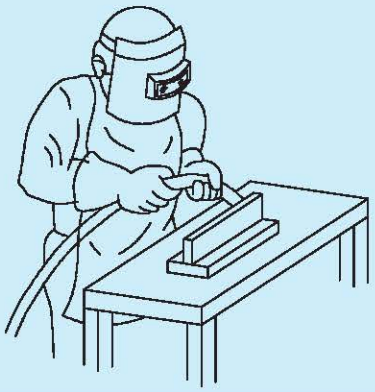
SCALE NTS	FILLET WELD TEE JOINT ON M.S.PLATE 10mm THICK IN HORIZONTAL POSITION BY DIP TRANSFER (2F)	TOLERANCE ±1	TIME
		CODE NO. WL20N1574E1	

Job Sequence

1 Prepare the plates to size (i.e 150 x 50 x 10mm) using gas cutting/grinding/filing.

2 Clean the base metal surface along the welding line with a carbon steel wire brush.

Fig 1



WL20N1574H1

3 Set the plates in the form of "T".

4 Tack weld the 2 plates on either end keeping the T joint in Horizontal position.

5 Strike the arc keeping proper angles for the torch.

6 Deposit the root run without weaving and ensure proper penetration and fill the crater.

7 Clean the root run.

8 Deposit the 2nd run using stringer bead.

9 Clean the 2nd run with steal wire brush.

10 Deposit the 3rd run using stringer bead.

11 Clean the 3rd run with steel wire brush.

12 Check for defects like overlap, undercut, porosity and check for correct leg size and throat thickness.

Skill Sequence

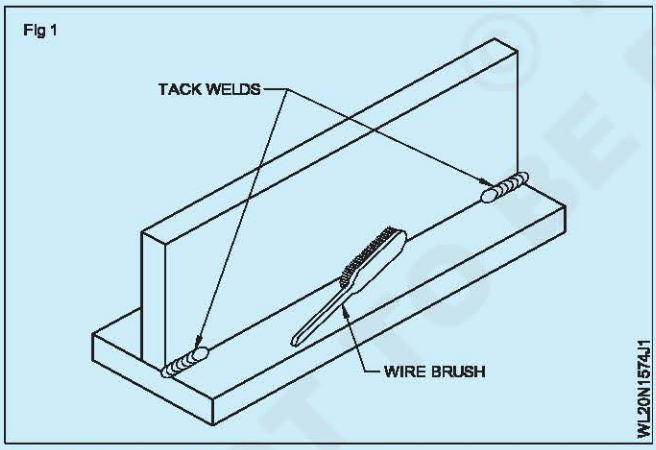
Fillet weld Tee joint on M.S plate 10mm thick in horizontal position by dip transfer 2F (GMAW 08)

Objectives: This shall help you to

- **prepare and weld fillet Tee joint on MS plate in position horizontal.**

1 Setting and tacking of the Tee joint in horizontal position:

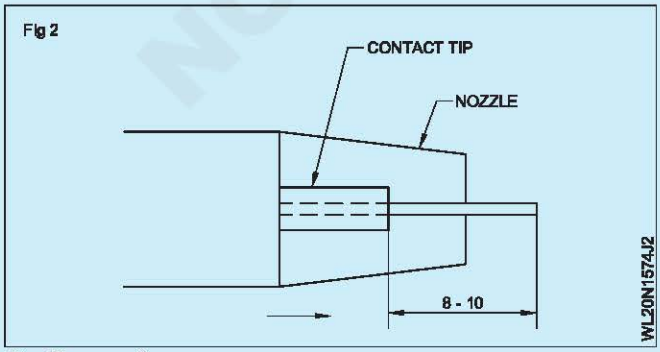
Fig 1



WL20N1574J1

2 Set the welding conditions:

Fig 2

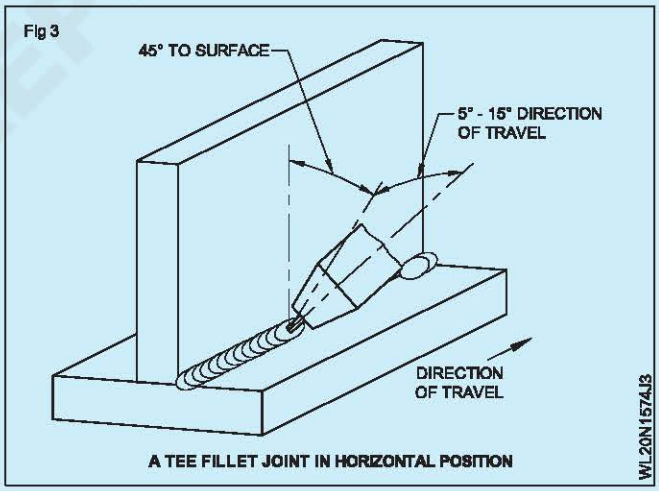


WL20N1574J2

3 Generate an arc:

4 Depositing the root run: Move the torch from left to right

Fig 3



A TEE FILLET JOINT IN HORIZONTAL POSITION

WL20N1574J3

Fill the crater: Clean the scales and other non-metallic materials and spatters from the root run and the joint.

Deposit the 2nd run using stringer bead technique such that the bead covers two thirds of the root run deposit and the bottom plate as shown in the Fig 5.

Clean the bead and the plate surface with carbon steel wire brush.

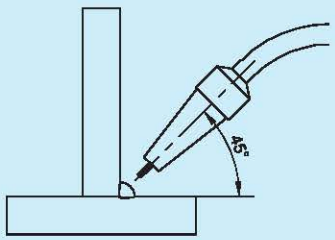
Deposit the 3rd run using stringer bead technique such that the bead covers the root run, two thirds of 2nd run and the vertical plate member as shown in the Fig 6.

In addition the leg length 'L' has to be maintained as 8mm.

The torch angle between the plates has to be changed as shown in the Figs 4, 5 and 6.

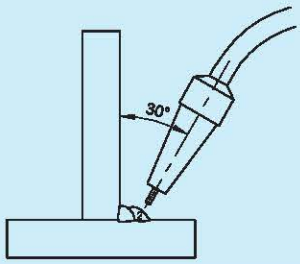
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Fig 4



WL20N1574J4

Fig 5



WL20N1574J5

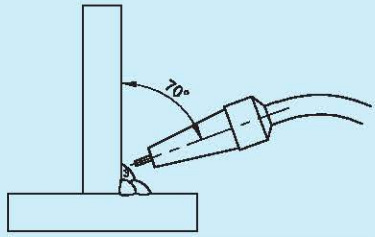
The torch angles are to be changed for 2nd and 3rd run in order to deposit the weld metal at proper places so that the correct leg length can be obtained. This also helps to avoid defects like overlap, undercut, insufficient throat thickness etc.

Ensure uniform travel speed for the torch for all the 3 runs to get proper bead profile and appearance.

Clean the joint after completion of the 3rd run.

As and when required, the torch nozzle is to be cleaned with anti-spatter spray / gel during welding.

Fig 6



WL20N1574J6

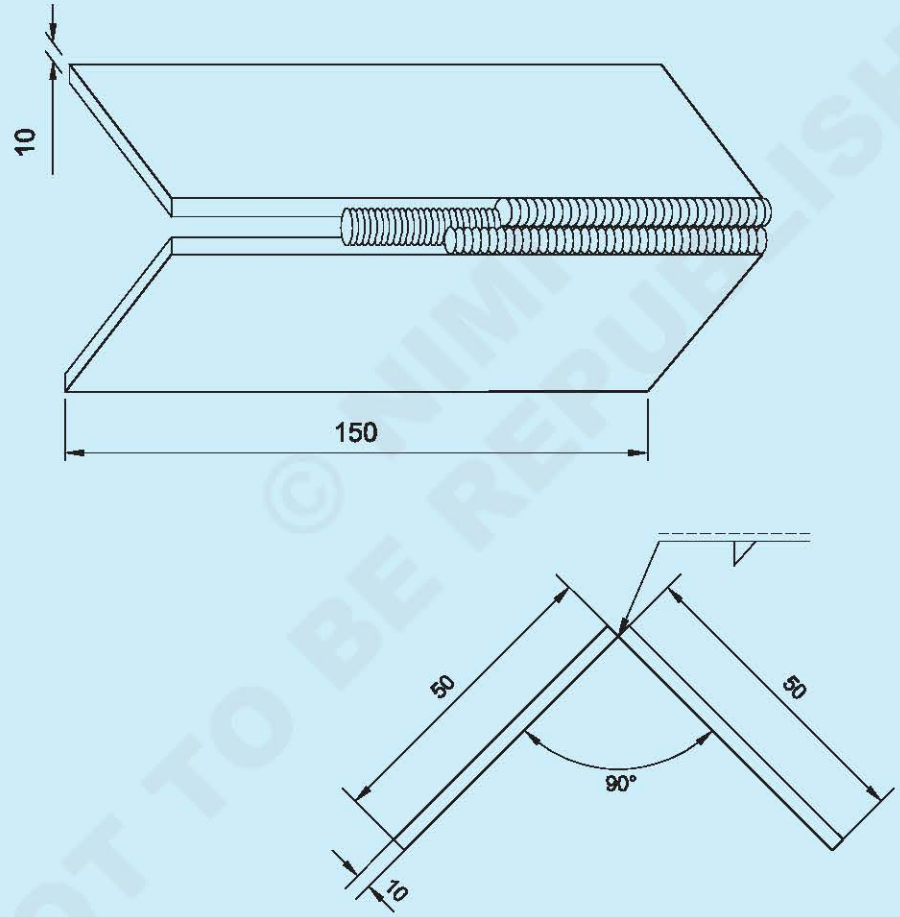
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Exercise 1.5.75

Fillet weld corner joint on M.S plate 10mm thick in horizontal position by dip transfer (2F) (GMAW - 09)

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

- **prepare and set the job as per drawing**
- **tack weld and set the job in horizontal position**
- **deposited root, 2nd and 3rd run using the stringer bead technique**
- **clean and inspect for surface defects**



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2	ISF 50 x 10 - 150		Fe 310			1.5.75
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO
SCALE NTS	**FILLET WELD - CORNER JOINT ON M.S.PLATE 10mm THICK IN HORIZONTAL POSITION DIP TRANSFER (2F)**				TOLERANCE ±0.5	TIME
					WL20N1575E1	

Job Sequence

1 Prepare the plates to size i.e 150 x 50 x 10mm by using gas cutting, grinding and filling.

2 Clean the base metal surface along the welding line with a carbon steel wire brush.

3 Set the plate in the form of corner joint as per drawing.

4 Wear protective clothing's.

5 Connect the torch to the positive terminal of the machine.

6 Set the current 90 to 100amps by corresponding wire feeding rate, 19 to 2 arc voltage and use dip transfer mode.

7 Tack weld (min. 10mm length) on both ends of the corner joint as shown in Fig 1.

8 Deposit root run by maintain key hole for fine penetration.

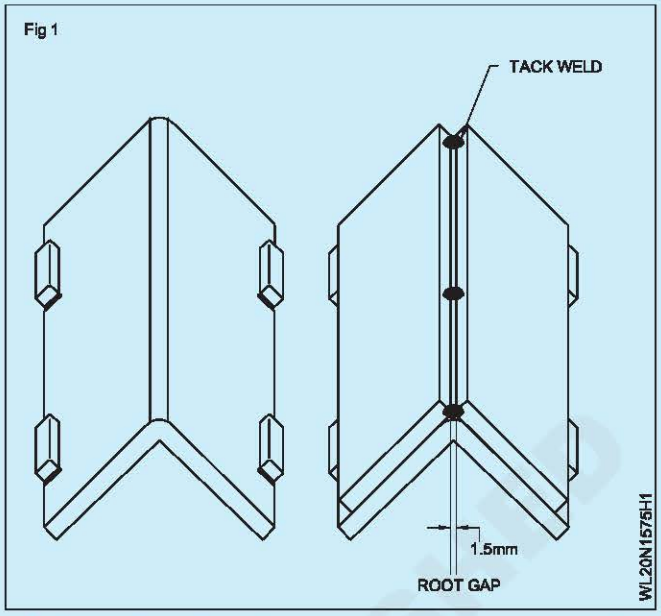
9 Clean the root run by wire brush.

10 Deposit the 2nd run using stringer bead.

11 Clean the 2nd run with steel wire brush.

12 Deposit the 3rd run using stringer bead and clean the bead by steel wire brush.

Fig 1



13 Check for defects like overlap, under cut, penetration, distortion and good bead profile.

Skill Sequence

Fillet weld corner joint on M.S plate 10mm thick in horizontal position by dip transfer (2F) (GMAW - 09)

Objectives: This shall help you to

- **prepare and weld fillet corner joint on MS plate in horizontal position.**

While tack welding plates. A and B for the corner joint the angle between them is to be kept at 90°.

Since GMAW 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. Maintain a uniform travel speed for the torch to get the required bead appearance, reinforcement, and height.

Use the anti spatter spray as and when the torch nozzle gets dogged with spatters. Note that if this is not done, the wire feed may be irregular causing unsuitabilished arc and the CO_2 gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

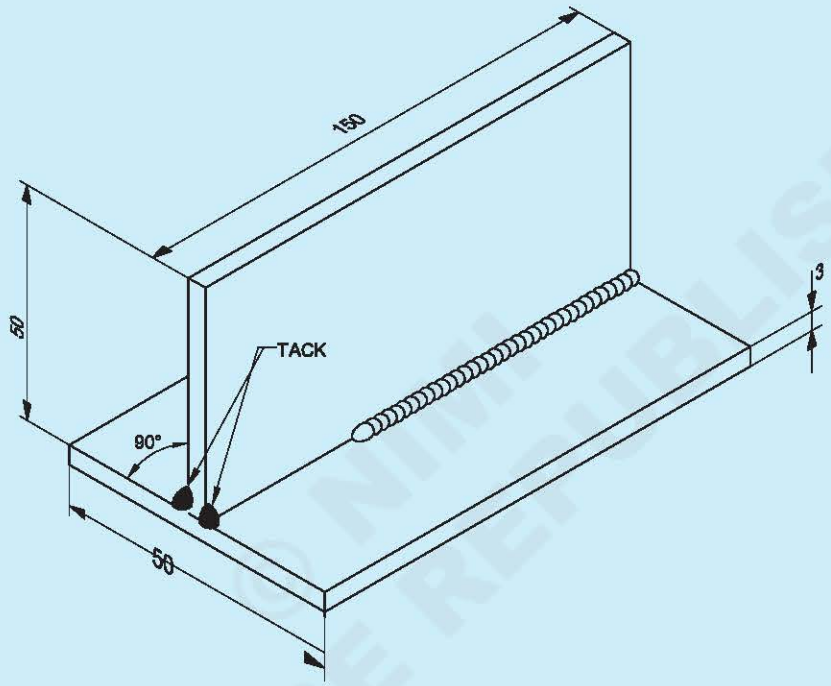
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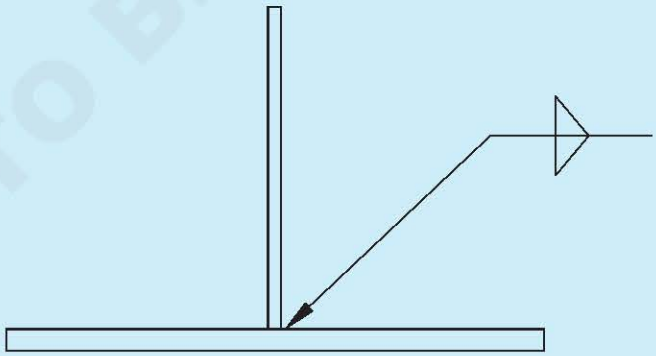
Exercise 1.5.76

Fillet weld 'T' joint on M.S sheet 3mm thick in horizontal position by dip transfer 2F (GMAW - 10)

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

- **prepare the job, set and tack weld as per drawing**
- **set the job in horizontal position**
- **deposit the bead using stringer bead technique**
- **clean and inspect for surface defects**





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2	ISST 50 x 3 - 150		Fe 310 - W			1.5.76
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO
SCALE NTS	**FILLET WELD TEE JOINT ON M.S. SHEET 3mm IN HORIZONTAL POSITION BY DIP TRANSFER (2F)**				TOLERANCE ±0.5	TIME
					WL20N1576E1	

Job Sequence

1 Cut the sheet as per drawing.

2 Grind and file the edges of sheet to square

3 Deburr and clean the surface of the plates by carbon steel wire brush and filing.

4 Set the Tee as per drawing.

5 Wear protective clothing's.

6 Connect the torch to positive terminal of the machine.

7 Tack weld (min. 10mm length) on both ends of the tee joint as shown in the Fig 1.

8 Keep the tack welded job in horizontal position.

9 Set current to 90 - 100 amperes / corresponding wire feeding rate (3 to 4 m/min), 19 to 2 arc voltage and deposit the root run using dip transfer mode.

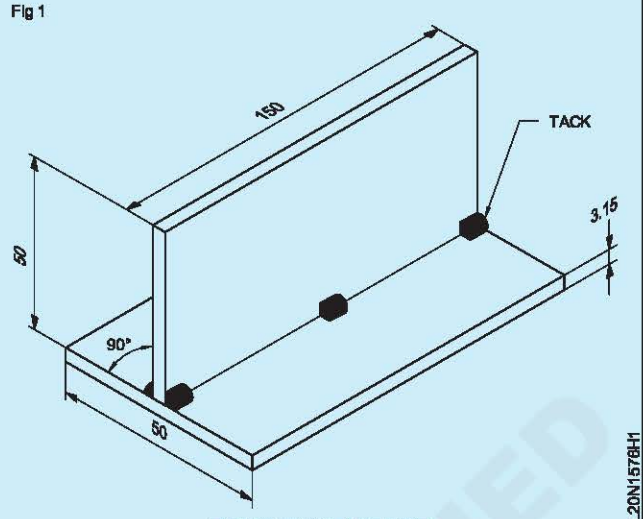
10 Weld the Tee joint by using 0.8mm dia copper coated. Mild steel filler wire and using stringer bead welding technique.

11 Ensure good leg length and even fusion of plates.

12 Avoid under cut.

13 Ensure the edges of the plate is not melted off due to excessive weaving.

Fig 1



TACK WELDING A TEE JOINT

14 Ensure there is no undercut.

15 Clean the bead by steel wire brush.

16 Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile.

Skill Sequence

Fillet weld 'T' joint on M.S sheet 3mm thick in horizontal position by dip transfer 2F (GMAW - 10)

Objectives: This shall help you to

- **prepare and weld fillet Tee joint on MS sheet in horizontal position.**

While tack welding plates A and B for the Tee joint the angle between them is to be kept at 91° initially as shown in Fig 1 (i.e a distortion allowance of 1° per run) or Tee fillet joints distortion allowance is recommended.

Since GMAW 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.

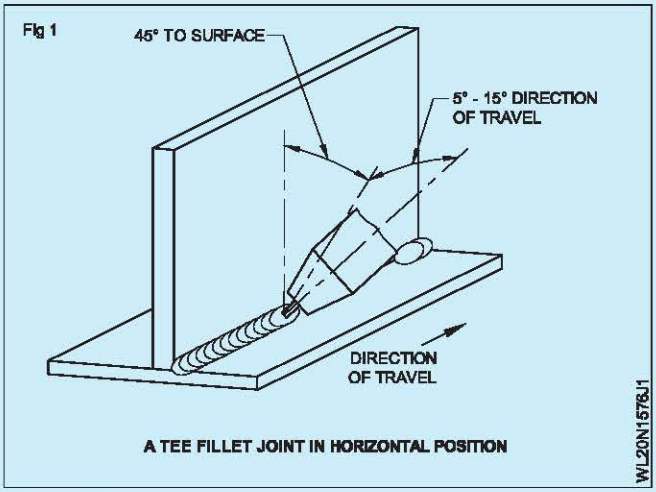
For welding the joints in flat (down hand) position it is convenient to use the channel to position the joints. This will permit the tack welded job to be kept at 45° angle with the horizontal plane.

The gun is held perpendicular to the joint at angle of 5 to 15 degree forward to the direction of travel as shown in Fig 1.

The torch movement at the edge of the top plate of the Tee 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 toe is properly filled with filler metal.

Maintain a uniform travel speed for the torch to get the required bead reinforcement, height and appearance. Use

Fig 1



A TEE FILLET JOINT IN HORIZONTAL POSITION

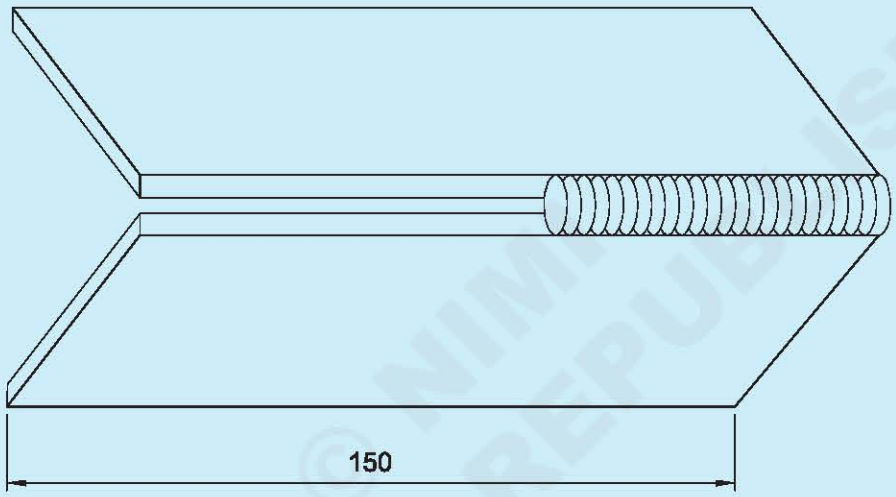
the anti-spatter spray as and when the torch nozzle gets clogged with weld spatters. Note that if this is not done, the wire feed may be irregular causing unestablished arc and the carbon-di-oxide gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

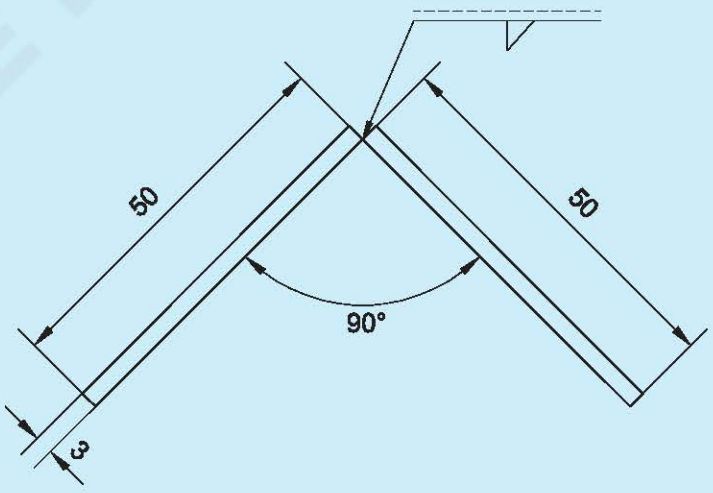
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Fillet weld - corner joint on M.S sheet 3mm thick in horizontal position by dip 2F transfer (GMAW - 11)

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

- **prepare plates as per drawing**
- **set and tack weld the plates**
- **set the corner joint in Horizontal position**
- **deposited the bead with appropriate amount of filler metal**
- **clean and inspect for surface defects on the weld**





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2	ISST 50 x 3 - 150		Fe 310 - W			1.5.77
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO
SCALE NTS	**FILLET WELD CORNER JOINT ON M.S.SHEET 3mm THICK IN HORIZONTAL POSITION BY DIP TRANSFER 2F**				TOLERANCE ±0.5	TIME
					WL20N1577E1	

Job Sequence

1 Cut the sheet as per drawing.

2 Grind and file the edges of sheet to square.

3 Deburr and clean the surface of the plates by carbon steel wire brush and filing.

4 Set the plate in the form of Corner joint at 90 degrees with specified root gap in flat position as per drawing.

5 Wear protective clothing.

6 Connect the torch to positive terminal of the machine.

7 Set current to 90 - 100 amperes / corresponding wire feeding rate 19 to 2 Arc voltage and deposit the root run 3-4m/mm using dip transfer mode.

8 Tack weld (min 10mm length) on both ends of the corner joint as shown in the Fig 1.

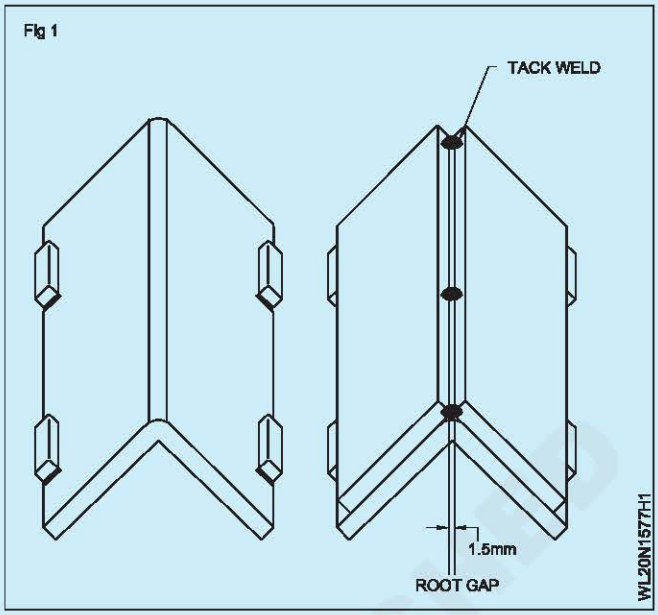
9 Keep the tack welded job in horizontal position.

10 Weld the corner joint by using 0.8mm dia. Mild steel copper coated filler wire and using stringer bead welding technique.

11 Deposit root run on the joint by forming key hole and obtain complete penetration and even fusion of plates.

12 Clean the bead by steel wire brush.

Fig 1



13 Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile.

Skill Sequence

Fillet weld - corner joint on M.S sheet 3mm thick in horizontal position by dip 2F transfer (GMAW - 11)

Objectives: This shall help you to

- **prepare and weld corner joint on MS sheet in horizontal position.**

Maintain a key hole and uniform travel speed for the torch to get the required bead appearance, reinforcement, height. 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 Carbon-di-oxide gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

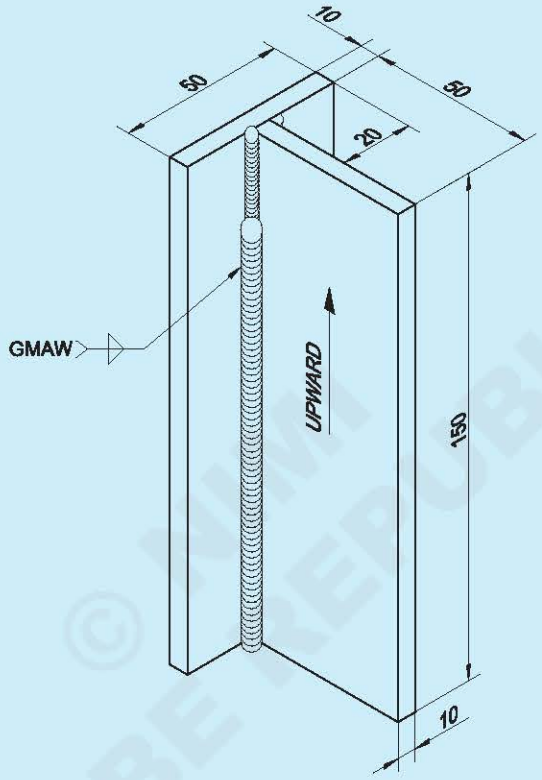
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Exercise 1.5.78

Fillet weld - Tee joint on M.S plate 10mm thick in vertical position by (vertical up) dip transfer 3F (GMAW - 12)

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

- **prepare the plates and tack weld as per drawing**
- **set the job by using positioner in vertical position**
- **deposit root run, 2nd run by weaving technique**
- **clean and inspect the weld defects**



Job Sequence

1 Prepare the plates to size (i.e 150 x 50 x 10mm) using gas cutting, grinding and filing.

2 Clean the base metal surface along the welding line with a carbon steel wire brush.

3 Set the plates in the form of an "T".

4 Wear all protective apparels.

5 Tack weld the 2 plates, keeping the T joint in horizontal position.

6 Adjust the power source and wire feeder (3-4m/min) to obtain 18 to 21 volts and 90 - 100 amperes, gas flow of 8 - 10LPM (Litre per minute). Select the lower side of the range for vertical welding.

7 Strike the arc keeping proper angles for the torch.

8 Deposit the root run without weaving and ensure proper penetration and fill the crater.

9 Clean the root run.

10 Deposit the 2nd run.

11 Clean the 2nd run.

12 Check for defects like overlap, undercut, porosity and check for correct leg size and throat thickness.

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2	50 ISF 10 - 150		Fe 310 - W			1.5.78
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

SCALE NTS	FILLET WELD TEE JOINT ON M.S. PLATE 10mm IN VERTICAL POSITION (UPWARD) (3F) GMAW-12	TOLERANCE ±1	TIME
		CODE NO. WL20N1578E1	

Skill Sequence

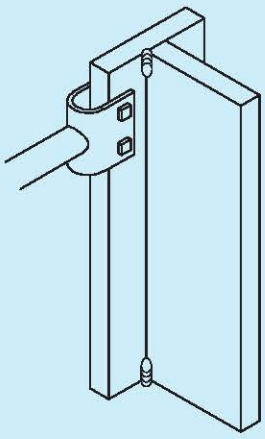
Fillet weld - Tee joint on M.S plate 10mm thick in vertical position by (vertical up) dip transfer 3F (GMAW - 12)

Objectives: This shall help you to

- **prepare and weld fillet Tee joint on MS plate in vertical position.**

Thoroughly clean the pieces to be joined, tack them together and position them as shown in Fig 1.

Fig 1

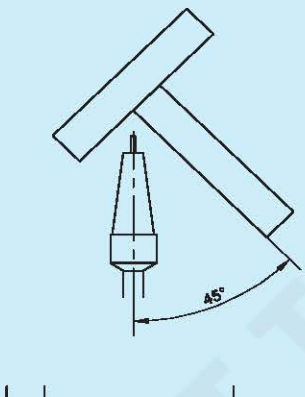


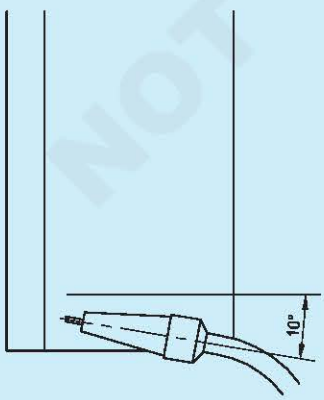
WELD POSITION FOR A VERTICAL UP TEE JOINT FILLET

WI.20N1578H1

Beginning at the bottom of the joint, use the gun angles shown in Fig 2. Begin to weld using a weaving motion similar to that given in Fig.3.

Fig 2





GUN ANGLES

WI.20N1578H2

The weld will deposit a shelf at the bottom of the joint on which you can build. Be certain when you weave the gun that the arc reaches the root of the joint to ensure good root penetration. Pause on the sides to fill in the weld and prevent undercut. Increase the travel speed of the gun when moving from side to side to prevent excessive buildup, which would make a very convex bead.

Complete the first pass, keeping the fillet size as close to 6mm as possible.

Cool the plate thoroughly and deposit a second pass. Keep the size of the second pass fillet to 8mm. (see Fig 4)

The weaving pattern to be used for the second pass is shown in Fig 5.

Weld the other side of the T assembly, using the same technique as for the first side.

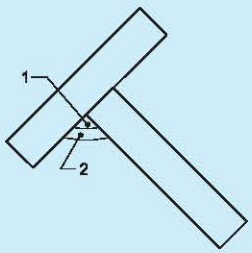
Fig 3



WEAVE PATTERN

WI.20N1578H3

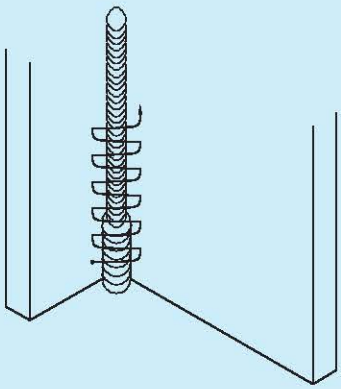
Fig 4



BEAD SEQUENCE

WI.20N1578H4

Fig 5



WI.20N1578H5

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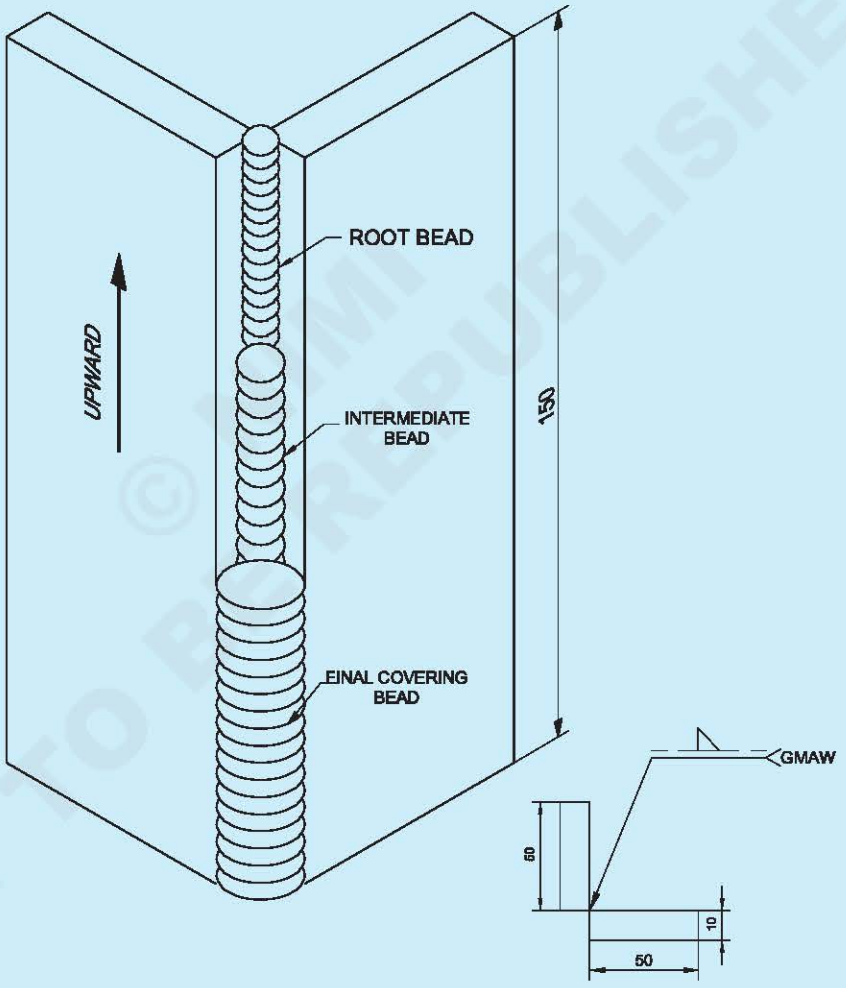
Exercise 1.5.79

Fillet weld outside corner joints on MS plate 10mm vertical position upward by dip transfer 3F (GMAW - 13)

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

- **mark and cut the piece asper drawing**
- **set the root gap and tack weld**
- **weld root, 2nd and 3rd weaving bead in vertical position**
- **clean and inspect the weld defects.**

Scan the QR Code to view the video for this exercise



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2	50 ISF 10 - 150		Fe 310 - W			1.5.97
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO
SCALE NTS	**FILLET WELD OUTSIDE CORNER JOINT ON MS PLATE 10mm IN VERTICAL POSITION (UPWARD) BY LAY DIP TRANSFER (3F) GMAW-13**				TOLERANCE ±1	TIME
					CODE NO : WL20N1579E1	

Job Sequence

1 Cut the flat, hack sawing / gas cutting.

2 Grind and file the edges of flat to square.

3 Deburr and clean the surface of the plates by carbon steel wire brush and filling.

4 Set the plate in the form of corner as per drawing.

5 Wear protective clothes.

6 Connect the torch to the positive terminal of the machine.

7 Set the current 90 to 100 amps by corresponding wire feeding 3-4m/min, 19 to 2 arc voltage and use dip transfer mode.

8 Tack weld (min.10 mm length) on both ends of the corner joint as shown in Fig 1.

9 Keep the tack welded jig in vertical position on a weld positioner.

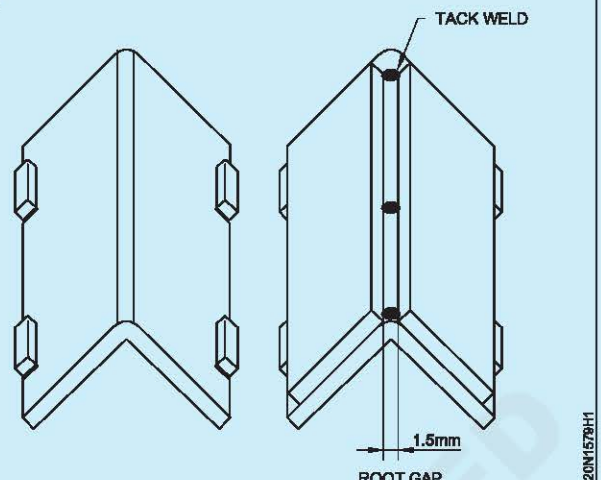
10 Strike an arc and move the torch steady straight from the bottom to top.

11 Weld the corner joint by using 0.8mm dia copper coated. Mild steel filler wire and using stringer bead welding technique.

12 Ensure good leg length and even fusion of plates.

13 Avoid under cut.

Fig 1



14 Ensure the edges of the plate is not melted off due to excessive weaving

15 Ensure there is no undercut at the other toe of the corner weld on plate

16 Clean the bead by steel wire brush

17 Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile.

Skill Sequence

Fillet weld outside corner joints on MS plate 10mm vertical position upward by dip transfer 3F (GMAW - 13)

Objectives: This shall help you to

- **prepare and weld outside corner joint on MS plate in vertical position.**

While tack welding plates A and B for the corner joint the angle between them is to be kept at 90°.

Since GMAW 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 the plate surface.

Maintain a uniform travel speed for the torch to get the required bead appearance, reinforcement, and height.

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 unstabilished arc and the CO_2 gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

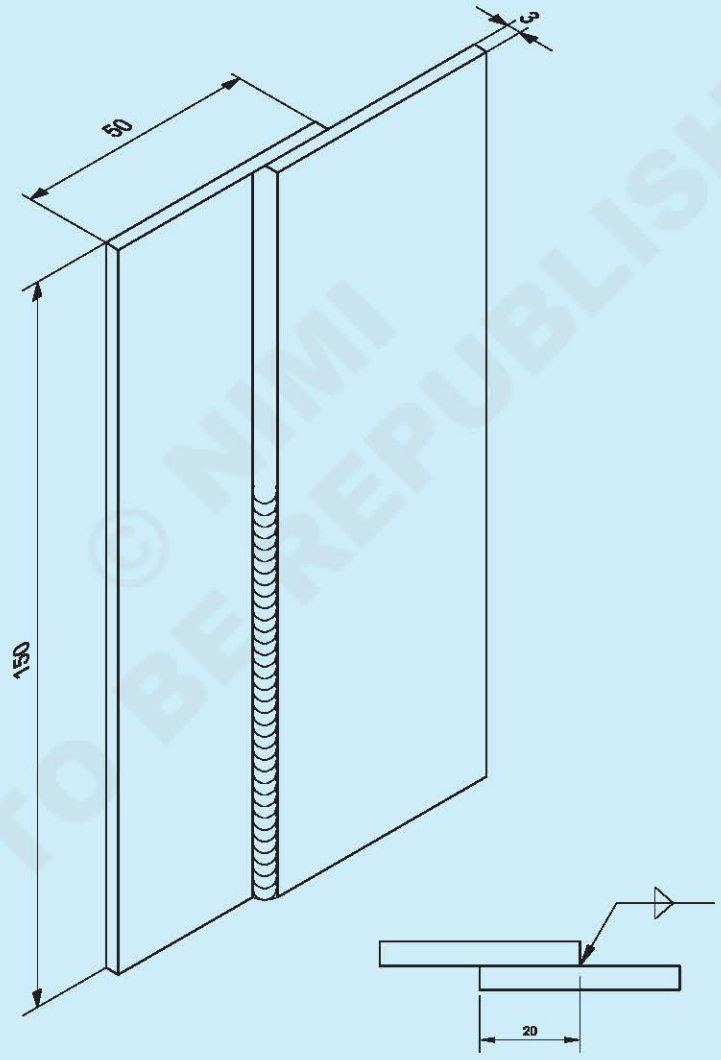
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Exercise 1.5.80

Fillet weld - Lap joint on M.S sheet 3mm thick in vertical position by dip transfer 3F (GMAW - 14)

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

- **prepare the plates as per drawing**
- **tack weld and set the job in vertical**
- **deposit root run and 2nd run by weaving bead**
- **clean and inspect for surface defects on the weld.**



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2	ISST 50 x 3 x 150		Fe 310 - W			1.5.80
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO
SCALE NTS	FILLET WELD - LAP JOINT M.S. SHEET 3mm THICK IN VERTICAL POSITION BY DIP TRANSFER (3F) GMAW-14				TOLERANCE ±0.5	TIME
					WL20N1580E1	

Job Sequence

1 Cut the sheet as per drawing.

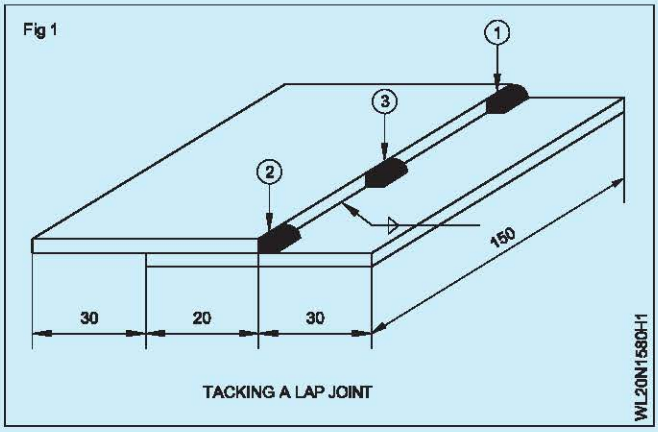
2 Grind and file the edges of sheets to square.

3 Deburr and clean the surface of the plates by carbon steel wire brush and filling.

4 Set in the form of lap as per drawing.

5 Wear protective clothes.

6 Connect the torch to the positive terminal of the machine.



7 Set 90-100A current/corresponding wire feed rate, 19 to 2 arc voltage and deposit the run using Dip transfer mode.

8 Tack weld (min. 10mm length) on both ends of the lap joint as shown in Fig 1.

9 Keep the tack welded job in vertical position on a weld positioner.

10 Strike an arc and move the torch steady straight from the bottom to top upwards.

11 Weld the lap joint by using 0.8mm dia copper coated. Mild steel filler wire and using stringer bead welding technique.

12 Ensure good leg length and even fusion of plates.

13 Avoid under cut.

14 Ensure the edges of the plate is not melted off due to excessive weaving.

15 Ensure there is no undercut lap weld on plate.

16 Clean the bead by steel wire brush.

17 Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile.

Skill Sequence

Fillet weld - Lap joint on M.S sheet 3mm thick in vertical position by dip transfer 3F (GMAW - 14)

Objective: This shall help you to
- **prepare and deposit weld lap joint on MS sheet in vertical position.**

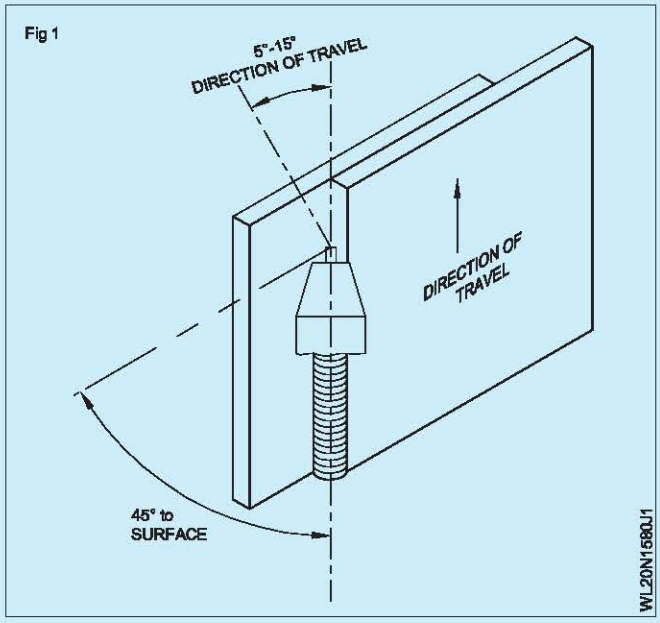
For the lap fillet joints no distortion allowance is recommended

Since the GMAW 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.

The gun is held perpendicular to the joint at angle of 5 to 15 degree forward to the direction of travel as shown in Fig 1.

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 toe is properly filled with filler metal.

Maintain a uniform travel speed for the torch to get the required bead reinforcement, height and appearance. 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 Carbon-di-oxide gas flow will not be uniform causing atmospheric contamination of the weld and porosity.



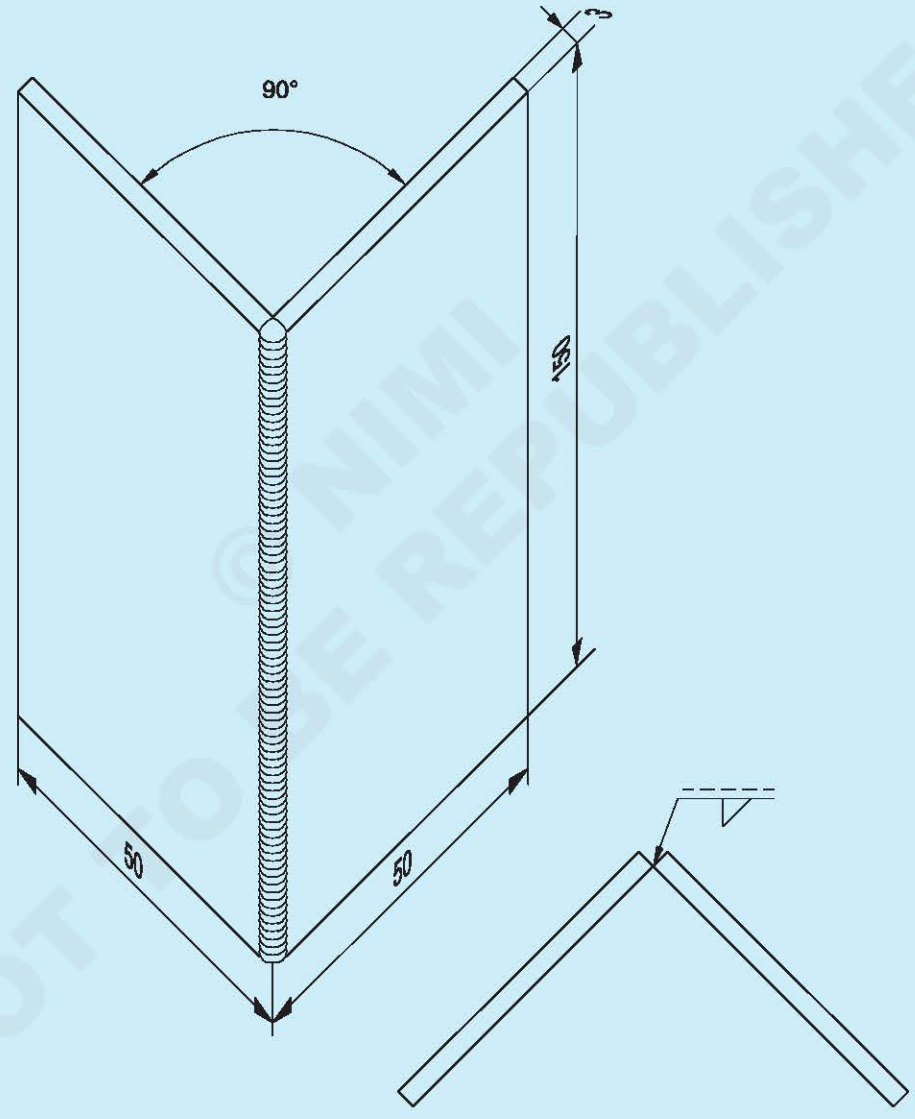
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Exercise 1.5.81

Fillet weld - corner joint on M.S sheet 3mm in vertical position by dip transfer 3F (GMAW - 15)

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

- **prepare the sheet as per drawing**
- **set and tack weld the sheets**
- **set the corner joint in vertical position**
- **deposited the bead with appropriate amount of filler metal**
- **clean and inspect for surface defects.**



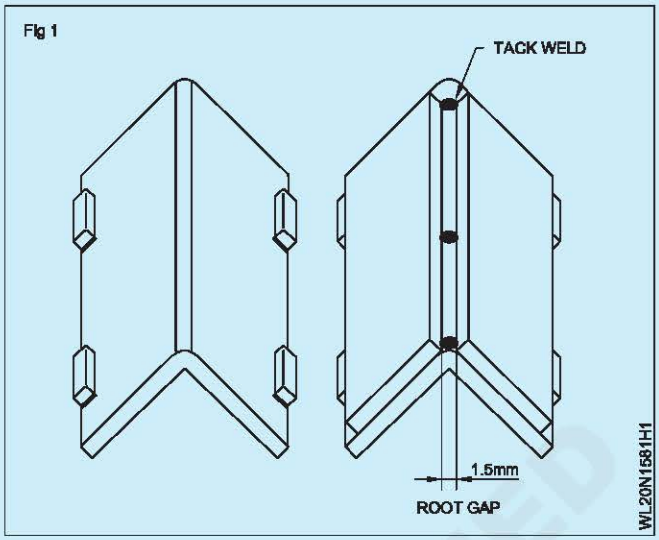
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2	ISST 50 x 3 - 150		Fe 310 - W			1.5.81
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO
SCALE NTS	**FILLET WELD OUT SIDE CORNER JOINT ON M.S.SHEET 3mm IN VERTICAL POSITION BY DIP TRANSFER (3F) GMAW-15**				TOLERANCE ±0.5	TIME
					WL20N1581E1	

Job Sequence

- Cut the sheet as per drawing.
- Grind and file the edges of sheets to square.
- Deburr and clean the surface of the plates by carbon steel wire brush and filling.
- Set the plate in the form of corner as per drawing.
- Wear protective clothes.
- Connect the torch to the positive terminal of the machine.
- Set 90-100A current/corresponding wire feed rate, 3-4m/min19 to 2 arc voltage and deposit the run using Dip transfer mode.
- Tack weld (min. 10mm length) on both ends of the corner joint as shown in Fig 1.
- Keep the tack welded job in vertical position on a weld positioner.
- Strike an arc and move the torch steady straight from bottom to top.
- Weld the corner joint by using 0.8mm dia copper coated. Mild steel filler wire and using stringer bead welding technique.
- Ensure good leg length and even fusion of plates.
- Avoid under cut.

Fig 1



- Ensure the edges of the plate is not melted off due to excessive weaving.
- Ensure there is no undercut at the toe of the weld on plate.
- Clean the bead by wire brush.
- Inspect the welded joint for undercut, porosity, uneven bead formation, edge of the plate melted off, distortion and good bead profile.

Skill Sequence

Fillet weld outside corner joints on MS plate

Objectives: This shall help you to
- **prepare and weld outside corner joint on MS plate in vertical position.**

While tack welding plates A and B for the corner joint the angle between them is to be kept at 90°.

Since GMAW 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 the plate surface.

Maintain a uniform travel speed for the torch to get the required bead appearance, reinforcement, and height.

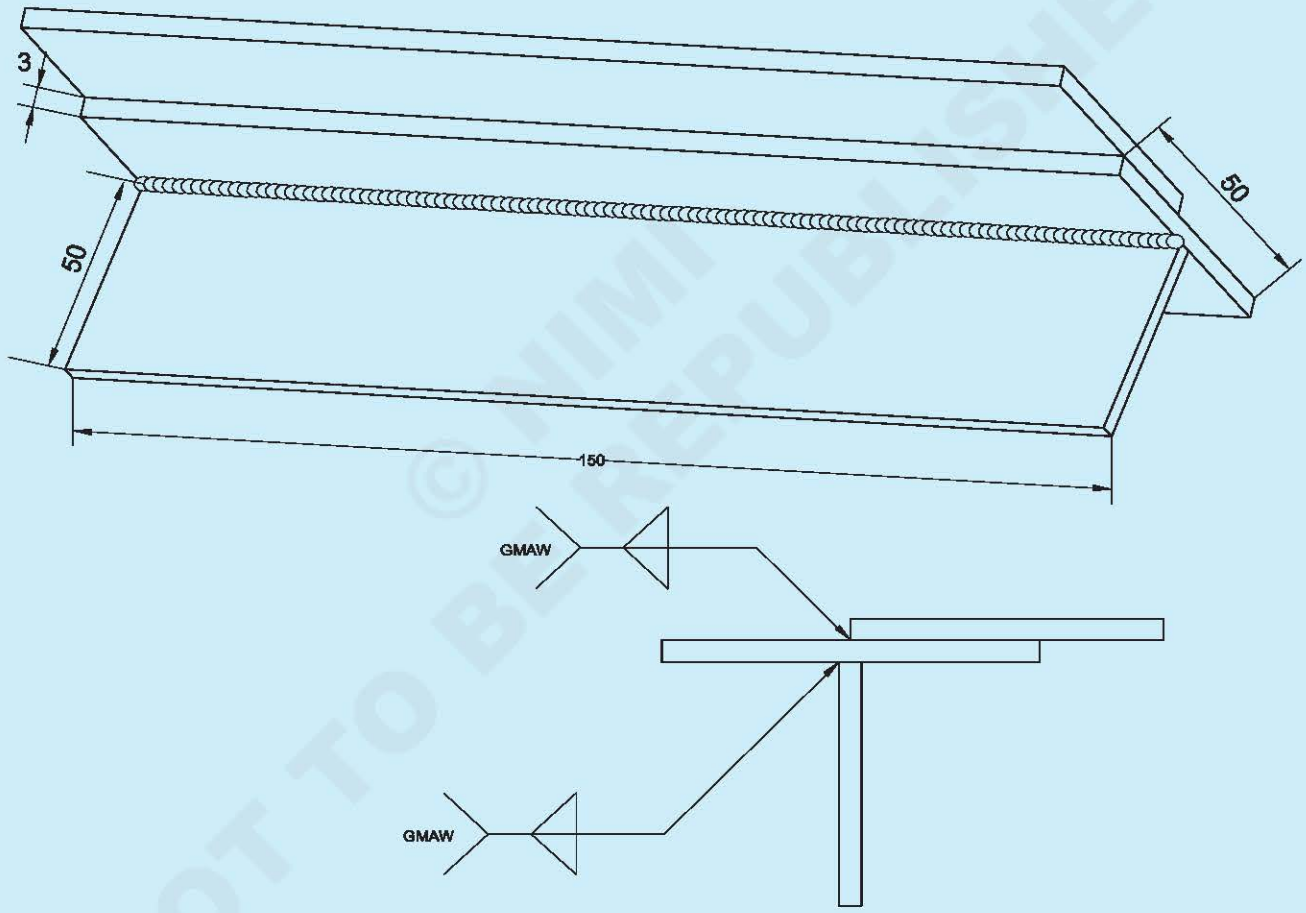
Use the anti spatter spray as and when the torch nozzle gets clogged with weld spatters. Note that if this is not done, the wire feed may be irregular causing unestablished arc and the CO_2 gas flow will not be uniform causing atmospheric contamination of the weld and porosity.

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Fillet weld - lap and 'T' joint on M.S sheet 3mm thick in overhead position by dip transfer 4F (GMAW - 16)

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

- **prepare the sheets as per drawing**
- **set and tack weld the sheets as lap and 'T' as per drawing**
- **set the job over head position for welding**
- **deposited the metal in the joints with proper leg length**
- **inspect for surface defects on the weld bead.**



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3	ISST 50 x 3 x 150		Fe 310 - W			1.5.82
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO
SCALE NTS	FILLET WELD LAP AND TEE JOINT ON M.S.SHEET 3mm THICK IN OVER HEAD POSITION BY DIP TRANSFER (4F) GMAW-16				TOLERANCE ±1	TIME
					WL20N1582E1	

Job Sequence

1 Cut the sheets by as per drawing.

2 Grind and file the edges of sheets to square.

3 Use plain goggles while grinding

4 Deburr and clean the surface of the sheets by carbon steel wire brush and filling.

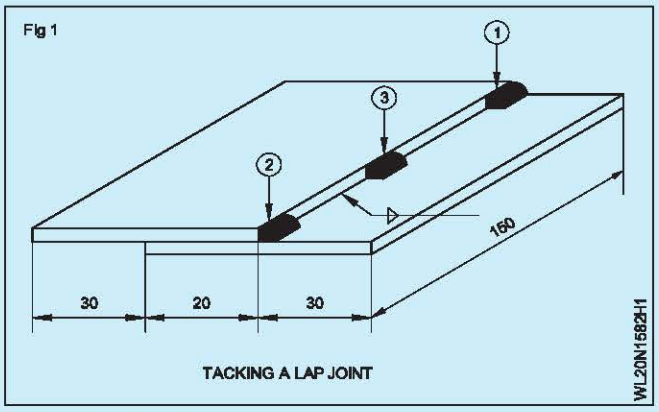
5 Set the sheet form of Tee as per drawing Fig 2.

6 Wear protective clothes.

7 Tack weld (min. 10mm length) on both ends of the Tee joint as shown in Fig 2.

8 Set the sheet Lap joint as per drawing Fig 1 on the 50mm sheet.

9 Tack weld (keeping minimum length of 10 mm) on both sides of the lap joint as shown in the Fig 1.



10 Fix the tack welded job in the weld positioned to overhead position.

11 Connect the torch to the positive terminal of the machine.

12 Set 90-100A current/corresponding wire feed rate 3-4m/min, 19 to 21 arc voltage and deposit the run using by transfer with 0.8mm dia copper coated mild steel filler wire mode.

13 Ensure proper leg length and even fusion of sheets suitable welding gun / torch angle and arc travel speed.

14 Clean the welded joint by steel wire brush.

15 Ensure good penetration and even fusion of sheets A and C with suitable torch angle and arc travel.

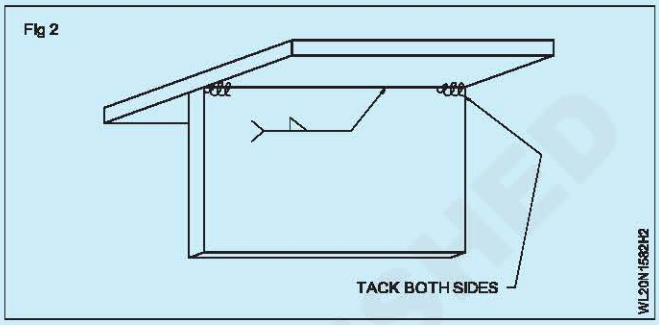
16 Avoid under cut on sheet C

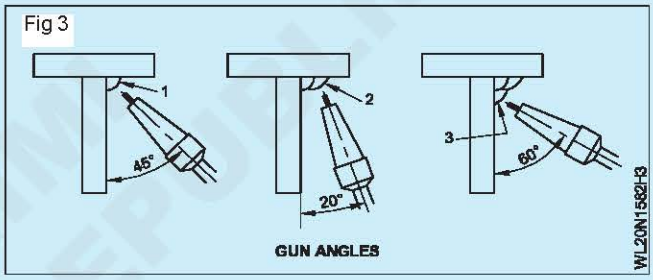
17 Ensure the edge of the sheet A (at the toe of the weld) is not melted off due to excessive weaving.

18 Ensure there is no undercut at the other toe of the lap weld on sheet C.

19 Clean the bead and the lap joint with steel wire brush

20 Inspect the welded joint for undercut, uneven bead, edge of the plate melted off, distortion and good bead profile.





Skill Sequence

Fillet weld - lap and 'T' joint on M.S sheet

Objectives: This shall help you to

- **prepare and weld lap and 'T' joint on MS sheet in overhead position.**

It is important to ensure that the Tee and lap joint is held in the weld positioner firmly.

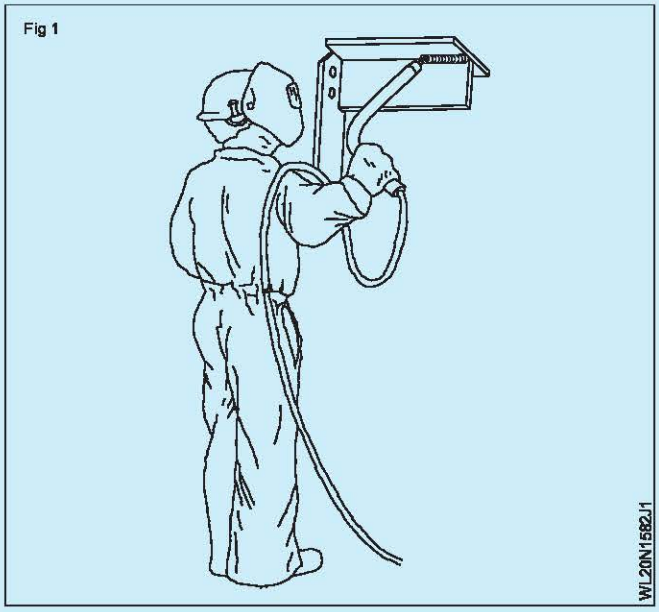
The line of weld of the joint should be parallel to the ground and is in such as a height from the ground that it is easily accessible to the welder depending on the height of the welder.

Ensure that the torch assembly hose, containing the spiral, filler wire, gas hose etc is long enough so that it can be carried over your shoulder while welding in overhead position refer Fig 1.

This will help in maintaining the constant distance between the torch and joint to be welded.

Using a welding helmet and wearing a welder overall is very essential to protect the whole body from the spatters in overhead welding position.

Use stringer bead welding technique and follow the same procedure to complete the lap joint.

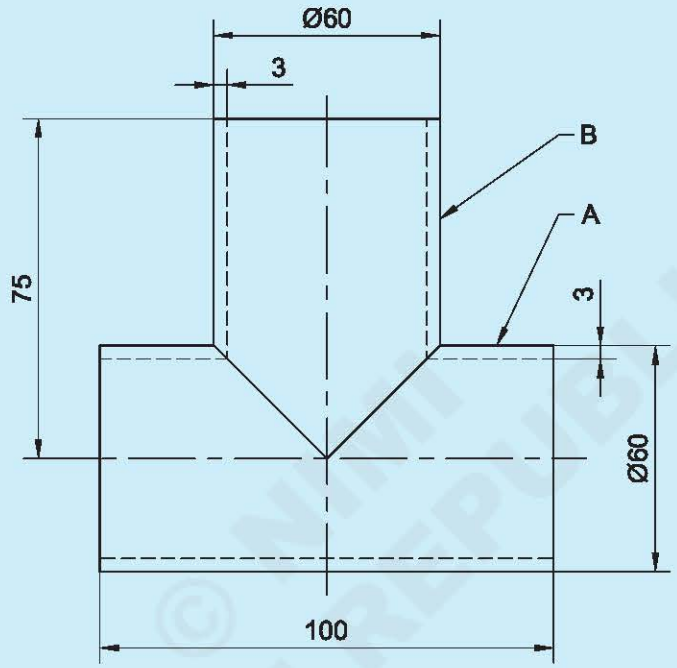


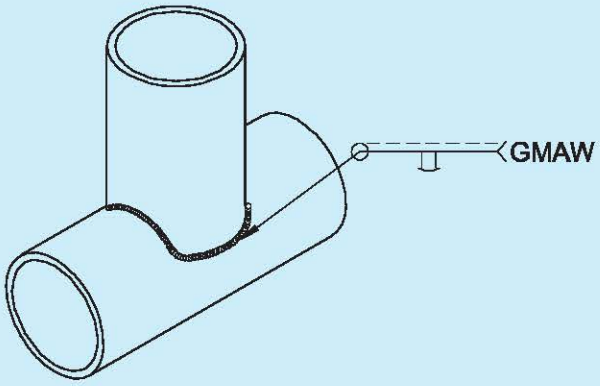
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Tee joints on M.S pipe ϕ60 mm OD x 3mm WT 1G position (ARC constant rolling) GMAW-17

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

- **draw pipe development as per drawing**
- **prepare the job and tack weld**
- **deposite the root and second runs**
- **clean and inspect the completed pipe weld.**





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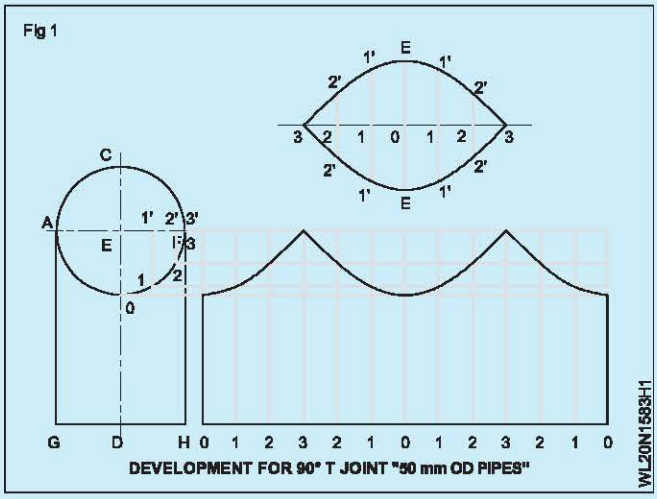
1	Ø60 x 3 - 180	-	Fe 310W	-	-	1.5.83
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

SCALE NTS	TEE JOINT ON M.S.PIPE Ø60MM OD X 3MM WT FLAT POSITION (ROLLING)	TOLERANCE ±1	TIME
		CODE NO. WL20N1583E1	

Job Sequence

1 Cut the pipes to the given size.

2 Prepare development for 90^0 Tee. (Fig 4)



3 Mark the development on the pipe and cut accordingly.

4 Ensure the correct size of pipes.

5 Branch pipes in mild steel may be cut on a special oxy-fuel gas profiling machine. Where such equipment is not available, the branch can be produced by marking the outline using a template figure as shown in Fig 4 and scriber or pointed chalk followed by centre punching. The branch can then be produced by cutting to the marked outline, using manually operated oxy-fuel gas cutting equipment.

6 Deburr the cutting edges and file the edges.

7 Clean the surface of the pipe if any oxide is found.

8 Set and align the branch pipe with the main pipe at an angle of 90^0. (Fig 5)

9 Tack-weld the joint with a 1.5mm root gap to control distortion and to obtain penetration. (Fig 5)

10 Weld all the pipes as shown in Fig 6.

11 Manipulation of the torch during welding the 'Tee' joint should be correctly followed. (Fig.7)

12 Weld and complete the joint-clean it.

13 Inspect for surface defects.

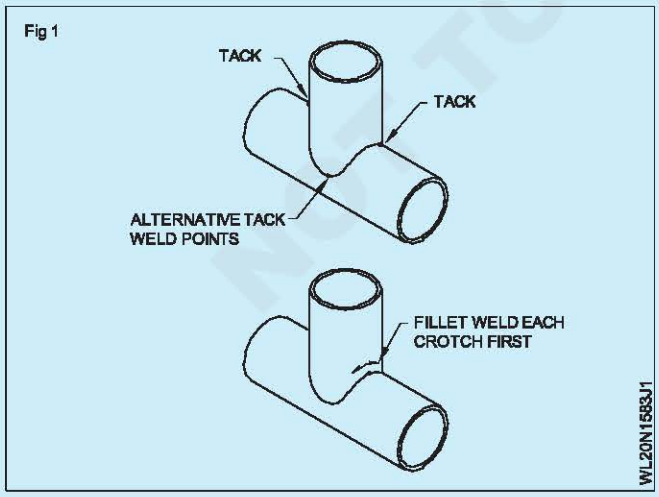
Skill Sequence

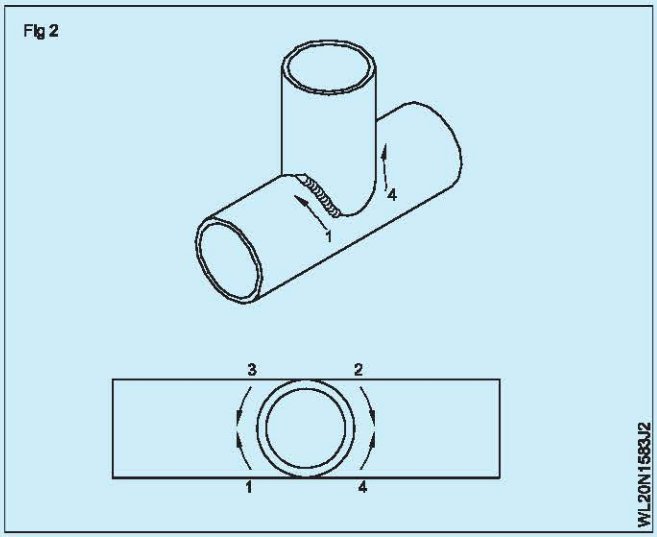
Tee joints on M.S pipe ϕ60 mm OD x 3mm WT 1G position (ARC constant rolling) GMAW-17

Objectives: This shall be able to

- **prepare and make pipe Tee joint.**

For welding the joints in 1G position it is convenient to use the pipe lines. Maintain a uniform travel speed for the torch to get the required bead reinforcement, use the and spatter spray as and when the torch nozzle gets clogged with weld spatters.



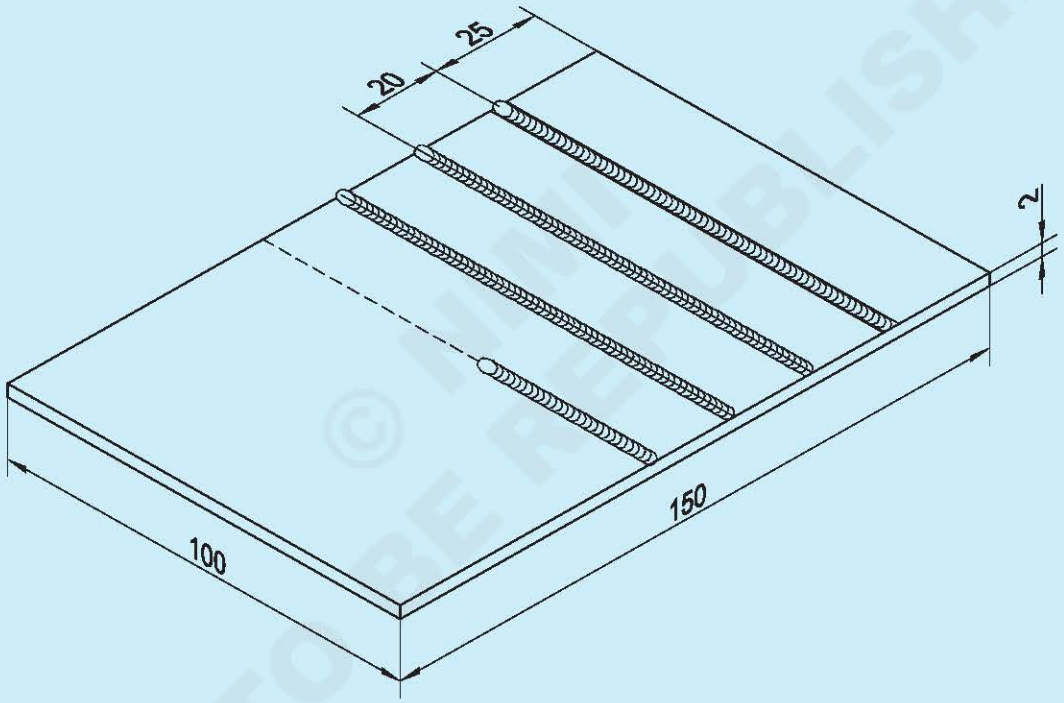


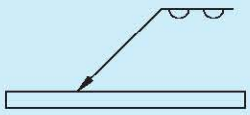
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Depositing bead on S.S sheet in flat position (GMAW - 18)

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

- **mark and set the plate as per drawing**
- **select filler wire and set the gas flow and current**
- **deposite the bead with weaving**
- **clean and inspect the weld.**





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1	100 x150 x 2	--	X04Cr19l9	--	--	1.5.84
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO
SCALE NTS	**DEPOSITING BEAD ON S.S.SHEET IN FLAT POSITION**				TOLERANCE ±1	TIME
					CODE NO. WL20N1583E1	

Job Sequence

1 Prepare the job to size as per drawing.
2 Clean the job surface with stainless steel wire brush.
3 Mark parallel lines on the job surface as per drawing and punch the lines.
4 Set the workpiece (job) on the work table in flat position.
5 Fix the 0.8mm diameter S.S. wire spool in position, lock it up and pull the wire through the guide tube, rollers, spiral and contact tip of the torch.
6 Start the welding machine. Connect the torch to the positive (DC +ve) terminal (DCRP) of the machine.
7 Open the argon gas flow before striking the arc.
8 Set the arc voltage at 19-21 volt as required for dip transfer mode.
9 Set the Gas Flow Rate at 8-10 LPM (Litres Per Minute).
10 Set the wire feed rate so as to get 90-100 Amp by striking the arc on a scrap plate.
11 Use DIN 11 or 12 black/green filter glass on Hand Shield/Helmet for above current setting.
12 Wear the protective clothing as required.
13 Switch over to Weld Mode as indicated in the machine.
14 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.
15 Deposit the bead on punched lines of the job from one end to other.
16 Remove spatters with chipping hammer and clean the joint using Carbon Steel Wire Brush.
17 Inspect the weld bead for finish and defects.

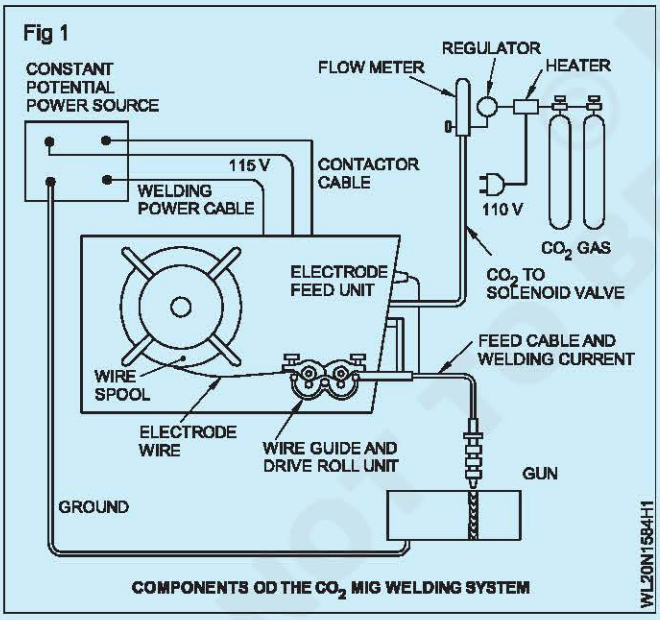
Skill Sequence

Depositing bead on S.S sheet in flat position (GMAW - 18)

Objectives: This shall help you to
- **mark and set the plate as per drawing.**

Setting up of the MIG 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 & 3)

Fig 2

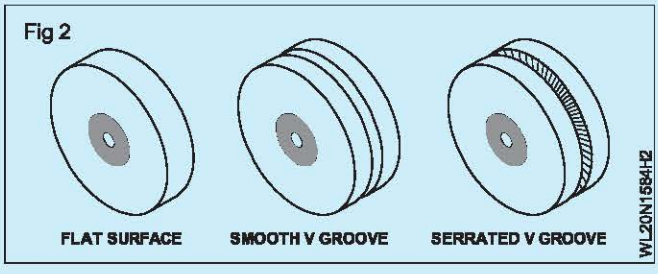
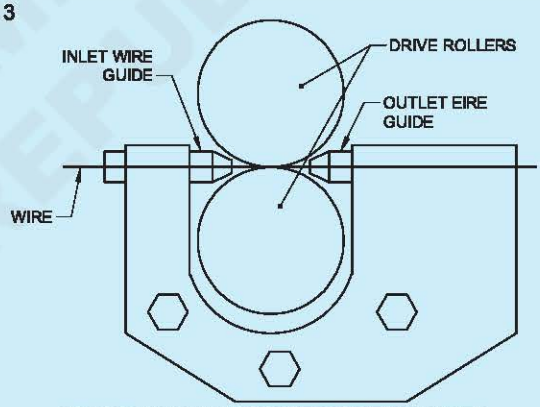


Fig 3



DRIVE ROLLS AND WIRE GUIDES PROPERLY ALIGNED

The roller should not be over tightened 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)

1 **Setting up arc voltage, stick out and wire feed rate of dip transfer**

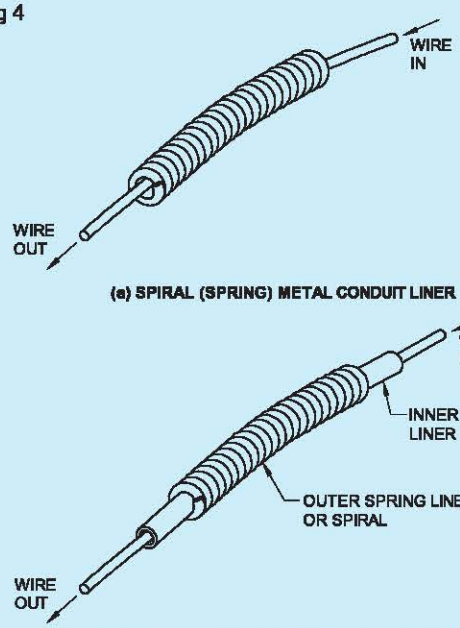
2 **Setting appropriate arc voltage for the corresponding current used**

3 **Setting the stick-out:** This is the distance between the end of the outer tip of the electrode till it touches the base metal refer (k) in the Fig 6.

4 **Welding procedure (depositing the beads):** Strike the arc by pressing the trigger in the welding torch (Fig 7) and at the same time touching the tip of the electrode wire to the job at the starting of the marked line.

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Fig 4



5 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.

Fig 5

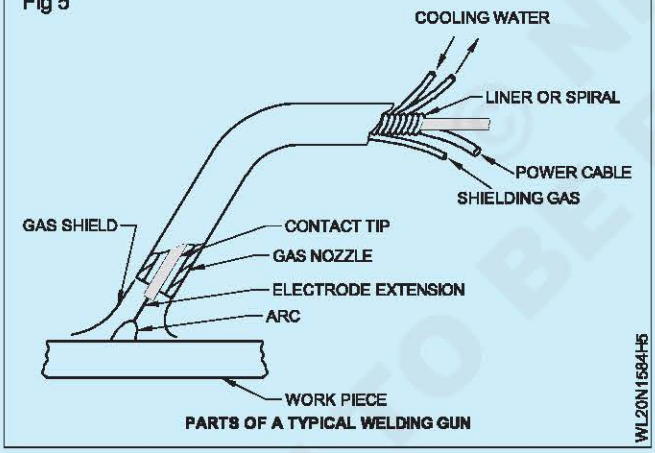


Fig 6

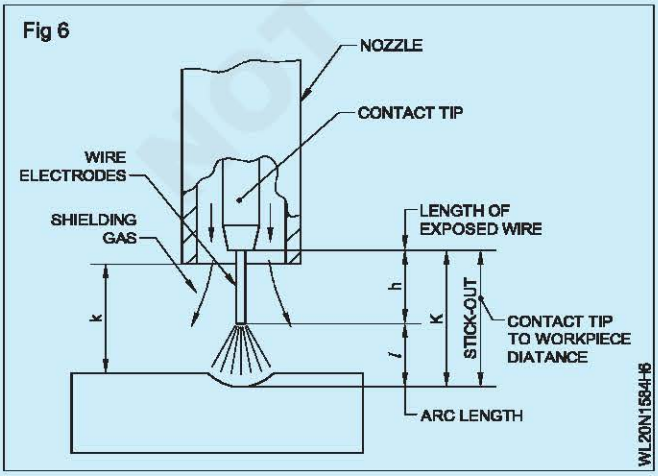


Fig 7

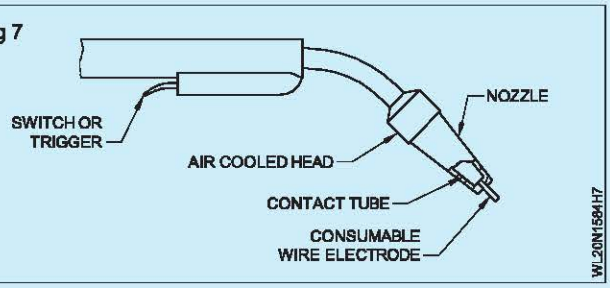


Fig 8

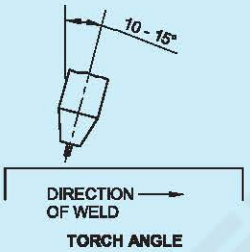


Fig 9

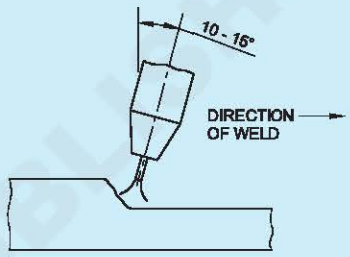
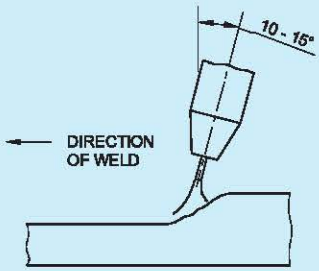


Fig 10



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Butt joint on stainless steel 2mm thick sheet in flat position by dip transfer (GMAW - 19)

Objectives: At the end of this exercise you shall be able to
- **prepare the plate and tack weld as per the drawing**
- **set the tack welded joint in flat position**
- **deposited the bead with appropriate amount of filler metal**
- **clean and inspect for surface defects.**

Job Sequence

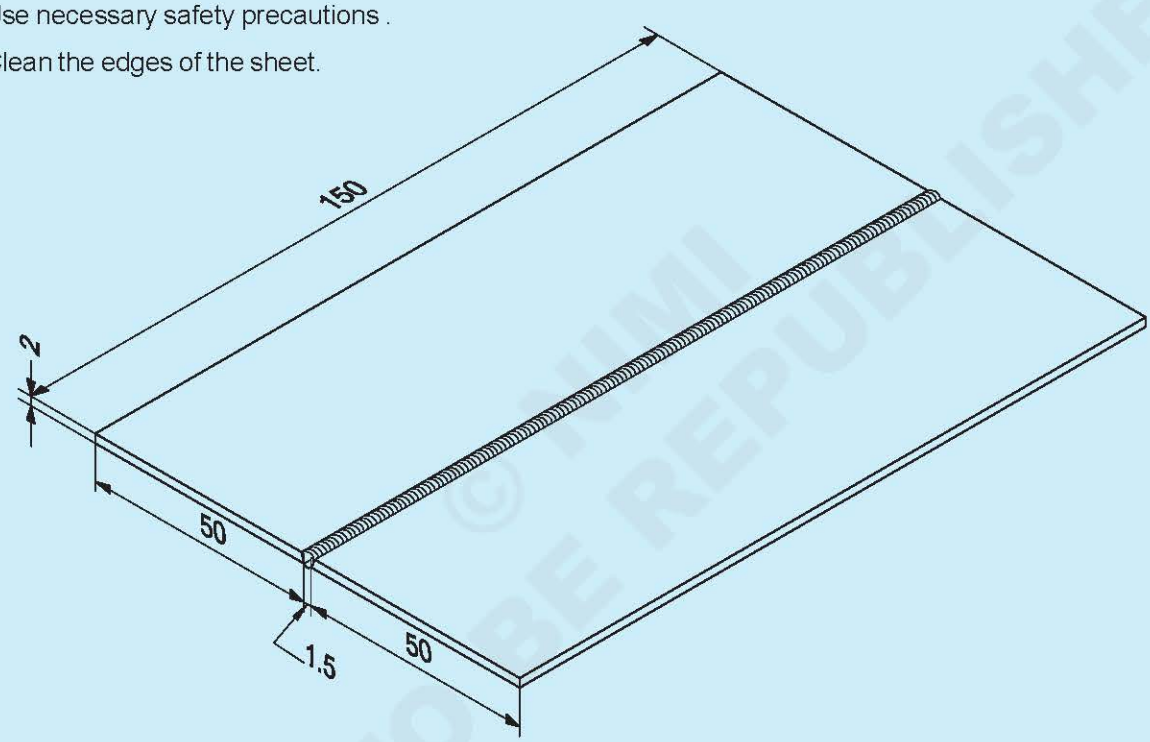
Skill Sequence

Refer Ex.No. 1.5.84

1 Prepare the sheets as per drawing

2 Use necessary safety precautions .

3 Clean the edges of the sheet.

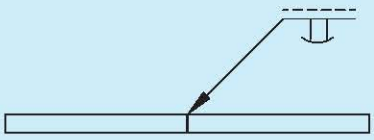


4 Set the sheets as a square butt joint and tack weld at the ends.

5 Fix the joint in on backing strip in flat position.

6 Strike an arc and move the torch steadily.

7 Use proper torch angles with slight weaving.



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2	150 x 50 x 2		X 04 Cr19 Ni9			1.5.85
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

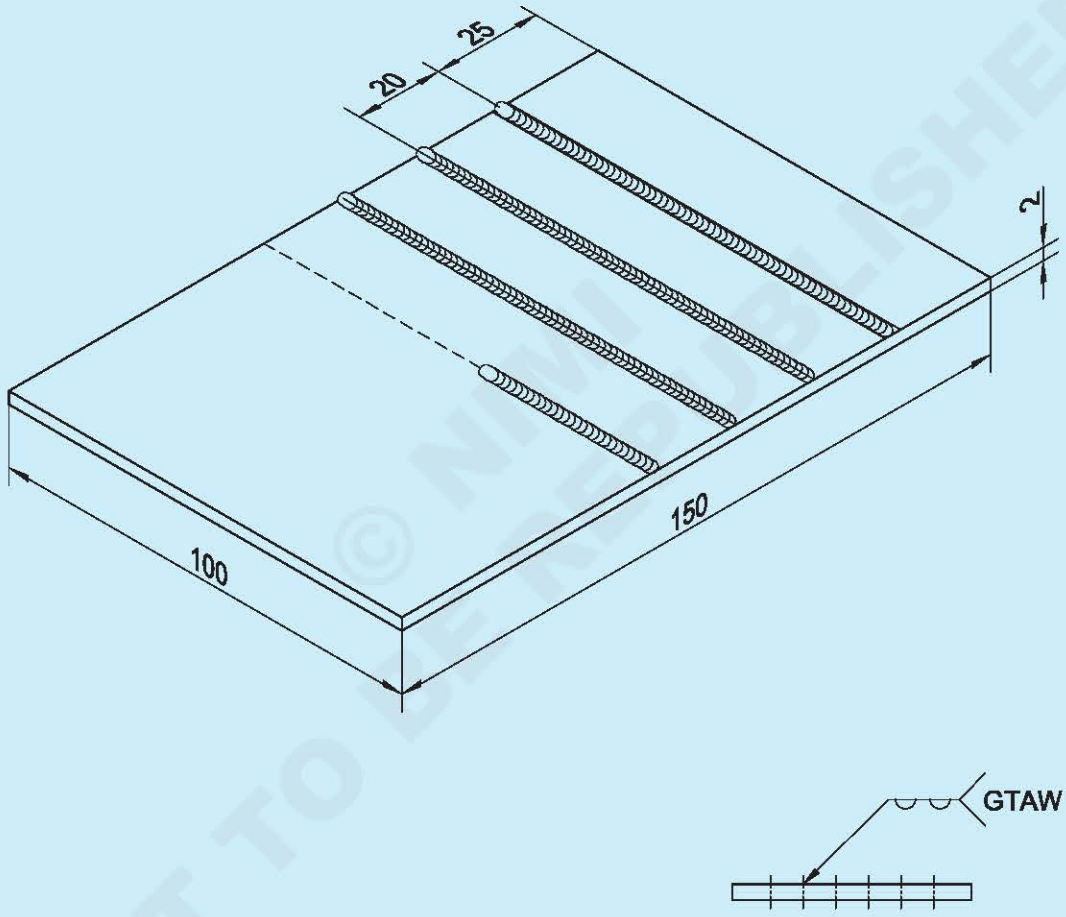
SCALE NTS	BUTT JOINT ON STAINLESS STEEL 2mm THICK SHEET IN FLAT POSITION BY DIP TRANSFER	TOLERANCE ±1	TIME
		WL20N1585E1	

Exercise 1.6.86

Depositing bead on aluminium sheet 2mm thick - position flat (GMAW - 01)

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

- **prepare the job as per drawing**
- **set up the GTAW machine accessories and parameters**
- **deposit fusion run with filler using leftward technique**
- **clean and inspect the job.**



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1	100 x 2 x 150	--	AL.199990 - IS 737	--	--	1.6.86
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

SCALE NTS	DEPOSITING BEAD ON ALUMINIUM SHEET 2mm THICK - POSITION FLAT	TOLERANCE ±1	TIME
		CODE NO. WL20N1686E1	

Job Sequence

1 Prepare the aluminium sheet as per dimensions.

2 Clean the surface with the stainless steel wire brush.

3 Also do the chemical cleaning with acetone/alcohol to remove dirts.

4 Draw parallel lines and punch the lines as per dimensions.

5 Set the job in flat position.

6 Select the power supply as follows:

- In case of helium as shielding gas use DCEN.
- In case of Argon as shielding gas and use AC power source. Majority of welding is done using argon gas.

7 Set up the GTA welding plant as per the Fig 1.

8 Select the type and size of tungsten electrode, current, gas flow rate and set them on the machine.

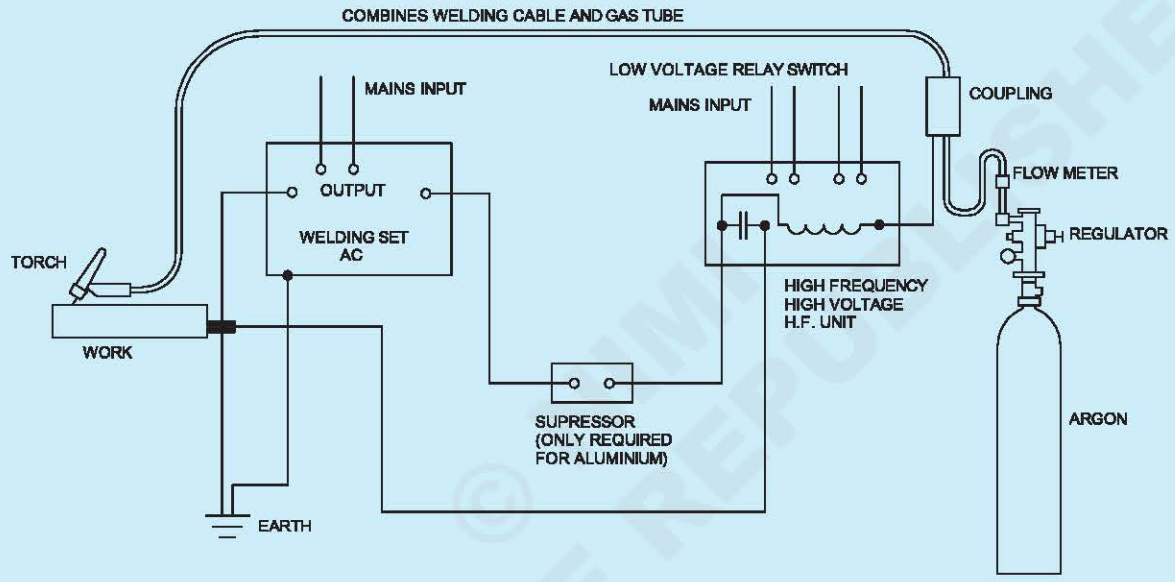
9 Select aluminium filler rod. 1.6mmf with 5% silicon.

10 Switch on the machine and strike the arc.

11 Deposit fusion run with filler wire using leftward welding technique.

12 Clean and inspect the weld job.

Fig 1



CONNECTIONS FOR INERT GAS WELDING USING AIR-COOLED TORCH

Skill Sequence

Depositing bead on aluminium sheet 2mm thick - position flat

Objective: This shall help you to

- **prepare and practice straight line beads on aluminium in flat position.**

Ensure to use correct size of the sheet for welding.

Select aluminium (95% AL and 5% SL) filler wire 1.6mmf.

Set the current and other parameters as per the Table given below.

Open the gas cylinder valve slowly.

The filler rod and torch are held at an angled of 10 to 15° and 70 to 80° to the line of weld.

Finish welding and ensure to fill the crater.

Brush the weld using SS wire brush and check for defects if any.

A table-1 of the variable used when manually welding aluminium with the gas tungsten arc using AC and high frequency.

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Metal thickness	Joint type	Diameter of tungsten alloy electrode with 1 to 27 Zirconium	Filler rod diameter (if required)	Amperage	Gas	
					Type	L/min
2 mm	Butt & Corner	1.6 mm	1.6 mm	60 – 85	Argon	7
	Fillet	1.6 mm	1.6 mm	75 – 100	Argon	7
3.15	Butt & Corner	3.15 mm	2.4 mm	120 - 150	Argon	9.5
	Fillet	3.15 mm	2.4 mm	130 – 160	Argon	9.5
5 mm	Butt & Corner	3.15 or 4 mm	3.15 mm	120 - 150	Argon	12
	Fillet	3.15 or 4 mm	3.15 mm	130 – 160	Argon	12
6.3 mm	Butt & Corner	4 or 5 mm		240 - 280	Argon	14
	Fillet	4 or 5 mm		250 – 320	Argon	14

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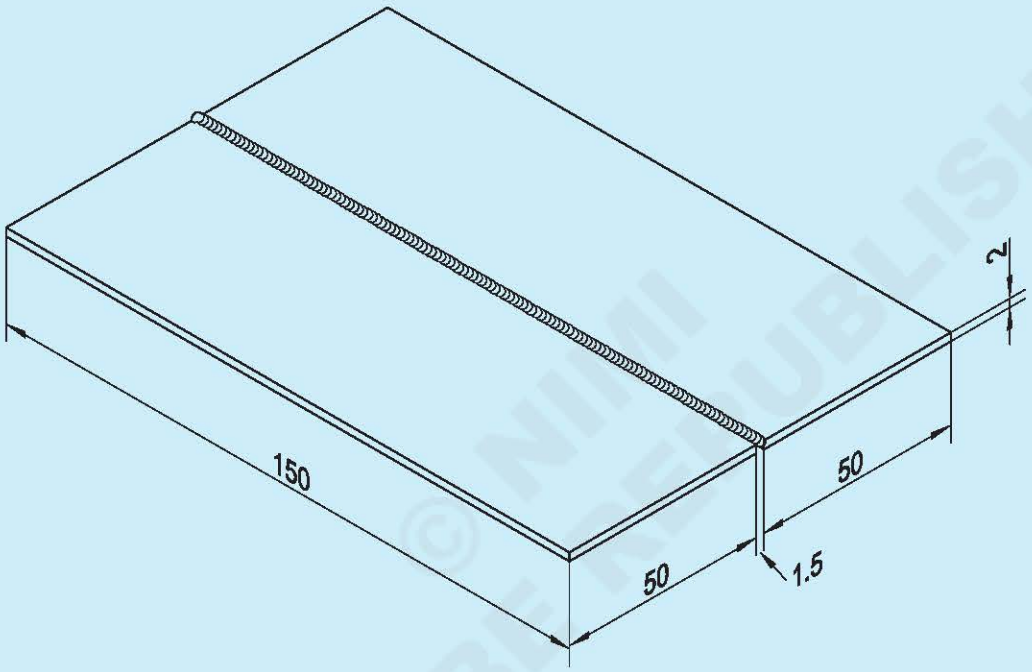
Exercise 1.6.87

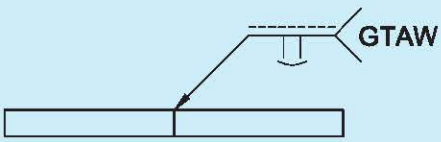
Butt weld square butt joint on aluminium sheet 1.6mm - position flat (GTAW - 02)

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

- **weld square butt joint on Aluminium sheet 3mm thick using TIG welding process.**
- **prepare the job as per drawing**
- **set the root gap and tack weld**
- **deposit weld bead by using leftward technique**
- **clean and inspect the job.**

Scan the QR Code to view the video for this exercise





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2	50 x 2 x 150	--	AL.199990 - IS 737	--	--	1.6.87
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

SCALE NTS	BUTT WELD SQUARE BUTT JOINT ON ALUMINIUM SHEET 1.6 mm - POSITION FLAT	TOLERANCE ±1	TIME 15h
		CODE NO. WL20N1687E1	

Job Sequence

1 Prepare aluminium sheets as per dimensions.

2 Use Tungsten (zirconium) 1.6mm dia electrode.

3 Clean the edges of the sheets.

4 Use the stainless steel wire brush for surface cleaning.

5 Set the square butt joint.

6 Select the various parameters as given in the Table 1 and set them accordingly.

7 Weld the joint in flat position using leftward technique.

8 Fill the crater.

9 Clean the weld area thoroughly.

10 Inspect the job for free from defects.

Skill Sequence

TIG welding process

Objective: This shall help you to

- **weld square butt joint on Aluminium sheet 3mm thick using TIG welding process.**

Ensure setting of Butt joint as per drawing.

Tungsten electrode tip to be ground for AC welding-Aluminium as shown in Fig 1.

Fig 1



ROUND TIP OF TUNGSTEN ELECTRODE IN AC TIG WELDING

WL20N1687H1

TABLE 1

Guideline for Manual AC GTA welding of aluminium

Plate thickness (mm)	Welding position	Joint type	Current AC (Amp)	Electrode Dia.(mm)	Nozzle size (10) mm (mm)	Argon flow Rate LPM	Filler rod Dia. mm	Number of runs
2 mm	F	Square butt	70 - 100	2.4	8.0	10	2.4	1
	H, V	Square butt	70 - 100	2.4	8.0	10	2.4	1
	O	Square butt	60 - 90	2.4	8.0	13	2.4	1
3.2	F	Square butt	120 - 150	3.2	9.5	10	3.2	1
	H, V	Square butt	110 - 140	3.2	9.5	10	3.2	1
	O	Square butt	110 - 140	3.2	9.5	13	3.2	1
4.8	F	60^0 Single Vee	180 - 220	4.0	11	12	4.0	2
	H, V	60^0 Single Vee	160 - 200	4.0	11	12	4.0	2
	O	60^0 Single Vee	170 - 200	4.0	11	12	4.0	2
6.35	F	60^0 Single Vee	220 - 240	4.8	12.7	15	4.0	2
	H, V	60^0 Single Vee	220 - 240	4.8	12.7	15	4.0	2
	O	60^0 Single Vee	210 - 250	4.8	12.7	18	4.0	2

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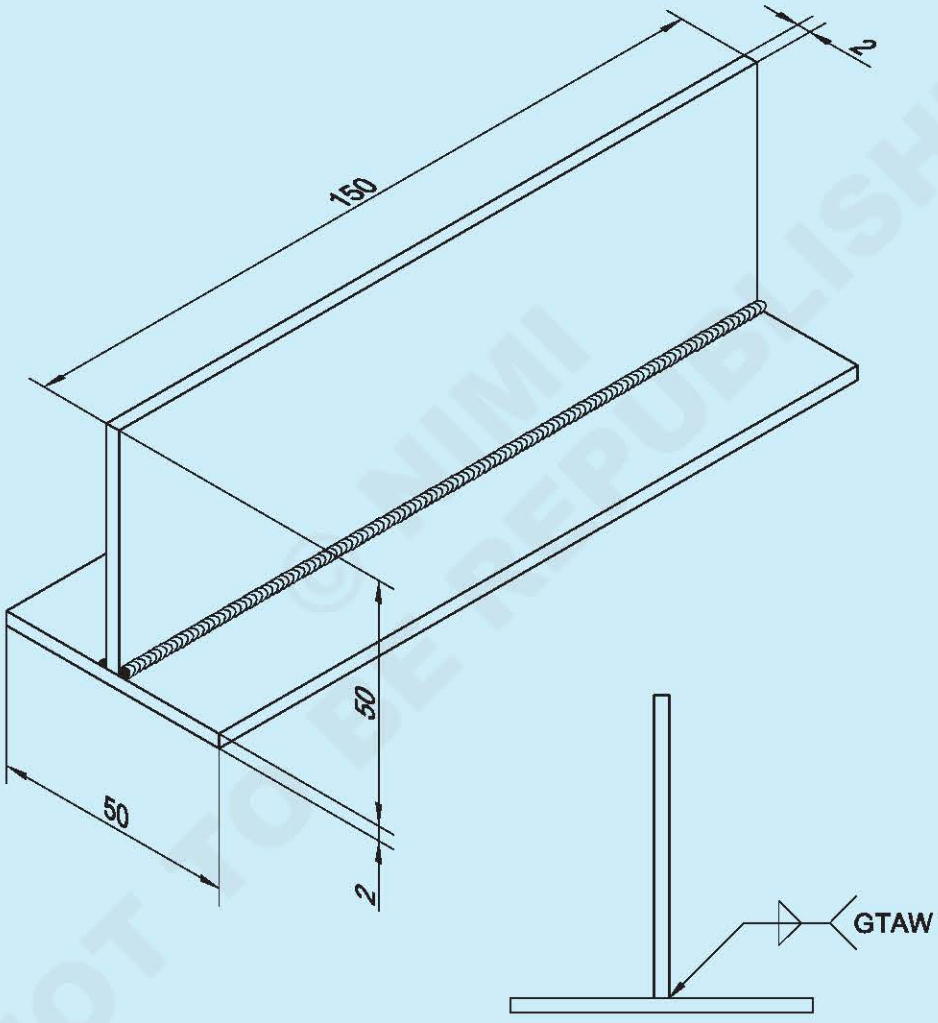
Exercise 1.6.88

Fillet weld - Tee joint on aluminium sheet 1.6mm - position (1F) (GTAW - 03)

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

- **prepare set and tack weld as per drawing**
- **select type and size of tungsten electrode and filler metal**
- **deposit weld bead in leftward technique**
- **clean and inspect the job.**

Scan the QR Code to view the video for this exercise



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2	50 x 2 - 150	--	AL.199990 - IS 737	--	--	1.6.88
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

SCALE NTS	FILLET TEE JOINT ON ALUMINIUM SHEET 1.6mm- POSITION FLAT (1F)	TOLERANCE ±1	TIME
		CODE NO. WL20N1688E1	

Job Sequence

1 Prepare aluminium sheets as per dimensions.

2 Clean the edges of the sheets by the chemical cleaning method and deburr. Use the stainless steel wire brush for surface cleaning

3 Set the "Tee" joint for aluminium welding.

4 Use 1.6mm size tungsten (zirconium) electrode.

Skill Sequence

Fillet weld - Tee joint on aluminium sheet 1.6mm

Objective: This shall help you to
• prepare and weld Tee joint on aluminium in flat position.

Ensure setting of the Tee joint as per drawing.

Tack weld at equal intervals (50mm spacing) so that the plates are set to form 90° equal Tee.

Take adequate care in selection of Tungsten Electrode Tip for alternating current power. (Fig 3)

Lack of penetration is avoided by judicially following the position of the Arc with respect to the joint. See Fig 1 and Fig 2.

Fig 1

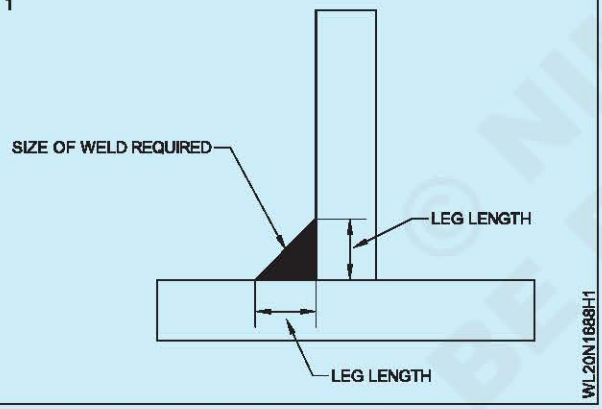


Fig 2

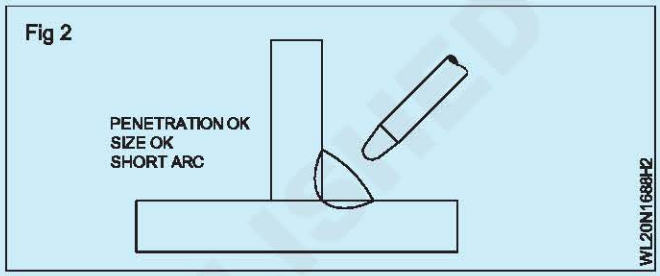
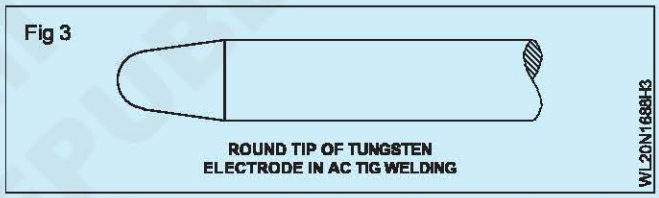


Fig 3



Select 95% aluminium 5% silicon filler wire 1.6 mmf.

Weld Tee joint in flat position using leftward technique.

Clean the weld area thoroughly.

Inspect the job.

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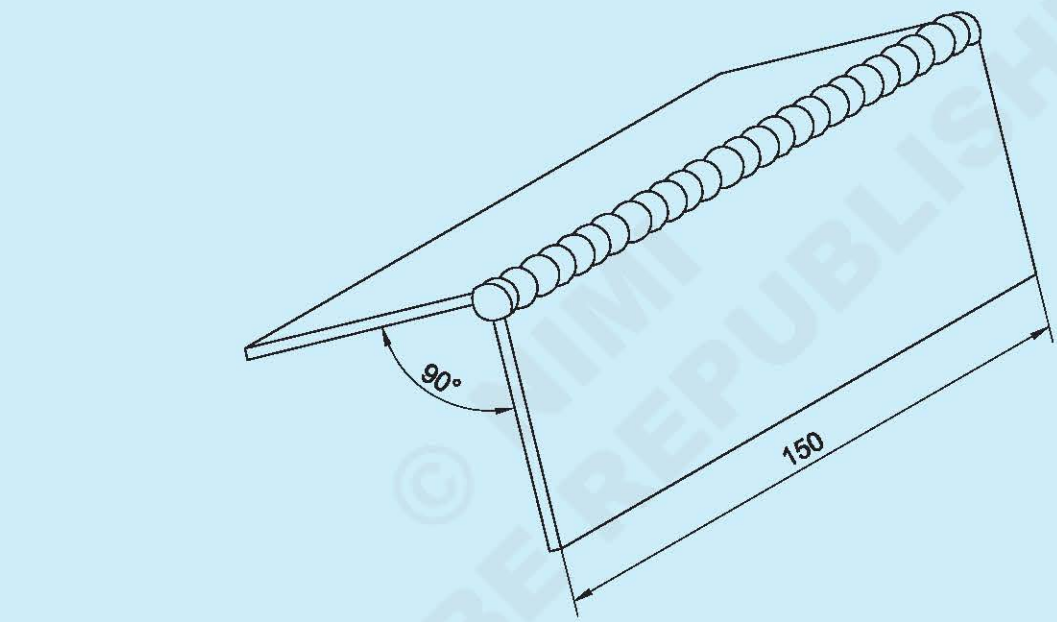
Exercise 1.6.89

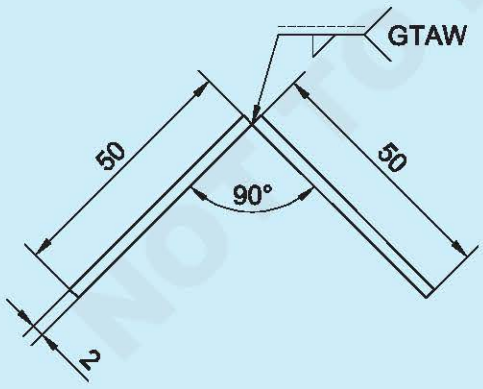
Fillet weld outside corner joint on aluminium sheet 2mm - thick in position flat (1F) (GTAW - 04)

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

- **prepare the job as per drawing**
- **set root gap and tack weld**
- **deposit weld bead by using left ward technique**
- **clean and inspect the job.**

Scan the QR Code to view the video for this exercise





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2	50 x 2 - 150	--	AL.199990 - IS 737	--	--	1.6.89
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

SCALE NTS	FILLET WELD OUTSIDE CORNER JOINT ON ALUMINIUM SHEET 2mm - POSITION FLAT (1F)	TOLERANCE ±1	TIME
		CODE NO. WL20N1689E1	

Job Sequence

1 Use pure aluminium filler wire/alluminium +5% silicon.

2 Use 1.6jmm (Zirconium) tungsten electrode.

3 Shielding gas argon.

4 Prepare aluminium sheet as per dimensions.

5 Clean the edges of the sheets.

6 Use stainless steel wire brush for surface cleaning.

7 Tack the set pieces at correct intervals and in correct alignment for an outside corner joint (Fig 1).

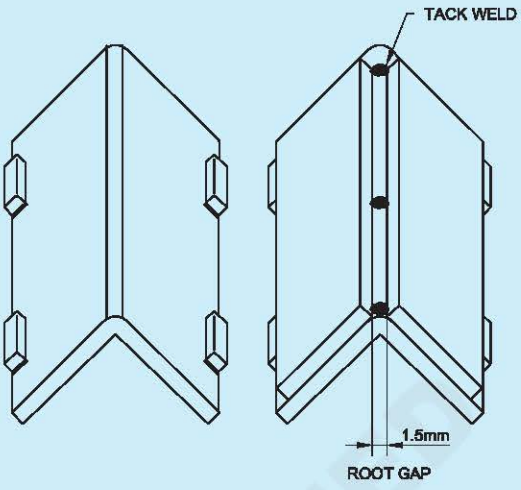
8 Weld the joint in flat position.

9 Make uniform size bead with correct penetration at the root in the outside corner joint.

10 Clean the weld area thoroughly.

11 Inspect the completed outside corner.

Fig 1



Skill Sequence

Fillet weld outside corner joint on aluminium sheet 2mm - thick in position flat (1F) (GTAW - 04)

Objective: This shall help you to

- **weld the outside corner joint on aluminium in flat position.**

Ensure the setting of an outside corner joint as per drawing.

Adjust current 60- 90 Amp in AC. (Refer Table 1 of fabrication -welder)

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 on to the backing bar with steel strap. 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 1

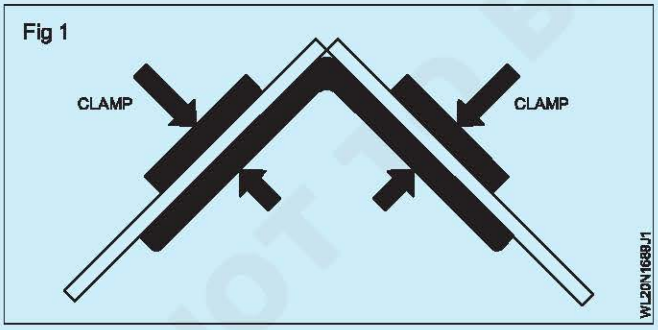
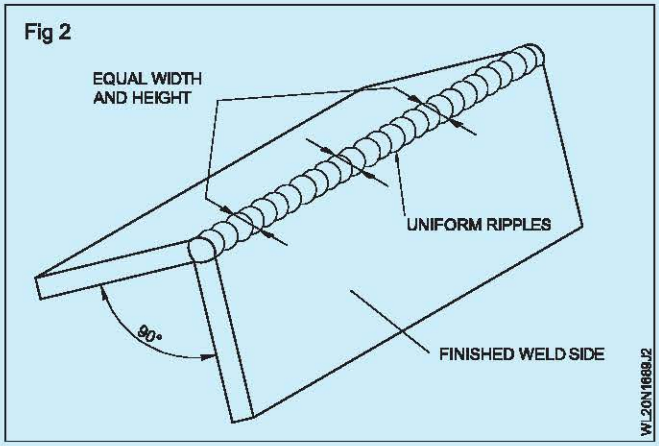


Fig 2

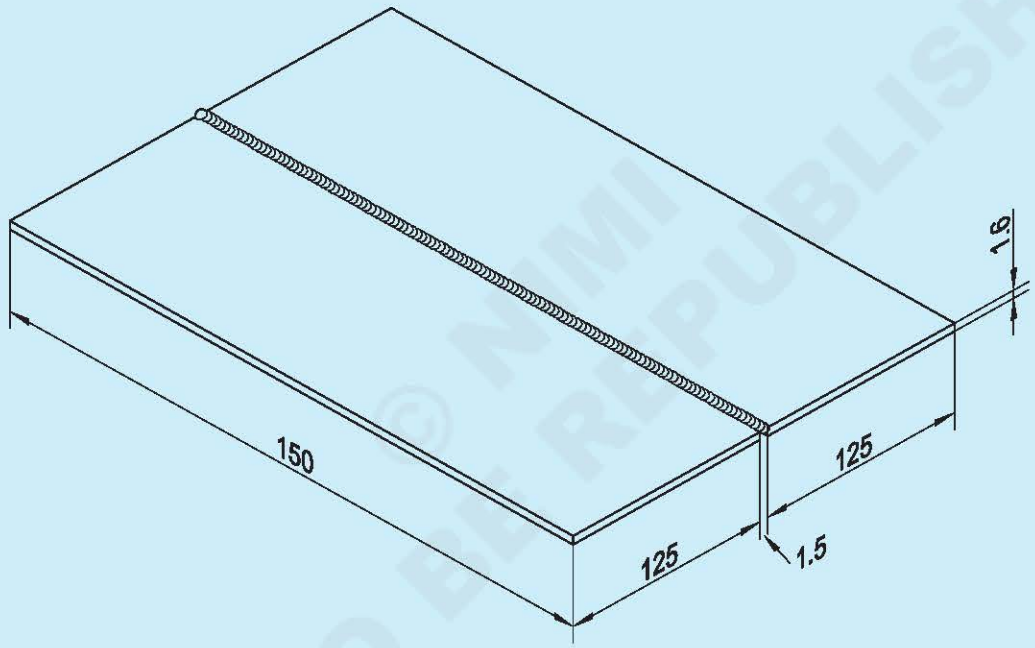


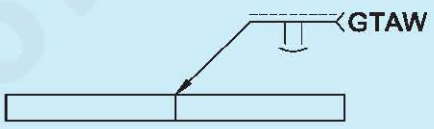
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Butt weld square butt joint on stainless steel 1.6mm thick flat with purging Gas (1G) (GTAW - 05)

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

- **prepare the job as per drawing**
- **set root gap and tack weld**
- **set the back shielding gas flow rate**
- **deposit weld bead.**
- **clean and inspect the job**





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2	50 x 1.6 - 150	--	X 04 Cr 19 Ni 9	--	--	1.6.90
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

SCALE NTS	BUTT WELD SQUARE BUTT JOINT ON STAINLESS STEEL SHEET 1.6 mm - POSITION FLAT WITH PURGING GAS (1G)	TOLERANCE ±1	TIME
		CODE NO. WL20N1690E1	

Job Sequence

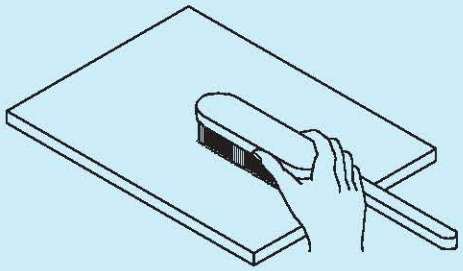
1 Select low-carbon grades of base metal SA 240 type 304L stainless steel.

2 Cut the materials to be welded to the required size and shaped for welding by arc appropriate method 1.6 x 125 x 150mm - 2 pcs.

3 Clean the surfaces to be joined prior to welding, to obtain high quality welds. (Fig 1).

4 Select the filler wire ER 308L, ϕ 1.6 mm x 1000mm long and welding procedures.

Fig 1



WLG2N1650H1

5 Select the tungsten electrode EWTh-2, ϕ 2.0mm.

6 Select the shielding gas for stainless steel welding and purging (i.e. Argon).

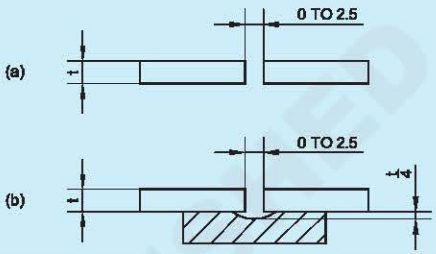
7 Prepare the welding power sources for GTAW.

8 Stainless steel sheet layout must be done perfectly.

9 Prepare and temporarily assemble the back purging arrangements (Fig 2).

10 Adjust suitable gas flow rate in the flow meter (refer Table-1) 10-12 lpm (litres per minute).

Fig 2



WLG2217H2

TABLE - 1

Base metal Thick mm	Electrode dia. mm	Electrical characteristics			Filler rod dia. mm	Shielding gas-argon flow rate l/min.	Purging Gas-Argon flow rate l/min.
		Amp	Volt	Nozzle size			
1.6 - 3.2	EWTh-2 2.0	50 - 90	12	10	1.6-2.4	10	3 - 4
3.2 - 6.4	2.0	70 - 120	12	10	2.4	10	3 - 4
6.4 - 12.7	2.0	100 - 150	12	12	2.4	12	3 - 4

11 Type of joint: Groove, Butt.

Tack welds are used to hold the sections of pipe together.

12 Cover and seal the weld joints by masking tape.

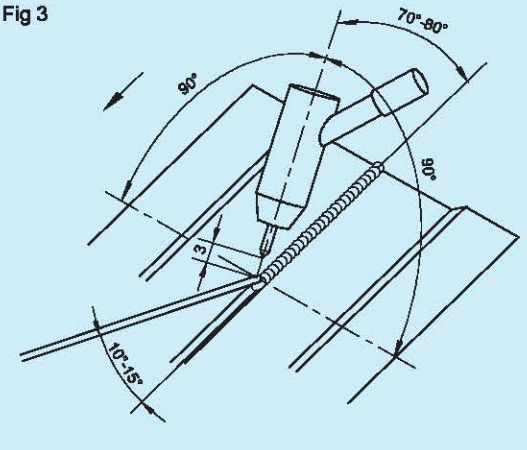
13 Input argon gas at a flowrate 20lpm initially and 3-4lpm during welding as a backing gas to protect the root pass.

Always wear PPE (Personal Protective Equipment) Fumes and gases can be hazardous to your health.

14 Practice starting and stopping, welding and running the bead by maintaining proper torch angle.

15 Hold the GTAW torch to about 70 to 80° against the welding direction and 90° against the base metal surface (Fig 3).

Fig 3



WLG2217H3

16 Strike the arc by switching on the torch and the electrode should be directed to be beading edge of the weld pool.

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Shield the welding area from direct exposure to fans, open doors or the wind by providing plywood or temporary shed.

17 Weld the root pass with the stringer bead technique. When the root pass is welded, the tack weld must be completely removed.

18 Maintain low heat input to avoid too high an interposes temperature and over heating of the weld area.

The backing gas purge shall be maintain until atleast two layers of weld deposit have been made. After completion of cover passes, the purging dams (arrangements) shall be removed.

19 Visual inspection shall be performed before during and after welding.

20 Any temporary welded attachments shall be ground off and inspected by suitable nondestructive test such as penetrant test.

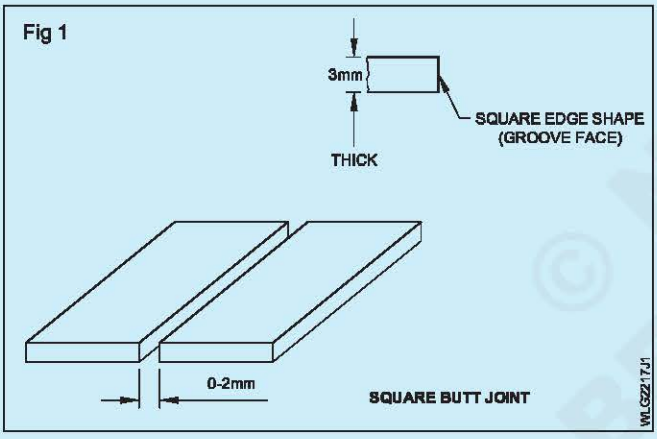
It is general practice to protect the roots of S.S welds with argon purging to prevent root oxidation.

Skill Sequence

This will help you to successful welding of S.S requires the following considerations when selecting welding consumables and procedures to assure satisfactory weld properties.

1 Joint Design:

Fig 1



Select single groove weld on square butt joint. The square butt joint is simplest, since it requires only a square edge for lesser thickness materials and is economical, provided one is able to get sufficient penetration and strength. (Fig 1)

2 Joint Cleanliness:

The area to be cleaned should include the weld groove faces and the adjacent surfaces for atleast 12mm on each side of the groove.

Stainless steel materials shall be cleaned with S.S wheels or S.S brushes not previously used on other materials. Carbon steel brushes shall not be used to clean stainless steel materials.

It is also good workmanship to retain a set of cutting and grinding tools, hammers etc. for use only on stainless steel and for as possible to avoid handling carbon steel and stainless steel on the same working tables and in the same workshop.

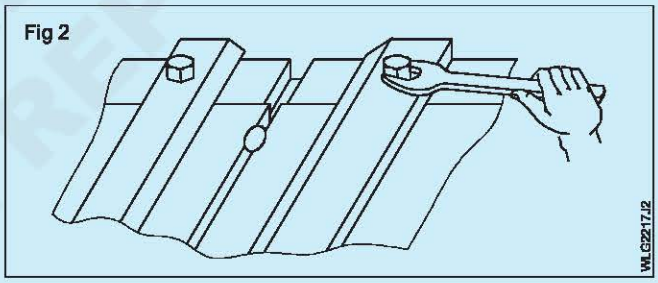
3 Joint Fit-up: (Distortion control)

Tight fit up and good joint preparation are critical to stainless steel weld quality and distortion control.

Stainless steel's thermal expansion is much greater than that of carbon steel, thus causing greater shrinkage stresses and the possibility of warpage.

This distortion can be controlled with suitable jigs and fixtures (Fig 2), proper joint fit-up and a correct welding sequence .

Fig 2

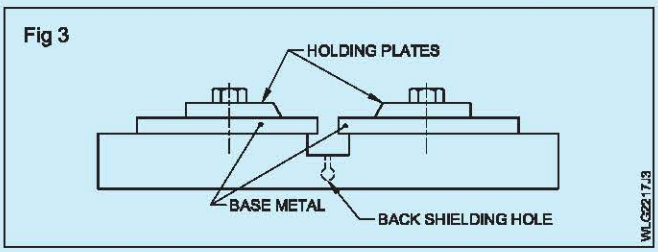


Using of Jigs and fixtures.

On thin materials it is difficult to completely avoid bucking and distortion.

Tack weld at 10mm inside from both ends of the joint and assemble the back purging set-up (Fig 3).

Fig 3

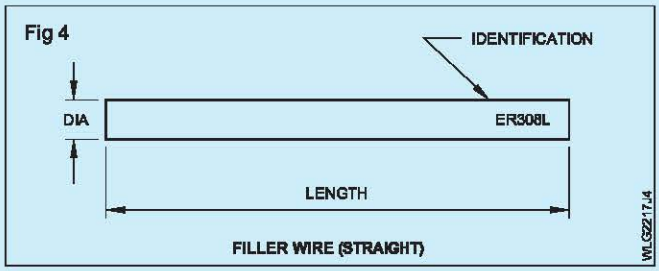


4 Filler Wire

The selection of the welding consumables depends on the type of austenitic stainless steel and the intended service.

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Select low carbon grades of filler wire for welding society (AWS) classified filler wire ER 308L used here ϕ2.0mm. 'L' indicates low carbon content. Lowering the carbon content also reduces the possiblity of carbide precipitation. (Fig 4)



Select a filler wire size proportional to the root gap.

Store the filler wires in sealed, dirt and moisture proof containers within a dry, dust-free enclosure.

Return the unused filler wires to their container and shall be seated.

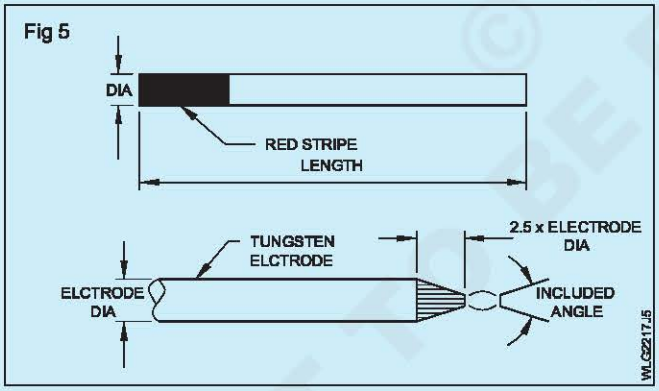
Discard the filler wires that have rusted or are contaminated with oil, grease, dirt, etc.

5 Tungsten Electrode preparation:

Tungsten electrodes are non consumable if the process is properly used, because they do not melt or transfer to the weld.

Tungsten tips are generally prepared (Fig 5)

The tungsten electrode should be extended approximately to mm beyond the gas cup.



Proper tungsten preparation (Fig 6):

- Grind tungsten electrode lengthwise grind marks don't restrict current. Mirror finish is even better.

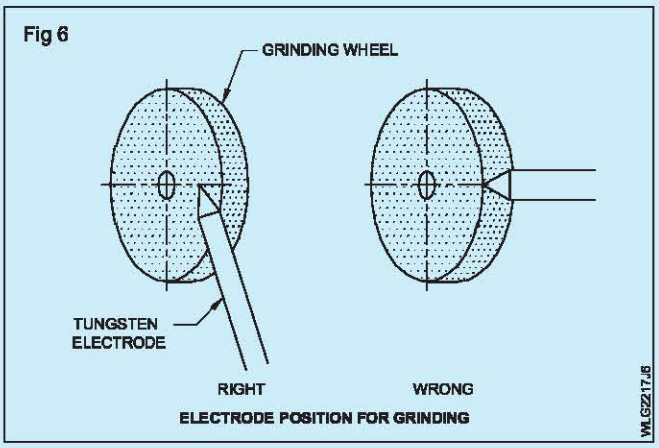
Wrong tungsten preparation

- Crosswise grinding marks restrict welding current, cause arc wander, tungsten inclusions.

Safety: The risk of injury when grinding a very hard brittle material like tungsten is quite high,

1 **Wear safety glasses**

2 **Special precautions relative to ventilation should be considered.**



A contaminated electrode will require dressing before further use.

6 Shielding Gas:

Choosing the right shielding gas for the GTAW process is going to make the welding of stainless steel a whole lot easier.

Argon is most commonly used shielding gas for GTAW. Most is used for joining stainless steel.

Adequate supply of argon is required as a shielding gas to avoid nitrogen pick up and the resulted lowering of ferrite content in weld.

7 Purging Gas:

All single welded groove joints in stainless steel shall be welded using a root pass with an inert gas back purge.

When making the root passes of welds in stainless steel, the air contained on the backside of the weldment can contaminate the weld.

To prevent root (under bead) oxidation and lack of fusion inside wall of the joint, the air must be purged from this region. Argon is the most widely used gas for this backside protection.

Nitrogen also can be used a backup gas. Argon back up gas will provide the maximum protection.

For flow rate refer Table-1.

8 Welding power source:

Normally, direct current electrode negative(DCEN) polarity is used with a welding power supply having drooping characteristic (volt-ampere) or a constant current output for GTAW of stainless steel.

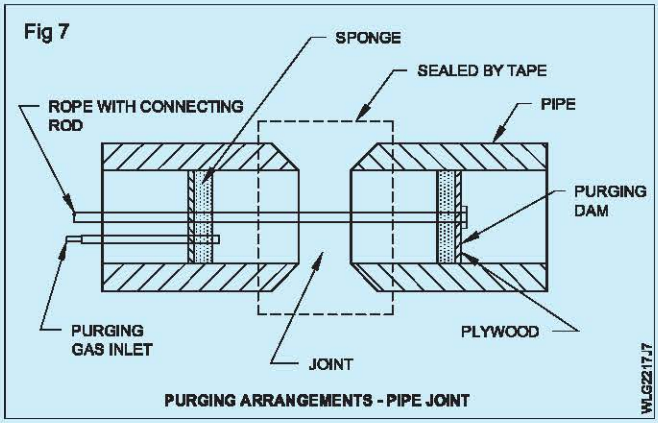
Stainless steel has a higher electrical resistance and lower thermal conductivity than mild steel. Therefore, stainless steel wires require about 20% less current than mild steel wires of the same size.

Optimum current ranges are given in Table 1.

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9 Purging Arrangements: (Fig 7)

Before starting welding, an adequate purging shall made in order to eliminate the oxidizing atmosphere inside the joint. Steps are follows:



a Use 99.99% Argon for back-purging.

b Cover and seal the weld joint by masking tape.

c Assure that the gas venting orifice has a flow capacity equal to or greater than that of input side, for assurance of a near zero interior purge gas pressure.

d Input argon at a flow rate of 20 litres per minute.

e Maintain gas flowing time prior to commencing the welding to achieve complete purging.

f The backup gas should preferably enter the system at a low point, to displace the atmosphere upwards and be vented at points beyond the joint to be welded.

10 Oxygen level measurement:

The permissible level of oxygen in the inside of the root area shall be less than 1%.

Carry out the measurement by welding - gas oxygen analyzer and record it. Increase the flow rate and flushing time, if the joint found with an unacceptable limit of oxygen content, and repeat the checking. In case of high level of oxygen content, the oxygen measurement shall be performed also on the argon contained in the cylinder.

11 Welding sequence

1 Reduce the gas flow-rate to the value given in the welding procedure before starting welding operation.

2 Use high frequency starting for initiating the arc, and avoid the scratch starting as the weld gets contaminated with tungsten.

3 Remove the seal tape during welding just in advance of welding progression around the joint, in order to minimize purge gas loss and atmospheric contamination through the root opening.

4 When the root pass is welded, the tack weld must be re-fused to become a part of the weld or completely removed.

5 Manipulate the torch carefully so that the tungsten electrode does not become contaminated.

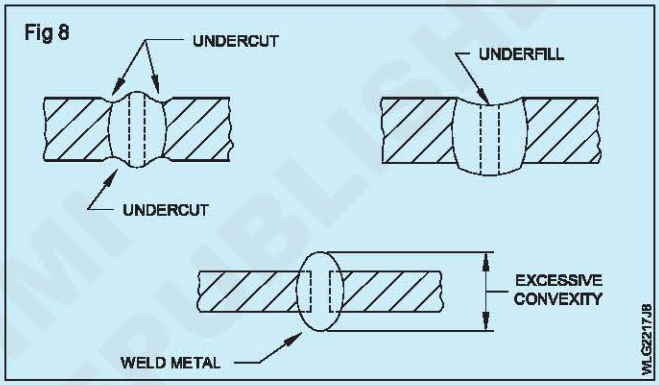
6 Maintain the maximum interposes temperature to 175°C from stainless steel welding. High travel speed is recommended, which will reduce the heat input, reduce carbide precipitation and minimise distortion.

7 The face of the weld should be slightly convex and the reinforcement should be about 1.5mm above the surface of the plate.

8 Cleanliness is very important, special attention shall be paid to the weld area to avoid carbon pick-up, hardening and hot cracking. Wire brushing should be done with stainless steel wire brushes.

9 Ensure that the purging dams removed after completion of welding.

The purging dam must be positioned far enough from the joint to prevent them from burning due to welding heat. (Fig 8).



12 Post weld cleaning:

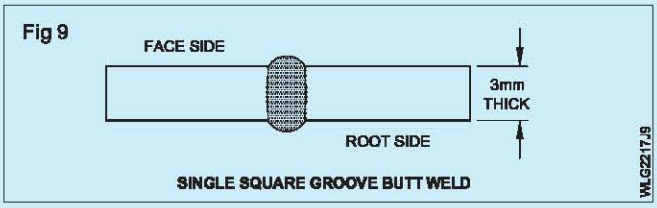
Remove the surface defects in order to restore the corrosion properties of the material. Some defects are easiest to remove by grinding such as weld spatter and slag in the weld metal. Heavy oxidation of the weld and heat affected zone, any objectionable surface discoloration from welding is best removed by pickling and passivation treatment.

13 Pickling and Passivation:

Pickling is the removal of oxide film from the surface of the weld metal by chemical means. Formulations of hydrofluoric (HF) and nitric (HNO_3) acids. To prepare 5% nitric acid solution, mix 50ml acid to 1 litre cold water. Always add to the water. Maximum contact time 30 minutes during acid application Apply water before and after acid application.

14 Visual Inspection

Perform visual examination of all welds for completeness, excess reinforcement and evidence of undercutting (Fig 9).



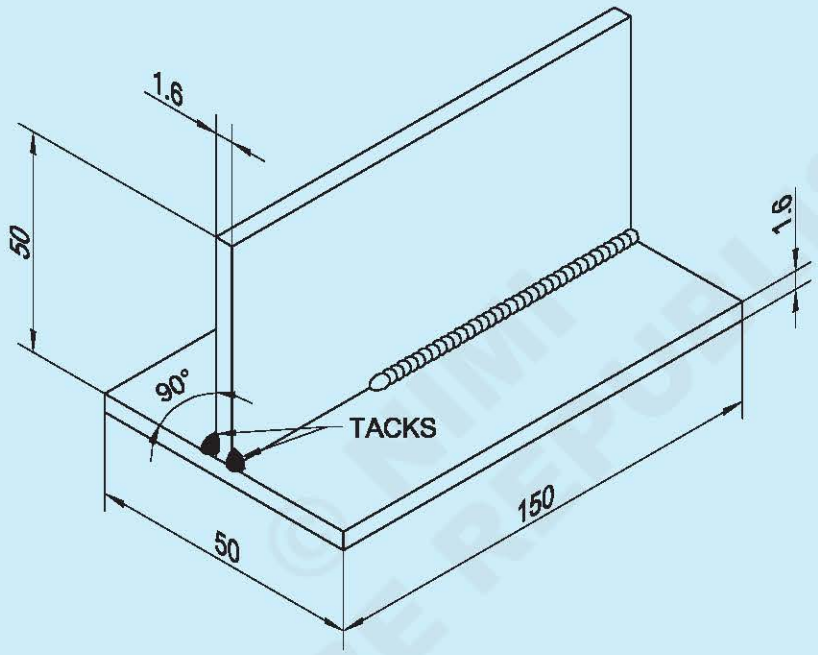
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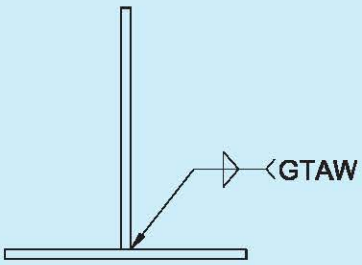
Exercise 1.6.91

Fillet weld Tee joint on stainless steel sheet 1.6mm - position flat 1F (GTAW - 06)

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

- **prepare, set and tack weld as per drawing**
- **deposit weld bead in flat position**
- **clean and inspect the job**





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2	50 x 1.6 - 150	--	X 04 Cr 19 Ni 9	--	--	1.6.91
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

SCALE NTS	FILLET WELD TEE JOINT ON STAINLESS STEEL SHEET 1.6mm - IN FLAT POSITION (1F)	TOLERANCE ±1	TIME
		CODE NO. WL20N1691E1	

Job Sequence

1 Prepare the sheets as per drawing and clean the edges.

2 Clean the surfaces using the stainless steel wire brush.

3 Set the sheets in the form of a 'Tee' joint on the welding table.

Wear safety equipment's.

4 Set the GTA welding plant with argon gas.

5 Select the 1.6 mmf electrode and 2mmf filler rod and electrode tip be grinded for DC semicircle.

6 Set the current 60 amps to 90 amps.

7 Setting and tacking the job pieces

8 Place the pieces on the welding table as Tee joint.

9 Hold the pieces in position using support.

10 Ensure the vertical piece is perpendicular to the horizontal place without gap.

11 Check with a try square.

12 Tack-weld the joint at both ends and also in the centre.

13 Hold the torch perpendicular to the joint and pointing at an angle of about (15-30°) toward the direction of travel.

14 Strike an arc and establish a puddle. Make sure the side walls melt down to the root of the 'T' joint.

15 Add the filler rod in a tapping motion, advancing the torch when you withdraw the filler metal.

16 Remember, when withdrawing the wire, keep the wire in the protective gas shield.

17 Complete the bead, cool the assembly.

Skill Sequence

Fillet weld Tee joint on stainless steel sheet 1.6mm - position flat 1F (GTAW - 06)

Objective: This shall help you to

- **prepare, set and tack weld as per drawing.**

In 'T' Joint - filler metal is necessary regardless of the thickness of the metal.

As a rule, weld should be made on both sides of the fillet joints.

Fig 1

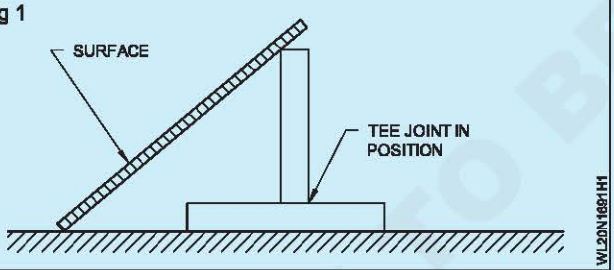
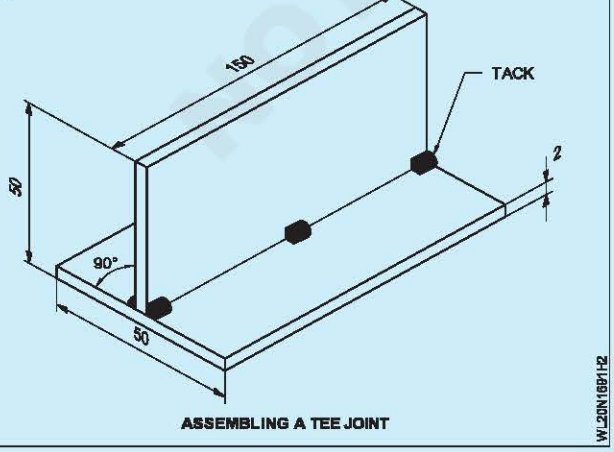


Fig 2



The number of passes over the seam will depend on the thickness of the material and the size of the weld to be made in the process.

Follow the recommendations for the correct gas flow, otherwise the shielding gas will not be effective.

Fig 3

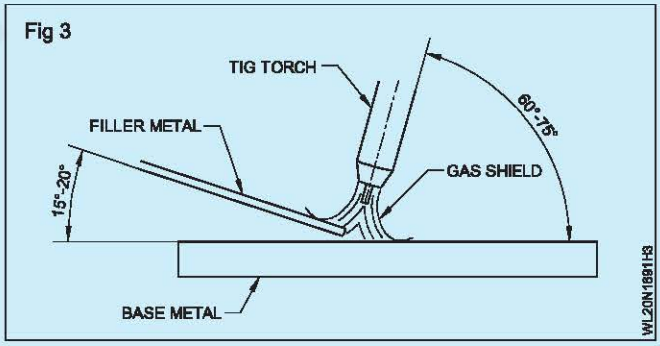
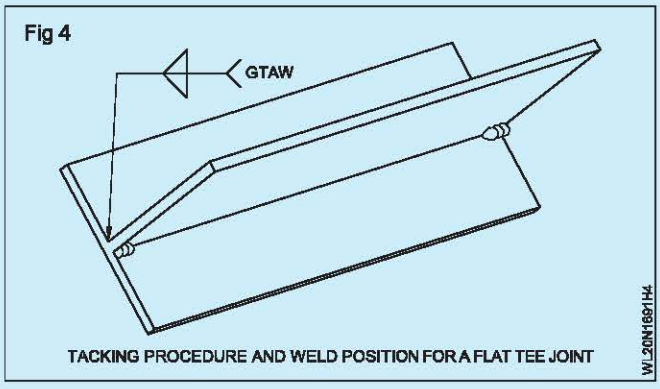


Fig 4

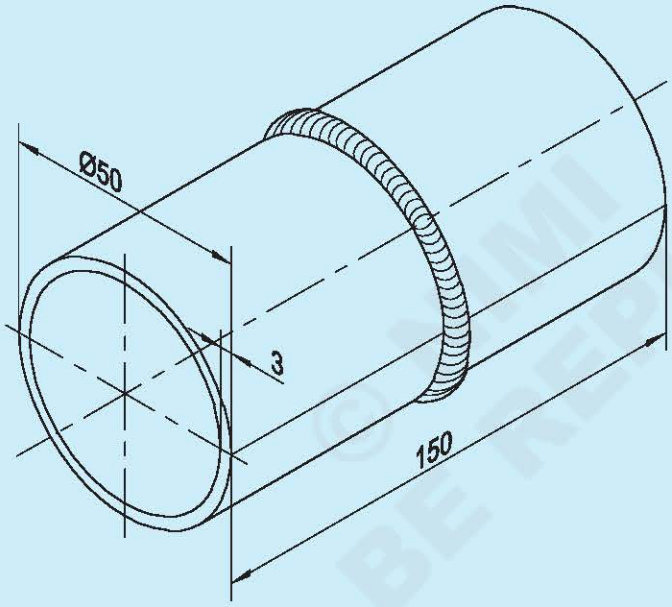


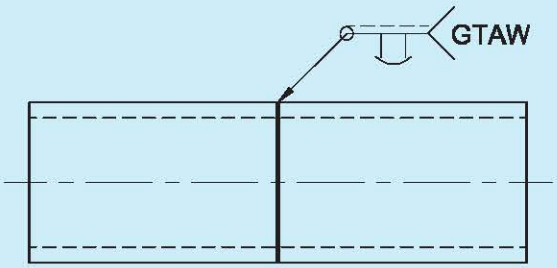
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Pipe butt joint on Aluminium pipe ϕ50mmx3mm WT in flat position 1G (GTAW - 07) (1G)

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

- **prepare the job as per drawing**
- **prepare the job as per drawing**
- **set root gap and tack weld**
- **deposit weld bead by using down ward welding**
- **clean and inspect the weld defects**





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2	Ø50 x 3 - 75	--	Aluminium	--	--	1.6.92
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO
SCALE NTS	**PIPE BUTT JOINT ON ALUMINIUM PIPE Ø50mm x 3mm WT IN FLAT POSITION (1G)**				TOLERANCE ±1	TIME
					CODE NO. WL20N1692E1	

Job Sequence

1 Cut and prepare the aluminium pipe as per the dimensions given.
2 Align the pipes in flat position (butt) for tack weld with the help of a Vee Block-angle iron.
3 Tack the joints at 120^0 by rotation and complete the tacking.
4 Use the roller stand to maintain the downward welding position.
5 Rotate the pipe at uniform speed for good weld result.
6 Further welding is done by rotating the pipe to the next segment and completed.
7 Repeat the above procedure till the joint is completely welded.
8 Remove the workpiece from the rotating fixture.
9 Clean the weld bead and inspect.

Skill Sequence

Pipe butt joint on Aluminium pipe ϕ50mmx3mm WT in flat position 1G (GTAW - 07) (1G)

Objective: This shall help you to
- **prepare and weld aluminium pipe butt joint in flat 1G position.**

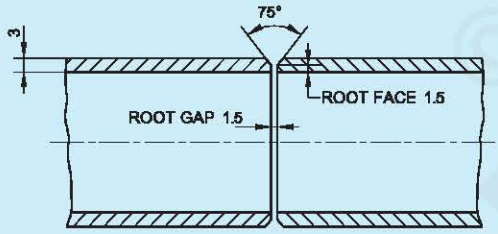
Pipe welding is a highly skilled welding operation, which involves correct alignment and good penetration by equally melted edges of the pipes.

Select the rotating fixture according to the diameter of the pipe.

Place the tacked pipes on the rotating fixture and check the freeness of rotation.

Ensure proper melting of tacks for good penetration and surface appearance.

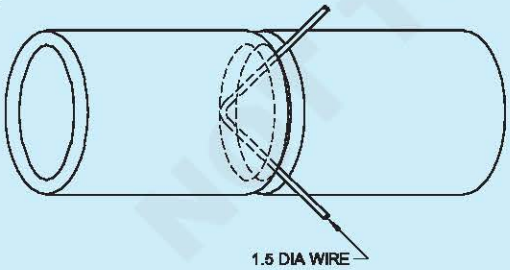
Fig 1



EDGE PREPARATION AND SETTING PIPE FOR BUTT WELD

WI_20N1692H1

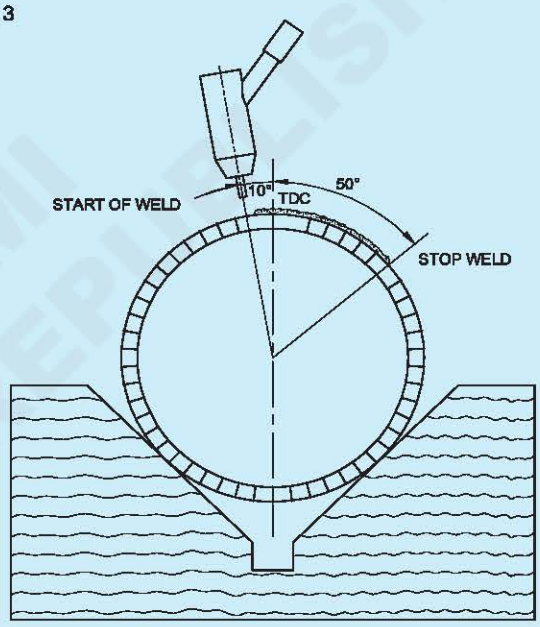
Fig 2



USE OF BENT WIRE OR SUITABLE SPACER TO SET ROOT GAP

WI_20N1692H2

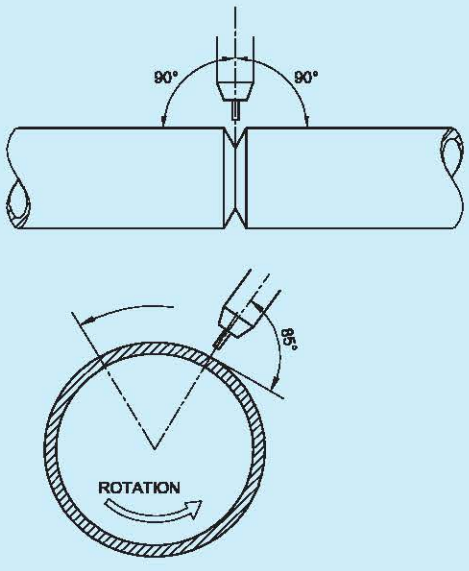
Fig 3



WELDING FIRST SEGMENT

WI_20N1692H3

Fig 4



WI_20N1692H4

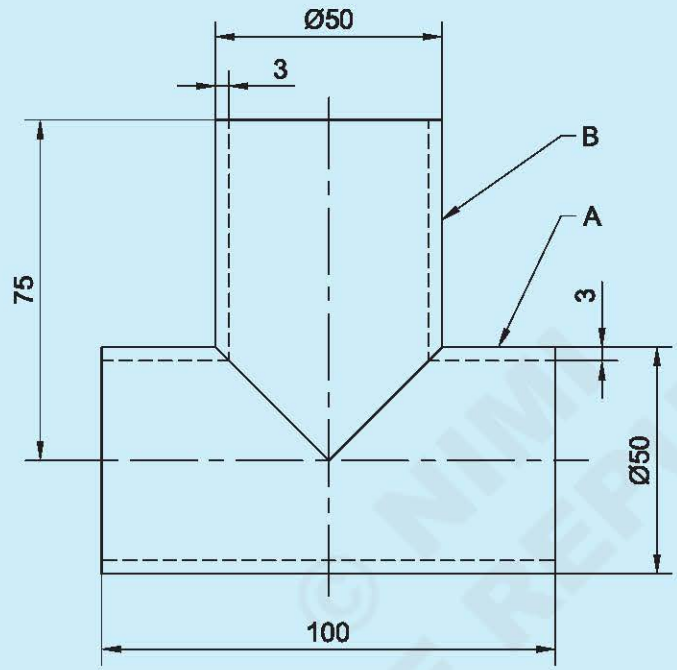
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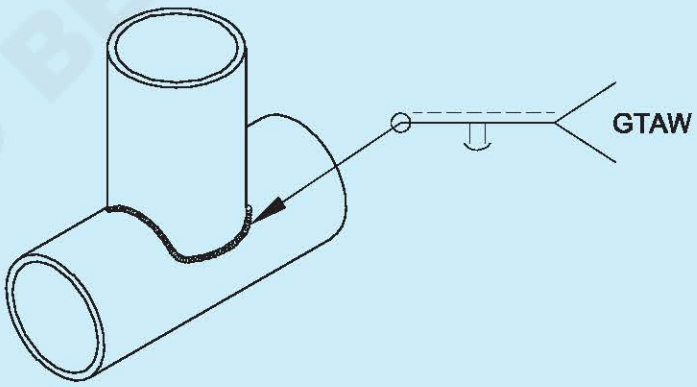
Exercise 1.6.93

Tee joint on MS pipe ϕ50mm OD x 3mm WT position flat 1F (GTAW - 08)

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

- **draw the development and prepare the pipes as per drawing**
- **set the root gap and tack weld**
- **deposit weld bead in rolling position**
- **clean and inspect the weld defect.**





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1	Ø50 x 3 - 180	--	Fe 310	--	A & B	1.6.93
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

SCALE NTS	FILLET TEE JOINT ON M.S. PIPE Ø50mm OD x 3mm WT POSITION FLAT	TOLERANCE ±1	TIME
		CODE NO. WL20N1693E1	

Job Sequence

1 Cut the pipes to the given size.

Cutting of branch components in mild steel

2 Prepare development for 90^0 Tee. (Fig 4)

3 Mark the development on the pipe and cut accordingly.

4 Ensure the correct size of pipes.

Fig 1

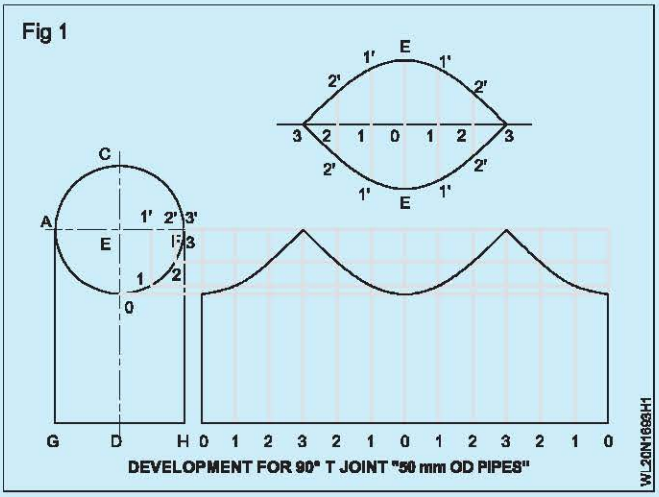
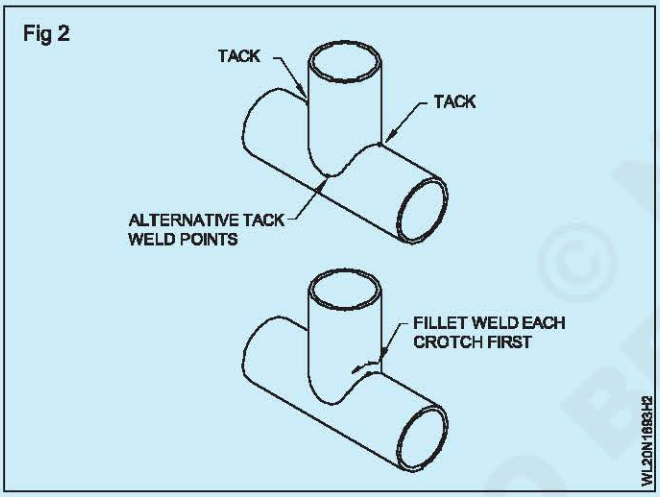


Fig 2



5 Branch pipes in mild steel may be cut on a special oxy-fuel gas profiling machine. Where such equipment is not available, the branch can be produced by marking the outline using a template figure as shown in Fig 4 and scriber or pointed chalk followed by centre punching. The branch can then be produced by cutting to the marked outline, using manually operated oxy-fuel gas cutting equipment.

6 Deburr the cutting edges and file the edges.

7 Clean the surface of the pipe if any oxide is found.

8 Set and align the branch pipe with the main pipe at an angle of 90^0. (Fig 5)

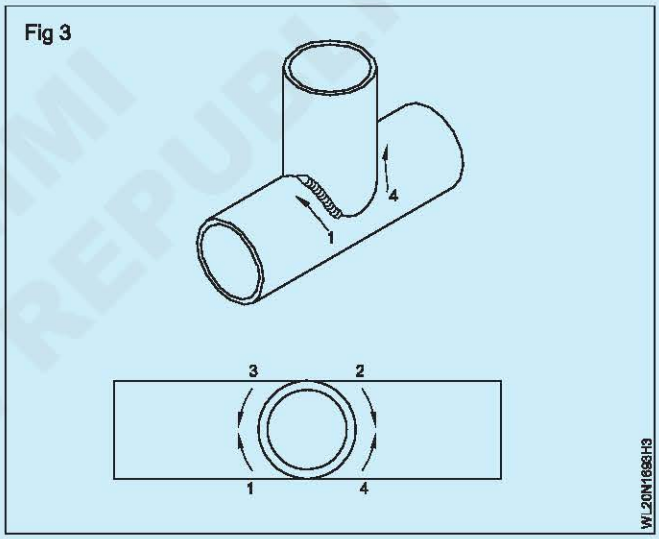
9 Tack-weld the joint with a 2mm root gap to control distortion and to obtain penetration. (Fig 5)

10 Manipulation of the torch and filler wire during welding the 'Tee' joint should be correctly followed. (Fig 7)

11 Weld and complete the joint-clean it.

12 Inspect for surface defects.

Fig 3



Skill Sequence

Tee joint on MS pipe ϕ50mm OD x 3mm WT position flat 1F (GTAW - 08)

Objective: This shall help you to

- **prepare and weld pipe Tee joint on MS pipe in flat position.**

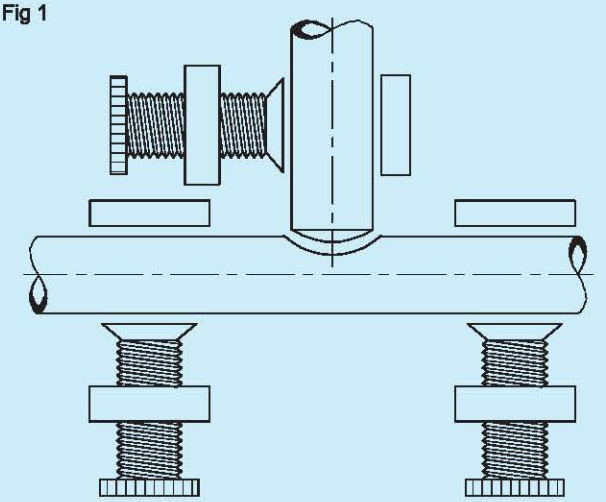
One difficulty encountered with all pipe welding is the distortion or misalignment of the pipes/tubes after welding is completed. One, very frequently used method to prevent or reduce distortion is to clamp the pipes or tubes in a fixture while welding and allow it to cool before removing the clamps.

Also, since the root of the weld is not accessible and because the inner surface is in contact with flowing fluids, the penetration standards are high. Two common pipe welding faults are too much penetration and lack of penetration. These faults must be repaired before the tubing can be used.

In pipe welding other than butt joint - it is very essential to get a development and prepare the template for the appropriate joints.

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Fig 1

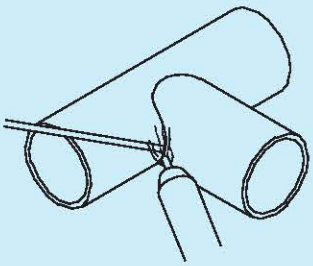


CLAMPING FIXTURE USED TO PREVENT PIPE FROM BEING OUT OF LINE AFTER WELDING

CLAMPING FIXTURE

WL20N1668J1

Fig 2



WL20N1668J2

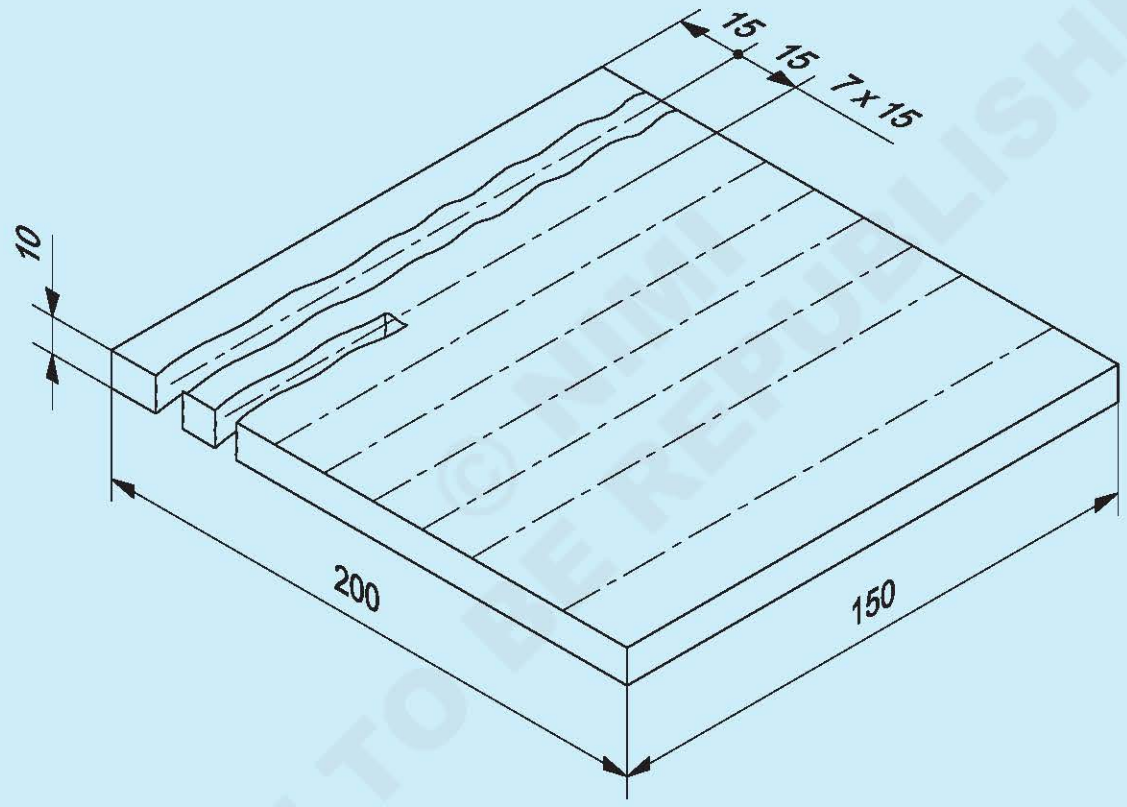
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Exercise 1.6.94

Plasma straight cutting on ferrous and non-ferrous metal (PAC - 01)

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

- **marking the cutting lines on the plate (job)**
- **set the job for straight cutting**
- **clean the edges and inspect for defects.**



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1	150 ISF 10 - 200		Fe 310 - W			1.7.94
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

SCALE NTS	PLASMA STRAIGHT CUTTING ON FERROUS AND NON-FERROUS METAL	TOLERANCE ±1	TIME
		WL20N1794E1	

Job Sequence

1 Begin cutting by placing the torch as close as possible to the edge of the base metal.

2 Pull the trigger to ignite the pilot arc.

3 Move the torch near the workpiece to initiate the cutting arc

4 Wait for the arc to penetrate through the bottom of the workpiece.

5 Start moving the torch slowly, perpendicular to the workpiece. Watch sparks leaving the bottom of the workpiece to judge your speed. If the sparks are not visible at the bottom of the plate, you have not penetrated the metal. This is because your travel speed is too fast or you have insufficient output amperage.

6 At the end of a cut, angle the torch slightly or pause briefly to completely finish the cut systems.

7 Provide a post-flow circuit, the post-flow air will continue for a short period of time after the trigger is releases to cool the torch and consumable parts. However, cutting can be resumed immediately.

8 To maximize cutting speeds, it is recommended to turn your power source to full output for all material thicknesses.

Proper safety procedures

Safety procedures must be closely followed in any application of a plasma cutter.

1 Be aware of potential hazards involved with the process, including high voltages, noise, temperatures, flammable materials, fumes, ultravioltradiation, and molten metal.

Skill Sequence

Plasma straight cutting on ferrous and non-ferrous metal (PAC - 01)

Objectives: This shall help you to

- **cutting and practice plasma straight cutting on ferrous and non-ferrous metal.**

1 Plasma cutters use either "high frequency start" or "contact start" technology to initiate the pilot arc. If you plan to use a plasma cutter near telephones, computers, CNC machines or other electronic equipment, be aware that high frequency (HF) often interferes with electronic controls.

2 To avoid potential HF problems, all machines feature contact start design that does not cause interference. Even better the contact start method creates a visible pilot arc that helps you better position the torch.

Pre-cut checklist

A few final words of advice before cutting:

3 Follow proper safety procedures and wear personal safety equipment - read the Owner's Manual!

4 Inspect the torch tip, electrode and shield cup and replace worn items. The expense is well worth avoiding the poor cutting performance (and operator frustration) caused by worn parts.

5 Check gas/air pressure at the compressor or bottle gauge.

6 Turn on the plasma machine.

7 Set the amperage control (generally to maximum) and check the air pressure.

8 Grind off rust or paint where you plan to secure the ground clamp. This step is critical with 12-amp machines; they just don't have the power to drive through rust and paint like larger units do.

9 Place the ground clamp as close to the cut as possible, and place the clamp on the work piece itself when possible. Check for any loose connections between the work cable and the clamp.

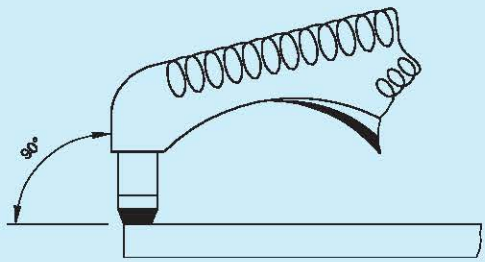
10 Begin cutting.

2 Cutting technique

Step 1: Place the drag shield on the edge of the base metal, or hold the correct standoff distance (typically 1/8 in.). Direct the arc straight down. (Dragging the tip will reduce tip life).

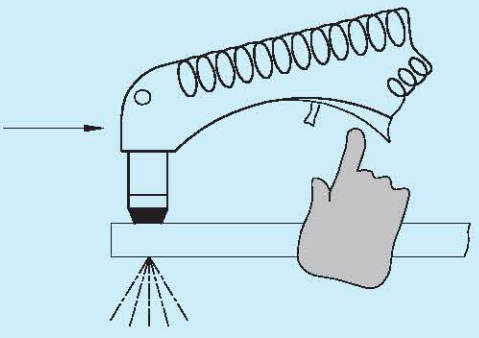
The arc starts immediately when trigger is pressed.

Fig 1



Step 2: Raise the trigger lock, press the trigger and the pilot arc starts immediately.

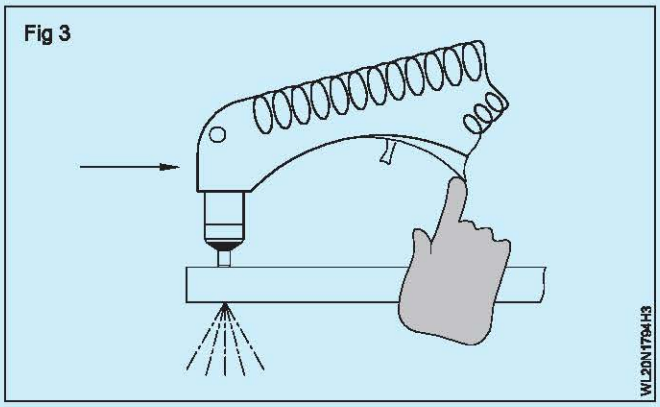
Fig 2



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Step 3: Once the cutting arc starts, begin to slowly move the torch across the metal.

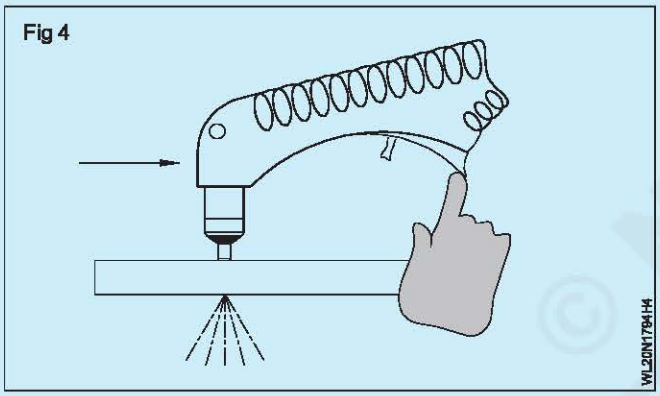
Fig 3



Step 4: Adjust your speed so sparks go through metal and out bottom of cut.

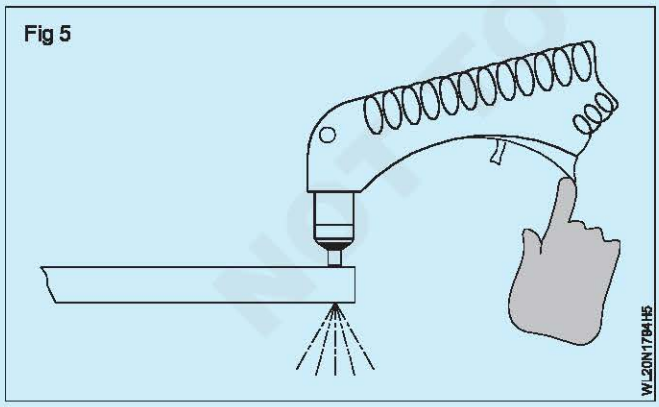
If the sparks are not visible at the bottom of the plate, the arc is not penetrating the metal. This can be caused by moving the torch too quickly, insufficient amperage or directing the plasma steam at an angle (not straight down). Insignificant grounding can also cause this problem.

Fig 4



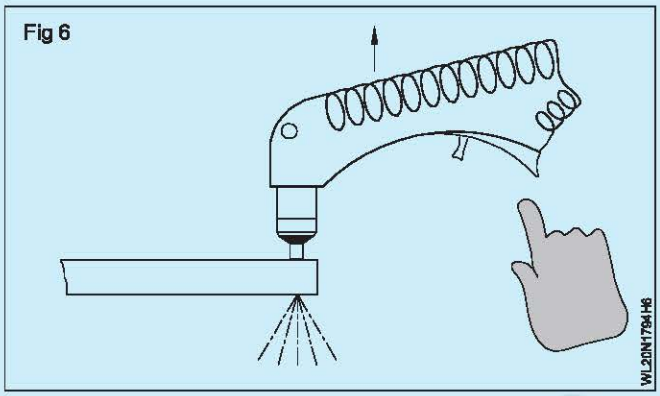
Step 5: At the end of a cut, angle the torch slightly towards the final edge or pause briefly before releasing trigger to completely sever the metal.

Fig 5



Step 6: To cool torch, post-flow air continues for 20-30 seconds after releasing the trigger; pressing the trigger during post-flow instantly restart the arc.

Fig 6



Travelling at the right speed produces a very clean cut with less dross on the bottom of the cut, as well as little or no distortion to the metal. If the travel speed is too slow, the material you are cutting may become hot and accumulate more dross. To minimize dross, increase travel speed or reduce amperage (for a rated cut). Dross also accumulates when you push a machine to its maximum thickness. The only cure for this is a bigger machine.

3 Gouging techniques

To gouge - to remove old welds or imperfections - hold the torch at a 40 to 45° angle to the base metal. Establish an arc length of 1 to 1-1/2 in. and move the torch across the metal, adjusting torch speed, arc length and angle as needed. Direct sparks away from the torch, and do not gouge too deeply on one pass. Make multiple passes if needed.

To pierce metal - creating a hole, such as to start coping or insert a valve - place the torch at a 40 to 45° angle to the work piece. Press the trigger. After the machine initiates the cutting arc, bring the torch tip to a 90° angle and the arc will pierce the base metal. Generally, a machine can pierce metal up to one-half of its maximum cutting thickness. Powerful machines pierce 1/4 in. steel within a second or two.

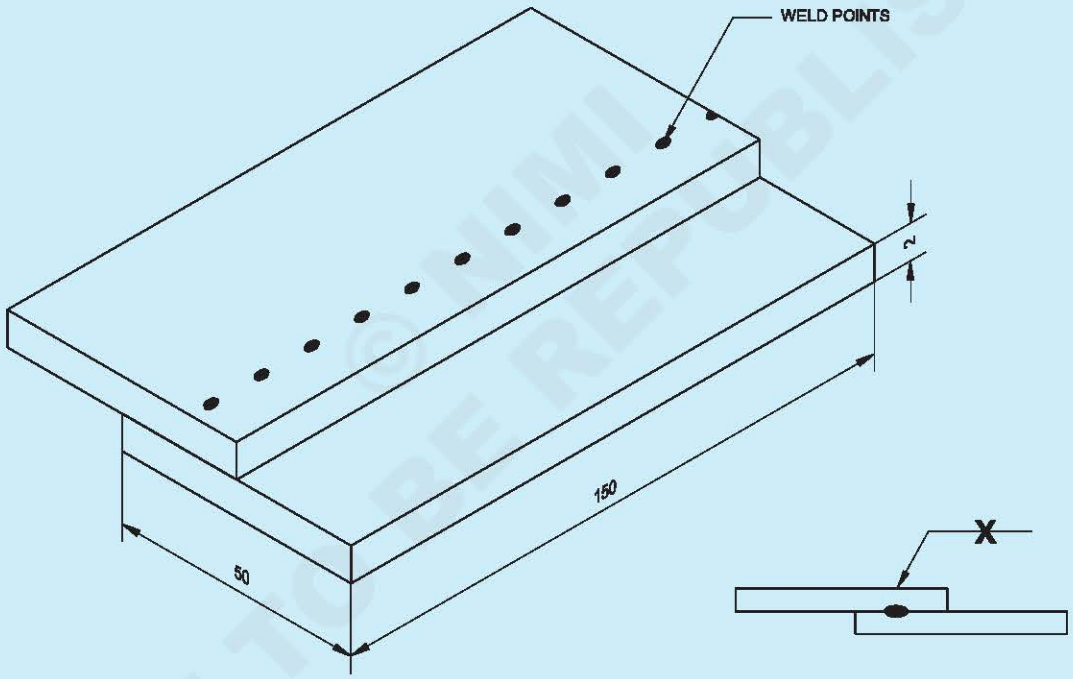
If you select the appropriate plasma cutter and service it properly, you can experience years of trouble-free performance. In fact, most "problems" with plasma cutting relate to otter systems (air, consumables), not the machine itself. Most importantly, almost every person who cuts with a plasma cutting gets hooked on the technology. They couldn't by paid to go back other cutting methods.

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Lap joint on stainless steel sheet by Resistance spot welding (R.W - 01)

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

- **prepare sheets by shearing and grinding**
- **set the lap joint and operate spot welding machine**
- **weld the lap joint by using spot welding machine**
- **clean and inspect the weld job.**



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2	150 x 50 x 2		Fe310-W			1.7.95
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO
SCALE NTS	**LAP JOINT ON STAINLESS STEEL SHEET BY RESISTANCE SPOT WELDING**				TOLERANCE ±1	TIME
					WL20N1795E1	

Job Sequence

1 Cut the sheet by hand shearing as per drawing.

2 File the edges to square.

3 Remove the burrs and clean the surfaces by wire brush.

Wear hand gloves.

4 Set the pieces in the form of lap joint.

5 Select proper spot welding machine.

6 Select centre tip type copper electrodes

7 Set current flow time, contact period time.

8 Check the water cooling system

7 Tack at both ends of job by applying the pressure with spot welding machine

9 Complete the welding (Wled nugget) carefully.

10 Clean and inspect the defects.

Skill Sequence

Lap joint on stainless steel sheet by Resistance spot welding (R.W - 01)

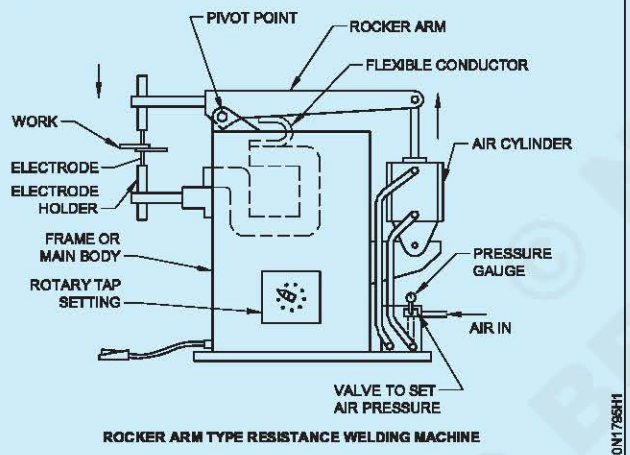
Objectives: This shall help you to

- **prepare and weld lap joint on SS by using spot welding machine.**

Set the pieces in the form of lap joint

Select proper spot welding machine as Fig 1.

Fig 1



ROCKER ARM TYPE RESISTANCE WELDING MACHINE

Select centre tip type copper electrodes.

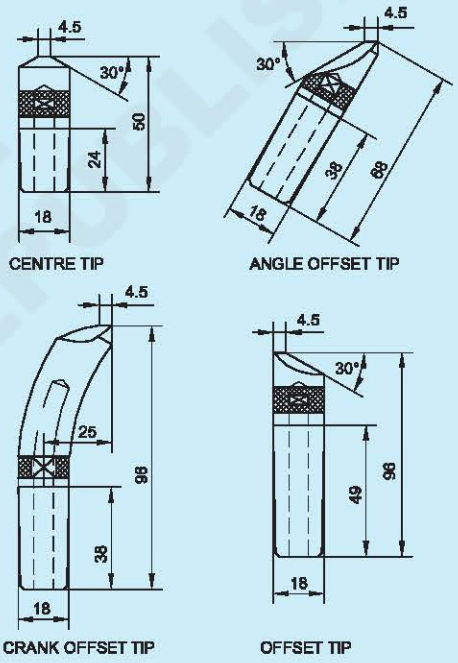
Set current flow time, contact period time.

Check the water cooling system.

Tack at both ends of job by applying the pressure with spot welding machine.

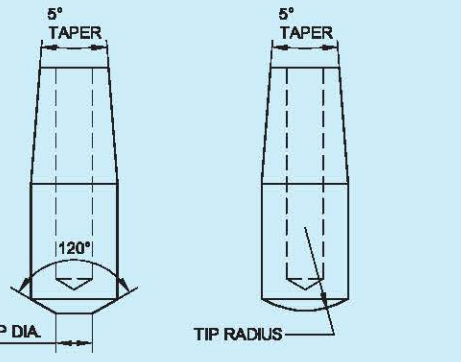
Complete the welding (Weld nugget) carefully as per Fig 2b

Fig 2



FOUR STANDARD TYPES OF ELECTRODES

Fig 3



THE RADIUS OF THE DOMED TIP (RIGHT) VARIES FROM 25mm FOR WELDING 26 S.W.G. MATERIAL, UPTO 150mm FOR 3 S.W.G. THE DIAMETER OF FLAT PART OF THE OTHER ELECTRODE VARIES FROM 4mm TO 12mm FOR SIMILAR MATERIAL THICKNESS.

TWO STANDARD TYPES OF CENTER TIP ELECTRODE

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M.S. Sheet Joining by Resistance spot welding (R.W - 02)

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

- **prepare sheets by shearing and grinding**
- **set plates as lap joint**
- **operate the spot welding machine**
- **complete the spot welding by applying pressure**
- **clean and inspect the weld job.**

Job Sequence

1 Cut the sheet by hand shearing as per drawing

2 Grind the edges to square

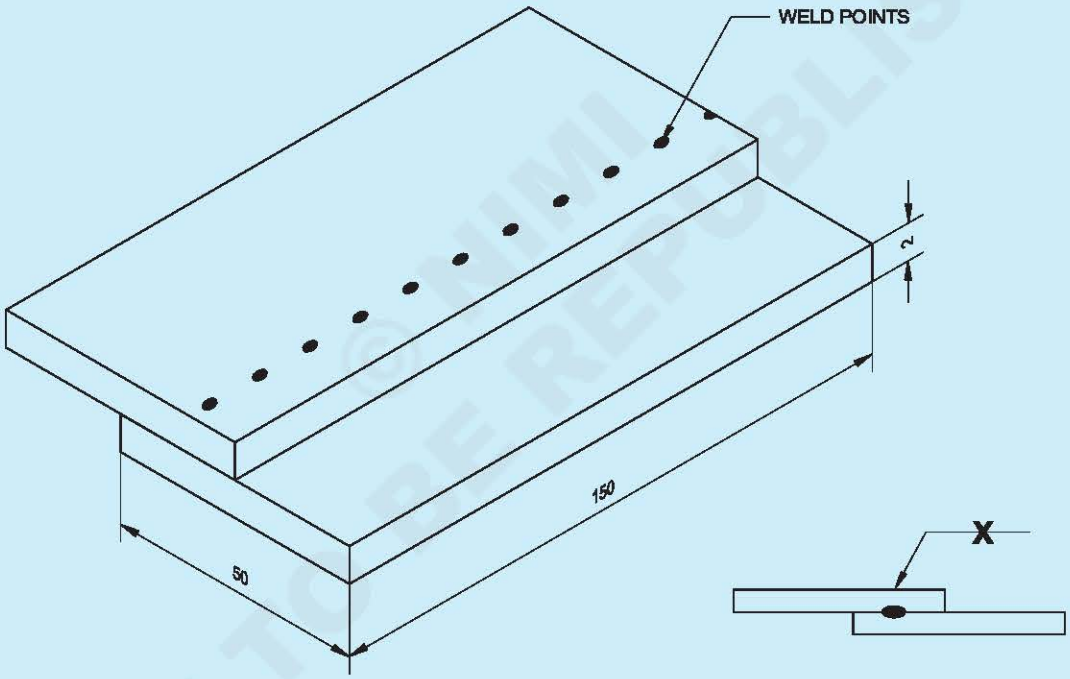
3 Remove the burns and clean the surfaces by wire brush.

4 Set the pieces in the form of lap joint as per drawing.

Wear hand gloves.

5 Weld at two ends with spot welding machine.

6 Complete the joint by spots.



Skill Sequence

Refer Ex.No. 1.7.95

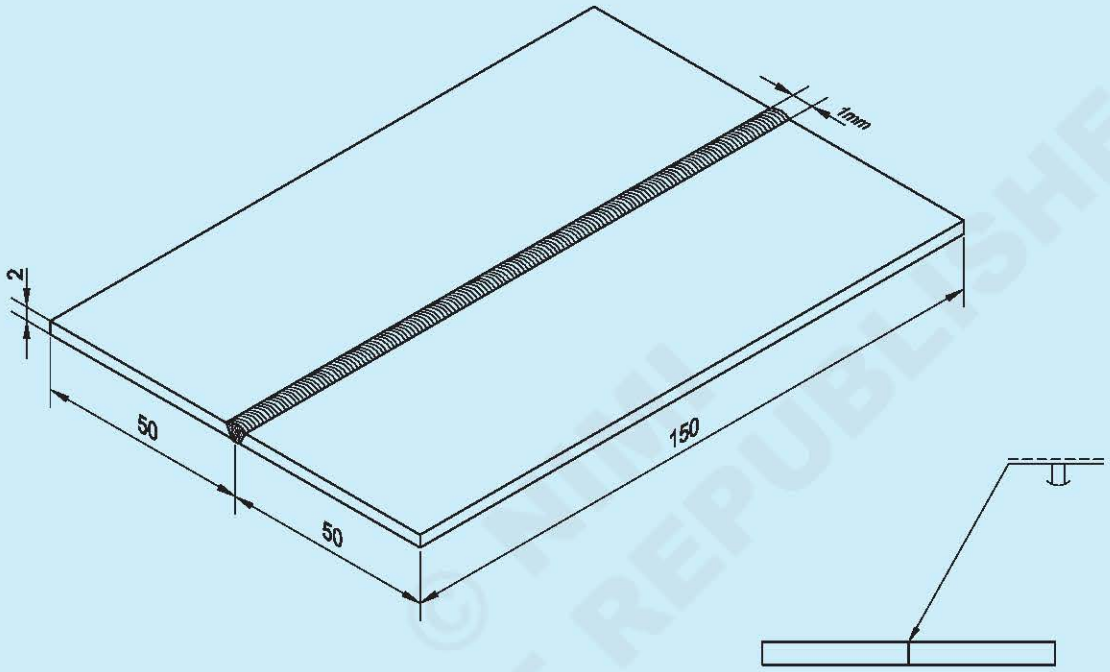
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2	ISST 150 x 50 x 2		Fe310-W			1.7.96
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO
SCALE NTS	LAP JOINT ON M.S BY RESISTANCE SPOT WELDING				TOLERANCE ±1	TIME
					WL20N1796E1	

Square Butt Joint on Copper sheet 2mm thick in Flat position (1G) (OAW 01)

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

- **prepare the jon with root gap as per drawing**
- **select nozzle filer rod flux and gas pressure**
- **maintain preheat and post heat**
- **deposit weld bead in the groove**
- **clean and inspect the defects.**



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Job Sequence

1 Remove the oxides from the surfaces of the deoxidised copper sheet.

2 Clean the joint from other impurities using solvent/ pickling.

3 If pickling/solvent is used for cleaning, then thoroughly wash and dry the joint before tack welding.

4 Prepare square edges of the pieces by filing.

Do not use grinding to prepare the edges of non-ferrous metals.

5 Select the nozzle No.7 and 0.15kg/cm^2 pressure for both the gases.

6 Select a 2.0 mm copper silver alloy filler rod.

7 Select copper/silver alloy flux.

8 Follow necessary safety precautions.

9 Set the job with a proper root gap or with diverging allowance.

Do not tack weld.

2	150 CU 50 x 2		CuDPA-IS: 2378			1.7.97
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

SCALE NTS	SQUARE BUTT JOINT ON COPPER SHEET 2mm THICK IN FLAT POSITION - 1G (OAW-01)	TOLERANCE ±1	TIME
		WL20N1797E1	

10 Apply the flux in the form of paste on both sides of the plate and on the filler rod.

11 Preheat the base metal with 350°C.

12 Deposit the weld metal in the groove in one run.

13 Post-heat the weldment and cool the joint slowly.

14 Clean the flux residue on the weldment and the penetrated portion.

15 Inspect the weld for defects.

16 Set neutral flame strictly.

Skill Sequence

Square Butt Joint on Copper sheet 2mm thick in Flat position

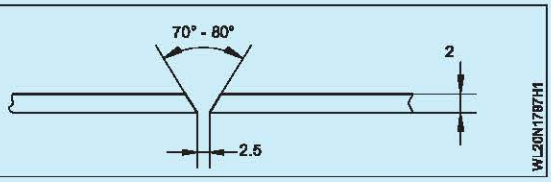
Objectives: This shall help you to

- **prepare and weld square butt joint on copper in flat position.**

File the edges to the required form. (Fig 1)

Select nozzle No.5-7.

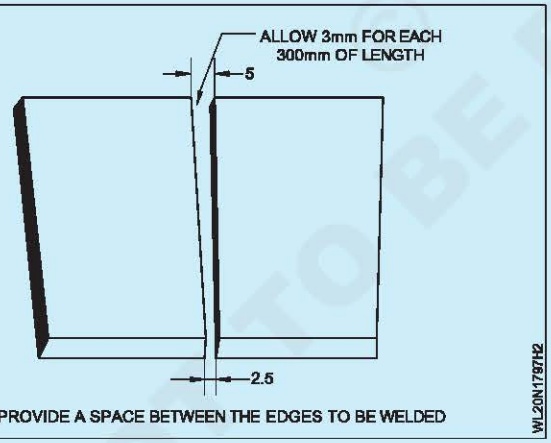
Fig 1



A nozzle one size larger should be used as compared with the M.S. sheet welding because of high conductivity and quick dissipation of heat.

Set the job with a proper root gap or with a diverging allowance. (Fig 2) Do not tack weld.

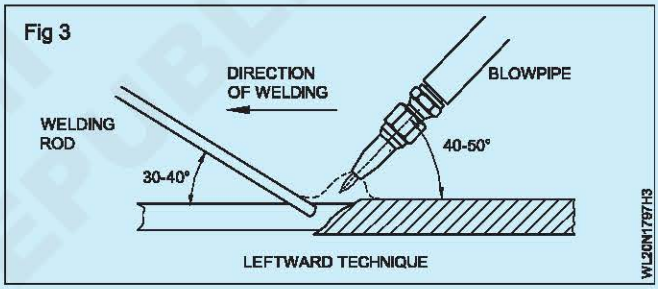
Fig 2



Copper has a high coefficient of expansion and it is necessary to set the plates diverging at the rate of 3-4 mm per 300 mm. run, because they come together and the root gap gets closed so much on being welded.

The blow pipe angle should be 60^0 - 80^0 and the filler rod angle 25^0 - 30^0 to the line of weld. Fig 3.

Fig 3



Always keep the molten pool and the tip of the filler rod under the shadow of the outer envelope.

Maintain the temperature of the job throughout the welding operation.

It is always better to keep a helper to continuously heat the job using another blow pipe as you are welding a copper joint. Otherwise the joint will begin to crack from the starting point as you proceed to weld further.

Post-heat the job to 300^0C and allow to cool slowly. Clean the bead and remove the flux residue on both sides of the joint.

Inspect the joint for external defects and bead size and profile.

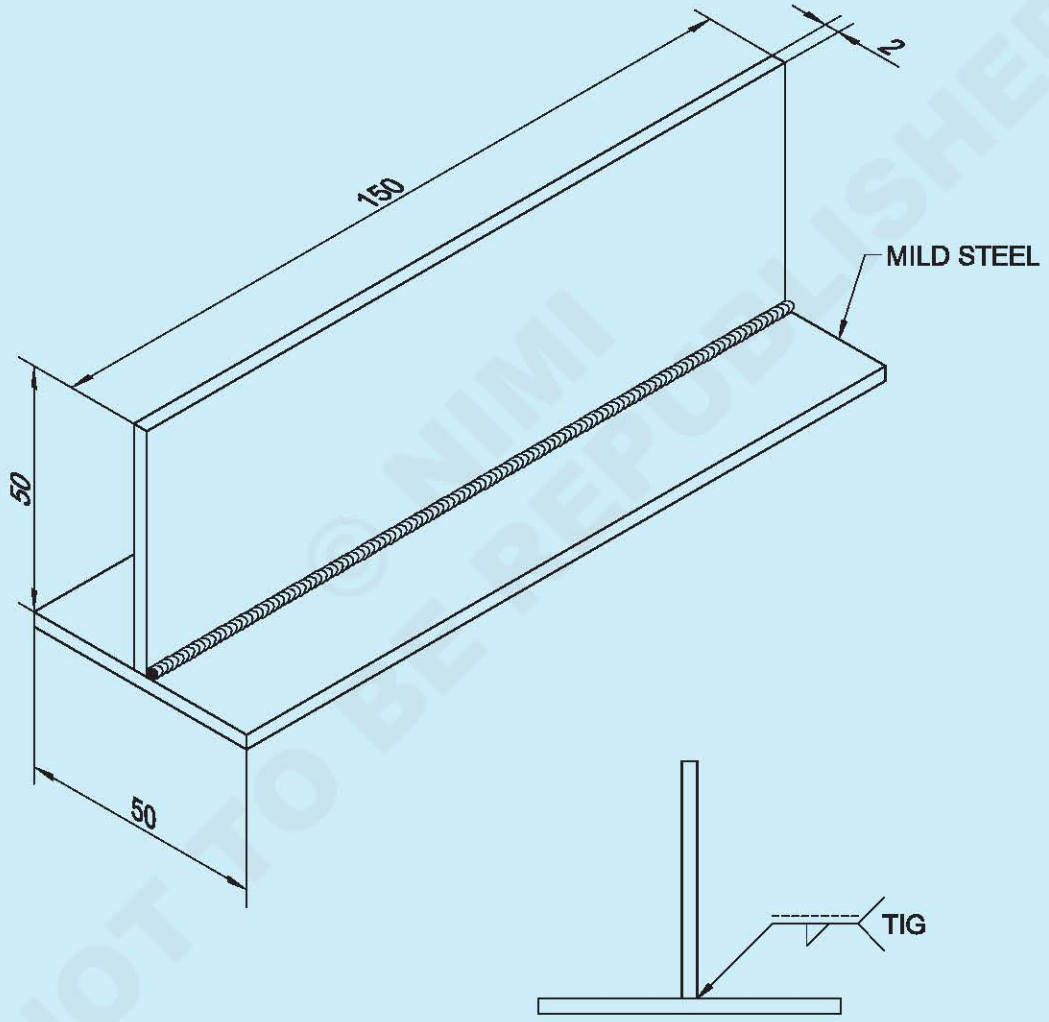
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Exercise 1.7.98

'T' joint on copper to M.S sheet 2mm thick in flat position by brazing 1F (OAW 02)

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

- **prepare and set on job as per drawing**
- **select filler rod nozzle and flame**
- **braze a Tee joint**
- **clean and inspect the weld defects**



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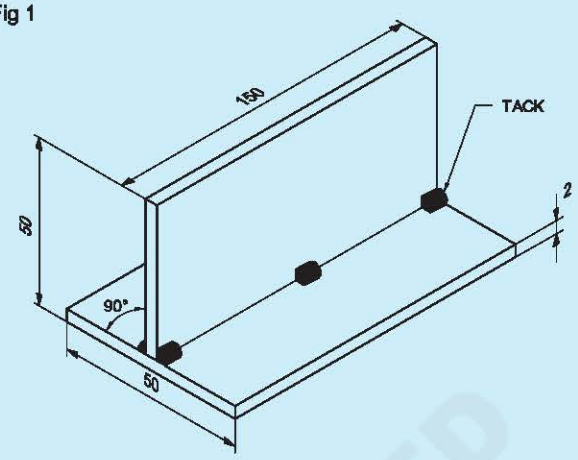
1	ISST - 150 x 50 x 2	--	Fe310	--	--	1.7.98
1	150 x 50 x 2	--	CNDPA-IS:2372	--	--	1.7.98
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

SCALE NTS	'T' JOINT ON COPPER TO M.S. SHEET 2mm THICK IN FLAT POSITION BY BRAZING (1F)	TOLERANCE ±1	TIME
		WL20N1798E1	

Job Sequence

- Prepare the sheets (M.S. and copper) by using shearing filing.
- Prepare the edges to right angles by filing
- Clean the base metal by steel wire brush.
- Set the sheets as Tee joint on welding table
- Wear all protective clothing.
- Open the Cylinder values (Both O_2 and C_2H_2) slowly and set the working pressure.
- Select nozzle one or two size bigger size than the sheet thickness.
- Select 1.6mm ø brass filler rod with suitable flux (Borax).
- Ignite the flame by spark lighter.
- Set slightly oxidising flame.
- Tack the job as per the fig shown below.

Fig 1



ASSEMBLING A TEE JOINT

WL20N1788H1

- Deposit filler metal to complete the joint.

Skill Sequence

'T' joint on copper to M.S sheet 2mm thick in flat position by brazing

Objective: This shall help you to

- **prepare the weld tee joint on copper to MS sheet by brazing.**

Set oxidising flame to avoid zinc evaporation.

Concentrate the flame towards copper sheet to reduce heat loss during brazing.

Cool the job slowly.

Clean the job by hot water to remove burnt flux (Slag).

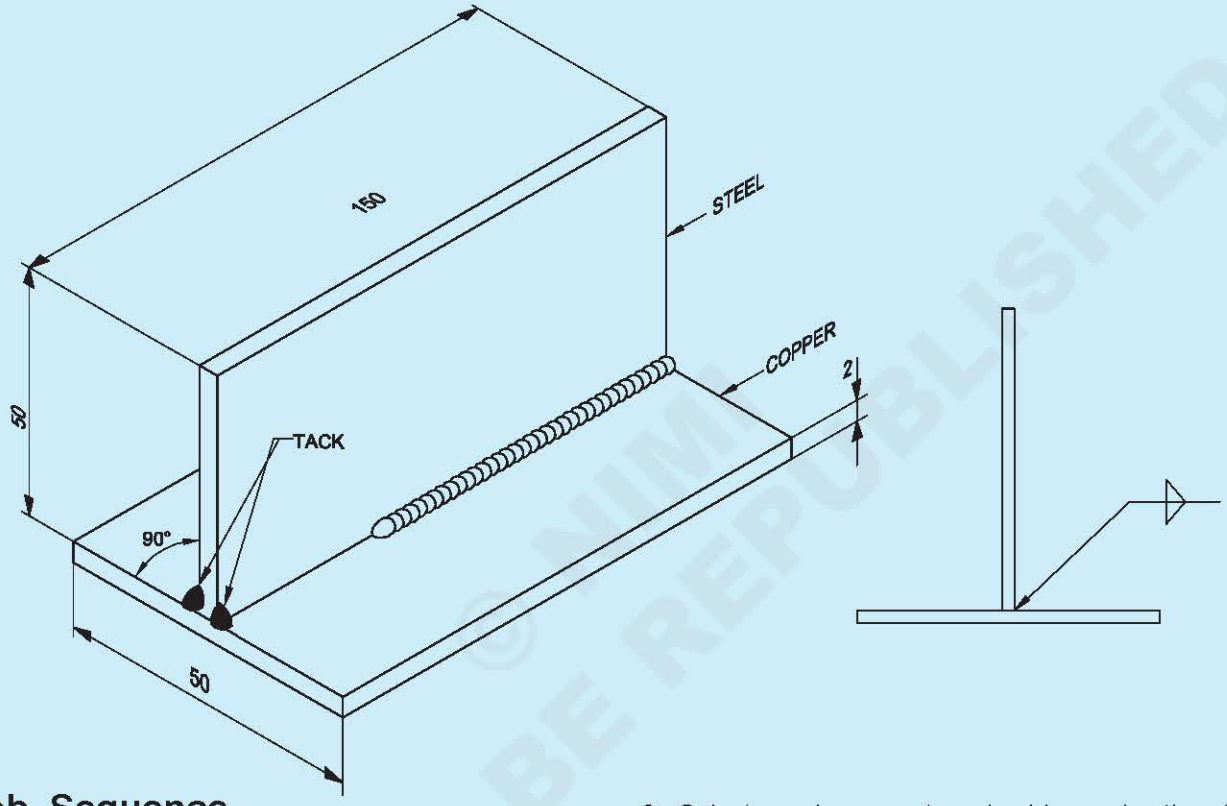
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Exercise 1.7.99

Silver brazing on S.S. sheet with copper sheet 'T' joint (OAW - 03)

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

- **prepare plates as per drawing**
- **set and tack joint the plates as per drawing**
- **set the 'T' joint in flat position for brazing**
- **deposit the bead with appropriate amount of filler metal**
- **clean and inspect for surface defects.**



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Job Sequence

1 Prepare the sheets (S.S. and copper) by using shearing, grinding & filing.

2 Clean the base metal by steel wire brush.

3 Set the sheets as 'T' joint on welding table

4 Wear all protective clothings.

5 Open the Cylinder values (Both O_2 and C_2H_2) slowly and let the working pressure.

6 Select nozzle one or two size bigger size than the sheet thickness.

7 Select 1.6mm ø filler rod with 40 to 50% silver and 15-25%-15% zinc remaining copper.

8 Ignite the flame by spark lighter.

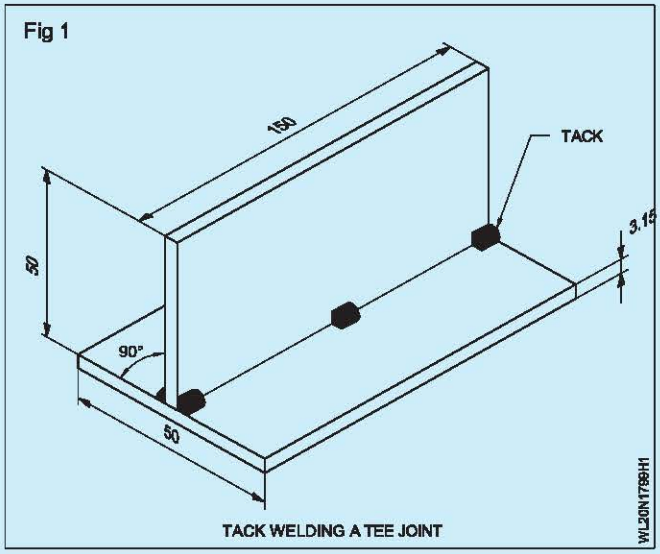
9 Set slightly oxidising flame.

10 Tack the job as per the fig shown below. (Fig 1)

11 Complete the joint.

1	ISST 50 x 2 - 150	- -	X04 Cr 19 Ni9	- -	- -	1.7.99
1	ISST 50 x 2 - 150	- -	CUDPA - IS - 2378	- -	- -	1.7.99
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO

SCALE NTS	SILVER BRAZING ON SS SHEET WITH COPPER SHEET 'TEE JOINT'	TOLERANCE ±0.5	TIME
		WL20N1799E1	



Skill Sequence

Silver brazing

Objective: This shall help you to

- **silver brazing on SS with copper sheet 'T' joint.**

Silver Brazing of: Place the tacked joint in flat position by tilting and supporting it. (Fig 2)

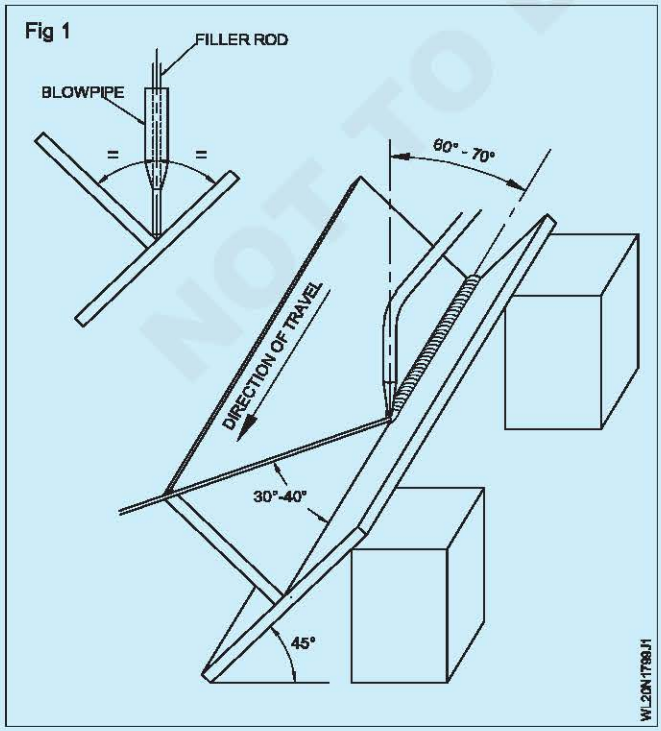
Start Brazing at the right hand end of the joint by fusing the tack-weld. Keep the blowpipe in the leftward direction at an angle of 60° to 70° and the filler rod at an angle of 30° to 40° to the line of travel. The blow pipe and filler rod should be held at 45° between the 2 surfaces of the joint. This will ensure root penetration. Watch the molten metal closely to make sure that both pieces are joined by brazing. When the molten pool is formed add the filler rod in the centre of molten pool. Give slight side-to-side movement to the flame (blowpipe) and a piston like motion to the filler rod.

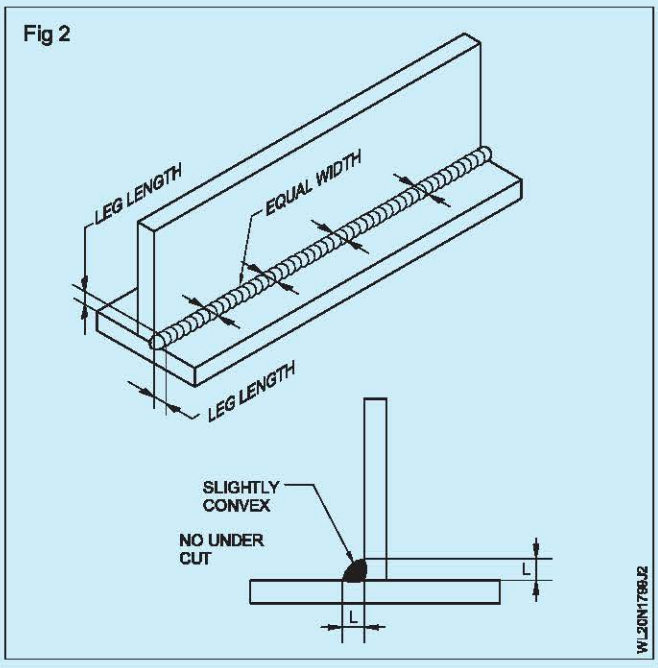
Adjust the rate of travel of the blowpipe and the filler rod to secure even penetration at the root and into both sheets, and to produce a fillet weld of equal leg length.

Visual inspection (Fig 3)

Clean the weldment and inspect for:

- uniform weld size and shape of bead (reinforcement and contour slightly convex)
- equal leg length.
- no porosity, overlap.





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Silver brazing on copper tube to tube (OAW - 04)

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

- **prepare a bell mouth by heating the tip of the pipe**
- **select nozzle, filler rod, flux and flame for brazing**
- **tack the bell mouth joint and braze the joint using pipe welding technique**
- **clean the joint and inspect for surface defects.**

Job Sequence

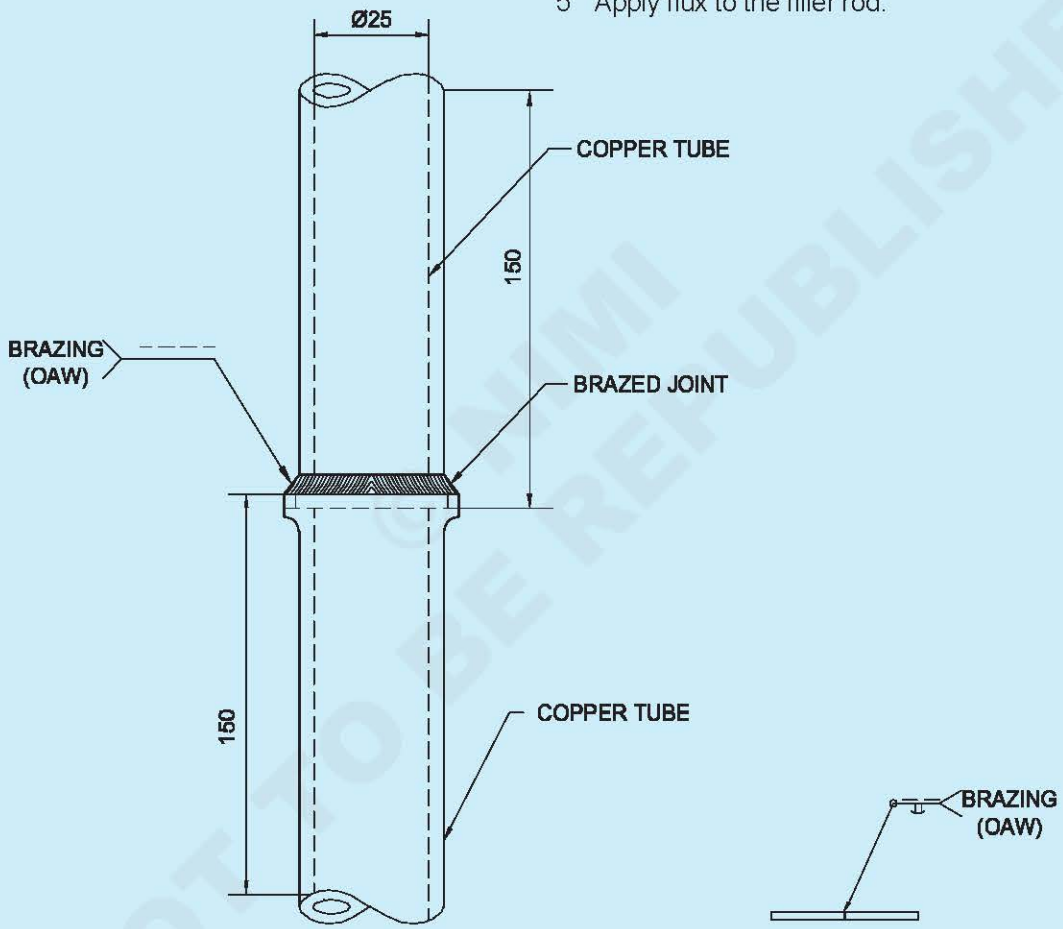
1 Prepare a copper tube as per dimension.

2 Expand the copper pipe to form as a bell mouth.

3 Clean and remove the surface oxides by wire wool.

4 Select the nozzle No.5 and 1.6mmø phosphorus bronze or 27-35% filler rod.

5 Apply flux to the filler rod.



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2	Ø25 x 2 - 150		CuDPA - IS: 2378			1.7.100
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO
SCALE NTS	**BRAZING ON COPPER TUBE TO TUBE**				TOLERANCE ±1	TIME 15 Hrs
					WL20N17100E1	

6 Set the oxidising flame.

7 Insert the copper tube into the bell mouth of copper tube and tack at 3 places.

8 Keep the tack welded pipes with their axes vertical.

9 Start Brazing at the mid point of two tack welds and end the first fun after brazing half the circumference of the pipe.

10 Braze the other half of the circumference of the pipe as second run.

11 Manipulate the blowpipe and filler rod with flux applied on it using proper angles to fill the bell mouthed groove.

12 Clean and remove the flux residue.

13 Inspect for external weld defects.

Skill Sequence

Silver brazing on copper tube to tube

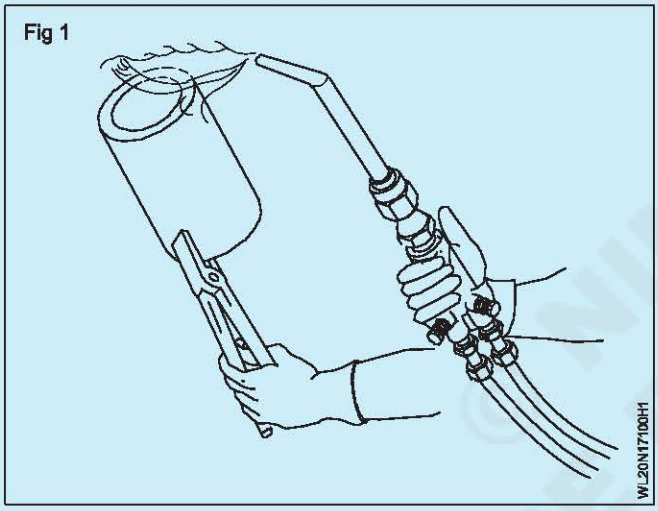
Objective: This shall help you to

- **prepare the brazing of copper to copper tube.**

Brazing of copper to copper tube

Soften the end of copper tube to be bell-mouthed by heating. (Fig 1)

Fig 1



Dip the heated end in water and remove the oxides. (Fig 2)

Use a mandrel to form the bell mouth. (Fig 3)

Insert the mandrel and drive into the softened end of the tube by hammering. (Fig 3)

Fig 2

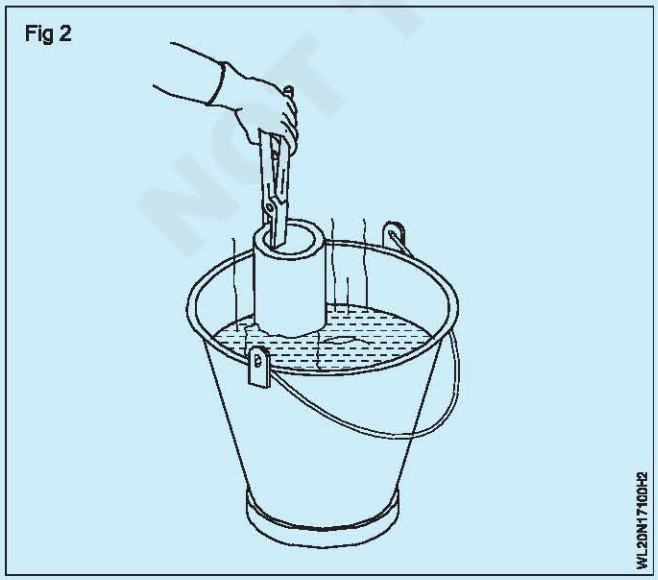
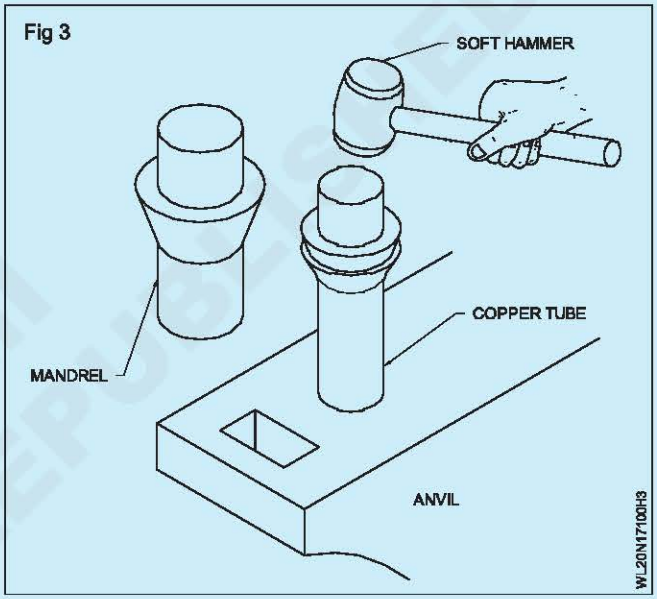
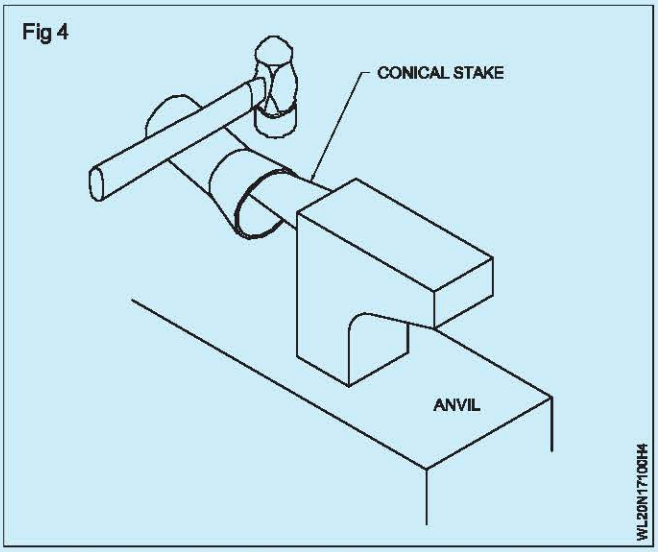


Fig 3



Remove any unevenness of the bell mouth. (Fig 4)

Fig 4

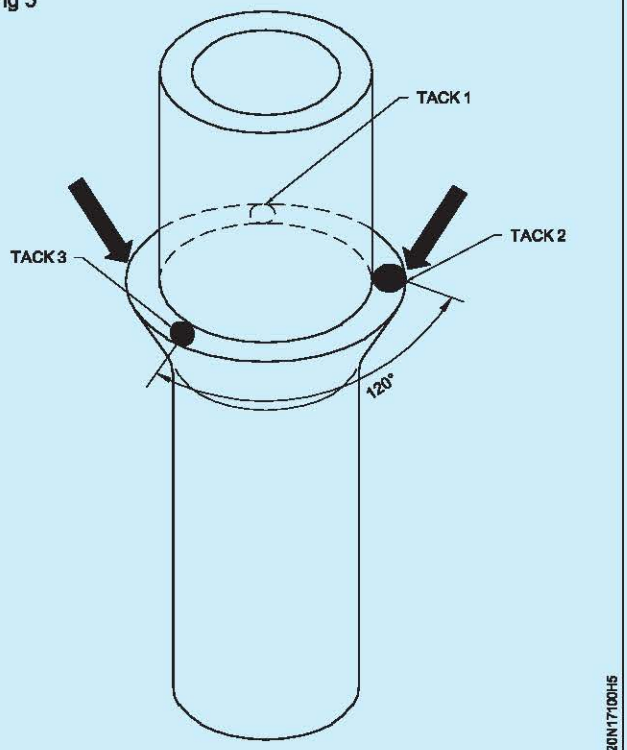


Insert the other tube into the bell mouth and tack it at 3 points. (Fig 5)

Keep the tack welded pipe assembly vertically and heat it until the colour of the tube starts changing.

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Fig 5



Make a thin run on the line formed by the outer circumference at the bottom end of the tube and the inner circumference at the bottom of the bell mouth of copper tube (i.e tip of the bell mouth).

Make the first deposit starting from the tack weld 1 and ending at the midpoint of the tack welds 2 and 3 covering half the circumference of the bell mouth. (Fig 6)

Clean the deposit.

Make the second deposit starting from the commencement point of deposit 1 and ending at the finishing point of the deposit 1 which will cover the remaining half circumference of the bell mouth.

Ensure the deposit 2 merges with the deposit 1 at both ends (i.e. terminal points) properly by withdrawing the filler rod and manipulating the flame over these merging points.(Fig 6)

Ensure that the weld deposit is of the correct profile and it completely covers and bonds (without over spilling the outer edge of the bell contour. (Fig 7)

Clean the bead and the joint and remove the flux residue thoroughly.

Inspect the braze deposit for uniform size and braze defects like porosity, etc.

Fig 6

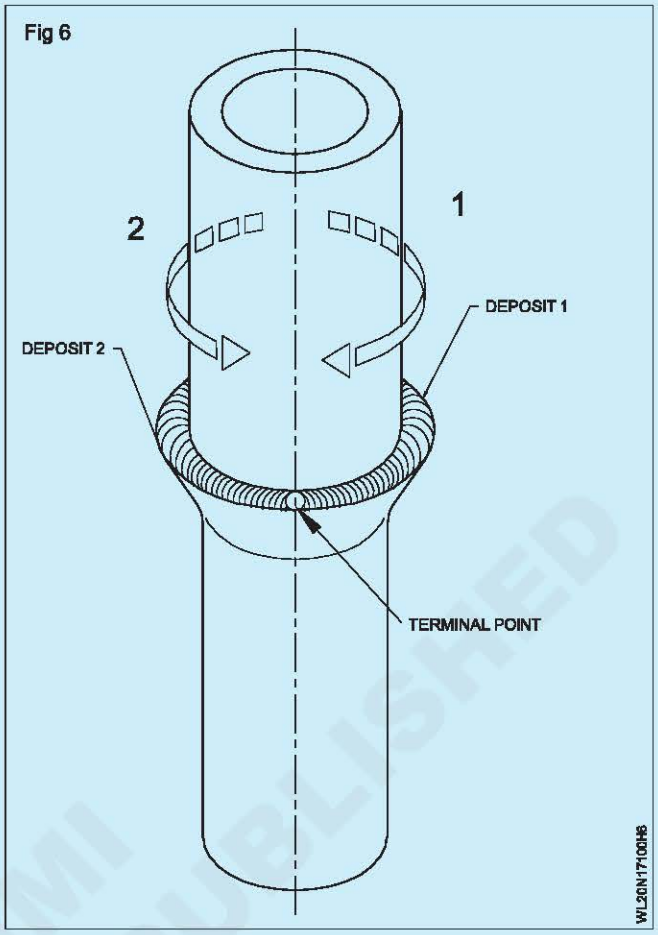
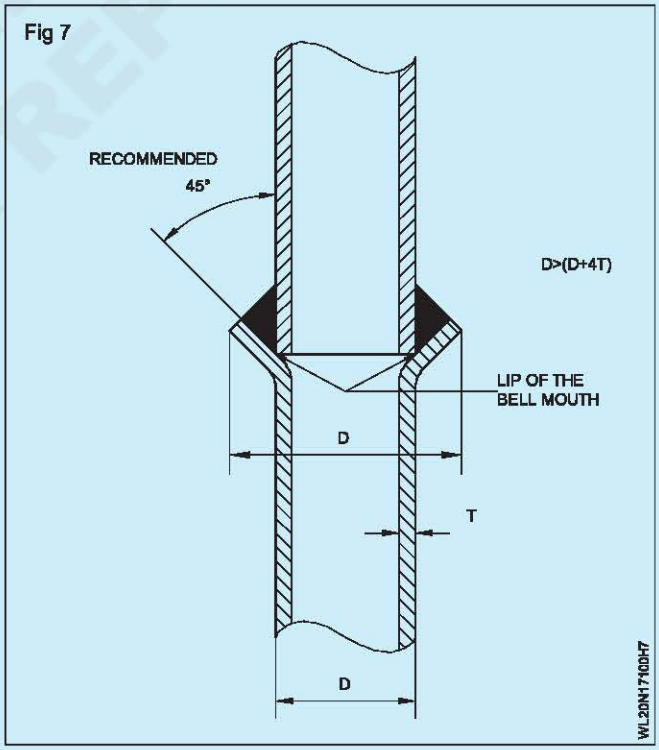


Fig 7



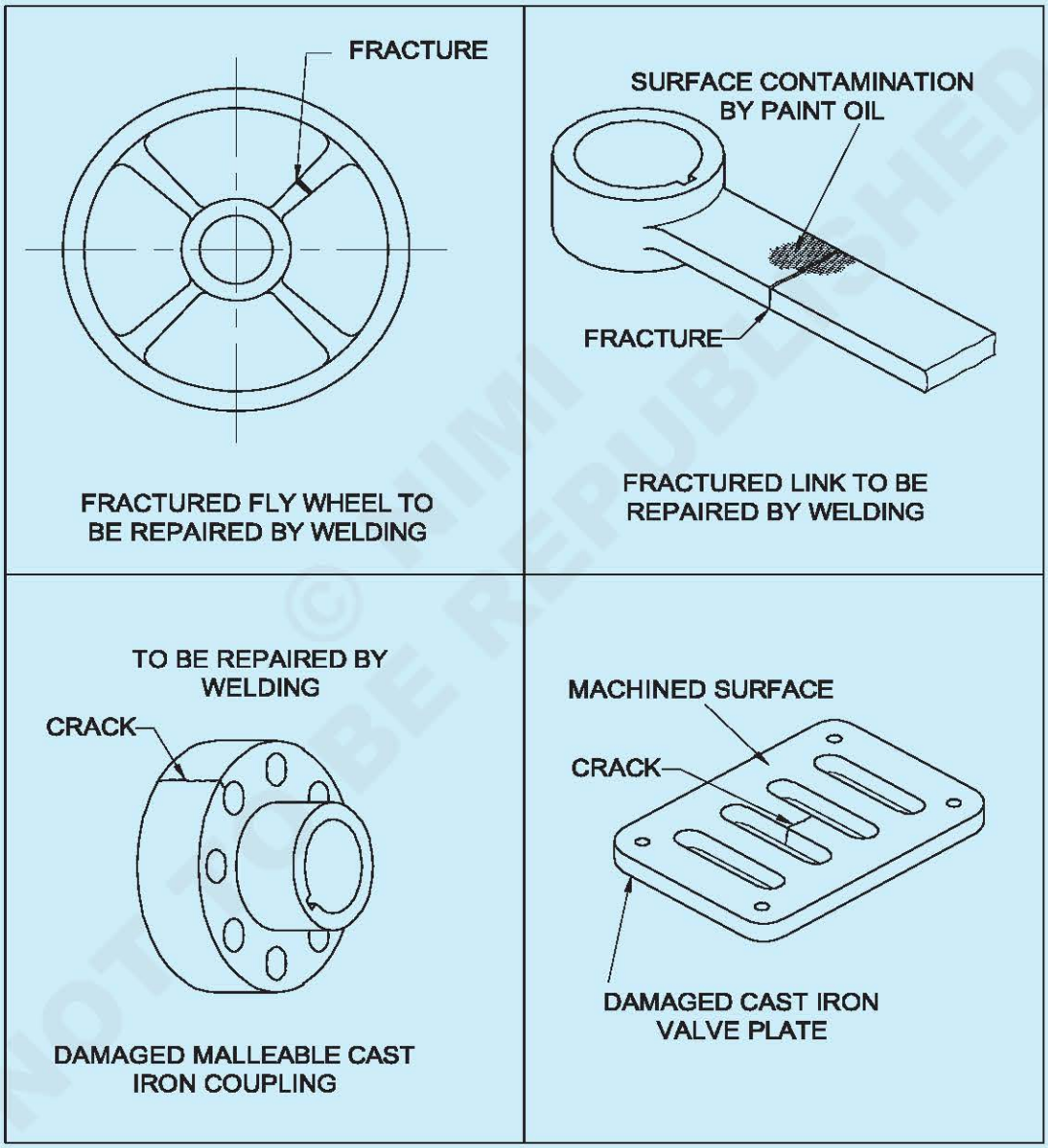
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Exercise 1.7.101

Repair welding of broken CI machine parts by oxy acetylene welding with CI and bronze filler rod (OAW-05)

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

- **clean the job pieces from oil grease etc.,**
- **select the correct nozzle size and weld filler rod and flux**
- **set a slightly oxidised flame**
- **clean and check the defects on the weldment.**



ANY BROKEN / CRACKED CAST IRON MACHINE PART

1	BROKEN/CRACKED MACHINE PARTS	-	CAST IRON	-	-	1.7.101
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	REPAIR WELDING OF BROKEN CAST IRON MACHINE PARTS BY USING LOW HEAT INPUT ELECTRODES.	TOLERANCE ±1	TIME 05 Hrs
		WLN17101E1	

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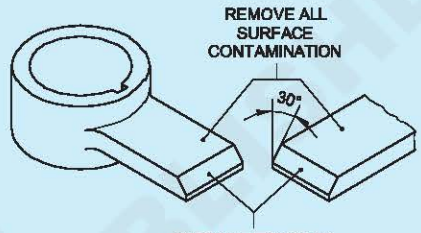
Job Sequence

- Clean the surface of the workpiece from oil, grease, dirt and remove oxides if any by filing/grinding.
- Grind the edges of the plate to (no feather edge) form a single Vee of included angle of 90^0. Round off all sharp edges.
- Select nozzle No.10.
- Select a silicon bronze filler rod of 3mmø for the root run and 5mmø for the 2nd run.
- Select bronze flux and 0.15 kgf/cm^2 pressure for both gases.
- Ensure all safety precautions before lighting the torch.
- Set a soft oxidising flame.
- Apply flux in powder form by dipping hot filler rod. Then tack weld on both ends of the joint with a uniform root gap of 2.5mm.
- Weld the root run using leftward technique and 3mmø filler rod keeping the job at 30^0 slope.
- Ensure welding of weld faces by the filler metal before building up the bead.
- Heat the weld faces only to dull red colour by giving circular motion to the blow pipe.

It is not necessary to melt the base metal for bronze welding of cast iron.

- Clean the root run and deposit the 2nd run using 5mm filler rod after applying flux.
- Fill the joint by filler metal to get a maximum of 1.5mm reinforcement, good ripple formation.
- Clean the joint removing any flux residue and inspect for defects.
- Heat control is important. If the heat is insufficient the bronze metal will not wet the surface or flow properly.
- Excess heat will cause the bronze metal to flow more freely and not allow it to build up.

Fig 4



Skill Sequence

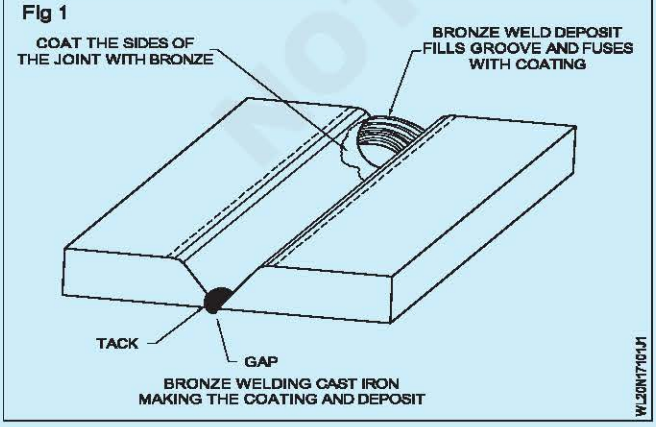
Repair welding of broken CI machine parts by oxy acetylene welding with CI and bronze filler rod

Objective: This shall help you to
- **prepare the broken CI machure parts by OAW.**

Set the bevel with 30^0 inclination. Keep the angle of the filler rod at 30^0 to 40^0 and give a rubbing action to the filler rod on the vee.

Maintain the angle of the blowpipe at 60^0 to 70^0 and give a circular motion to the blowpipe. (Fig 1)

Fig 1



Deposit a root run with a 3mmø filler rod and the finishing run with a 5mmø filler rod. Dip the hot filler rod end into the powdered bronze flux frequently.

In bronze welding of cast iron the base is only heated to 650^0C and it is not melted. So while depositing the root run the surfaces of the joint is coated with a layer of filler metal for about 20mm along the joint, ensuring that it is correctly bonded.

Then return to the starting point and add sufficient filler metal to produce a satisfactory weld. This method is repeated continuously until the root run is completed.

Clean the bead and remove the flux residue on both sides of the joint.

Inspect the joint for weld defects like porosity, incomplete penetration etc.

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Fig 2

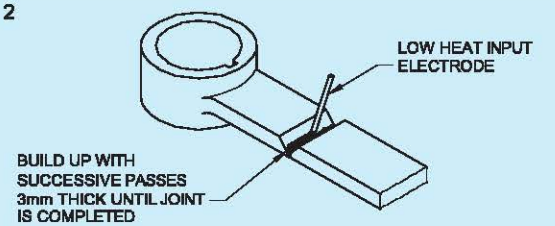
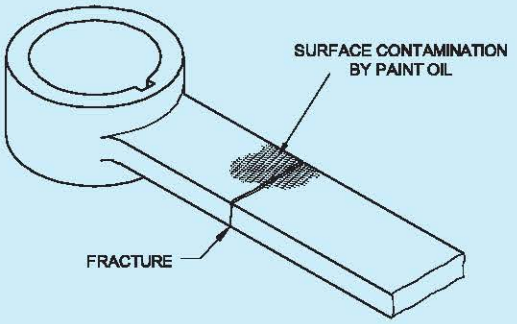


Fig 2

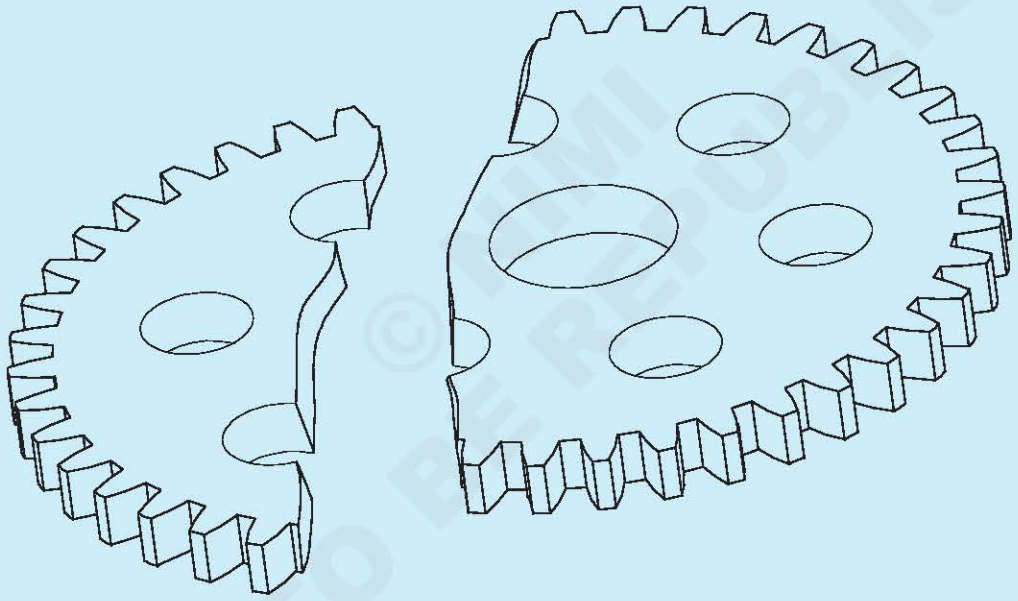


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Repair welding of broken CI machine parts by CI electrode. SMAW-01

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

- **prepare the edges, set the cast iron plates and tack weld**
- **preheat and post heat the joint**
- **select the electrode and set the current**
- **weld the broken part**
- **relieve the stresses from the joint by peening the bead**
- **inspect the joint for defects.**



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NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO
SCALE NTS	REPAIR WELDING OF BROKEN CI MACHINE PARTS BY CI ELECTRODE				TOLERANCE ±1	TIME
					WL20N17102E1	

Job Sequence

- Repairing of CI broken gear
- Cleaning the cast weld surfaces
- Preheating on the crack line
- Choosing welding techniques and consumable
- Choosing the proper electrode and wire consumables
- Finish with show cooling

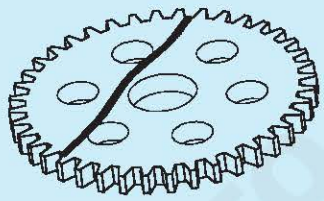
Skill Sequence

Repair welding of broken CI machine parts by CI electrodes

Objective: This shall help you to
- **prepare the 'T' joint on MS plate in vertical position.**

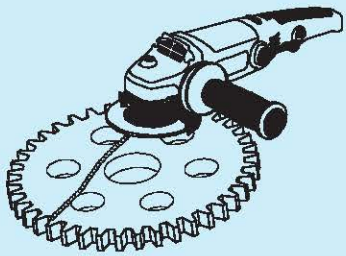
- Weld technique
- Run short weld beads (around 25mm long) at a time, to avoid overheating.
- Excessive current will cause over-heating, keep current/ amps setting as low as possible within the range
- After aligning the broken pieces make few drill holes in the crack line for good bonding between the pieces
- Rather than running each bead beside the next, stagger the welds over the length of the crack to help evenly spread heat and tension. For example, place a bead at each end of the crack then in the middle then stagger the rest,
- Peining each weld for 1-2 minutes using ball pein hammer immediately after each weld bead - helps to reduce the stresses induced by the contraction of the metal as it gets cooler.
- If the end of the last weld is too full grind the end back a little so you have an ideal start that will not encourage slag inclusions.
- Repeat above procedure until finished, ensuring that sufficient heat remains in the job
- Site preparation and filling (sealing) of the gap between two adjacent whole teeth with respect to the missing one.
- Making a holder for a gear cutting mill and an axis for fixing the gear block and gear on the machine during processing.
- The formation of the tooth profile by sampling the deposited material with a special cutter on both sides.

Fig 1



W-20N17102H1

Fig 2



W-20N17102H2

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Repair plastic broken parts or pipes by plastic welding machine

Objective: At the end of this exercise you shall be able to
- **prepare weld the plastic broken parts or pipes by plastic welding.**

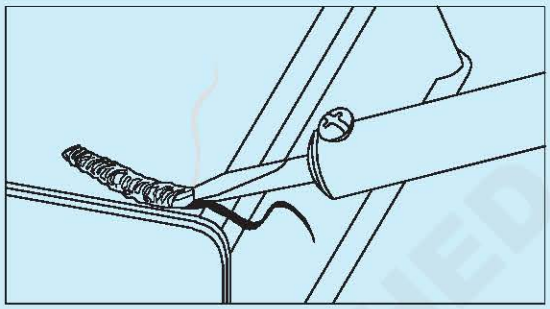
Job Sequence

Plastic welding

Definition: Heat generation is used to bond two or more individual pieces of thermoplastic materials to be joined to form a welding joint plastic repair and welding can be a simple proves.

- Pressing ensuring sufficient pressure when pushing the plastics together.
- Heating achieving the right melt temperature.
- Cooling length of time, the join is allowed to cool before releasing the pressure
- During the pressing step, the application of pressure-often used throughout both the heating and cooling stages is used to retain the parts in the proper orientation and to improve melt flow across the interface.

Fig 1



PIPE PLASTIC WELDING M/C

WLN1B103H1

- The purpose of the heating stage is to allow intermolecular diffusion form one part to the other across the faying surface (melt mixing).
- Cooling is necessary to solidify the newly formed bond, the execution of this stage can have a significant effect on weld strength.

Skill Sequence

Plastic repair preparation

Objective: This shall help you to
- **prepare weld the plastic broken and welding.**

Plastic repair preparation

Before plastic repair to correct tools for the job and that have prepared the surface of plastics correctly

Tools and equipment

There is no replacement for high-quality tools high-quality tools will allow to get the job done faster and with minimal interference. It's a good idea to stock up on the safety equipment needed too.

For most plastic repairs.

Kit a temperature controlled plastic welding kit with a selection of nozzles.

Rods plastic rods of the same material as the plastic to weld.

Gloves-high welding temperatures call for adequate hand protection

Eye protection eye protection suitable for welding is vital

A flat surface a flat and clear surface to work form that is heat resistant with some clamps would be a bonus.

Ventilation some plastics can give off foul smells when melting. Ensure the room is well ventilated.

Surface preparation

The plastic weld surface should be clean and clear of debris. Use simple soap and water to clean off most stains. If a stronger solvent is required, try using methyl ethyl ketone (MEK), but do not use any industrial strength solvents as this could damage the surface of plastic

Remove any pain and debris with a light grit sandpaper

Determine plastic-type by test welding

Getting the right plastic-type is vital for a stronghold.

Test weld by welding the end of the rod to a small inconspicuous area. If it holes firm have the right material.

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There are several things to consider when welding plastics. Let's take a look at consideration for the heat. The welding rod, the welding gun and the welding kit.

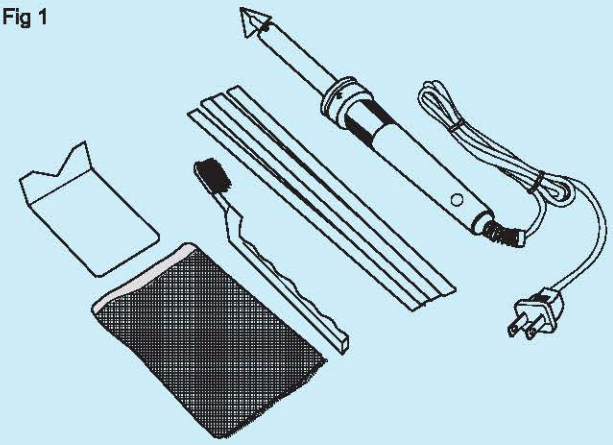
The heat you will likely need the temperature within the range of 200 and 300° C (392 and 572 °F) below or above that range will result in the plastic not melting enough or burning the plastic. You'll need to know what temperature you require based on what type of plastic you are welding.

The welding rod it's crucial that the welding rod is the same material as the plastic to be welded. It's also vital to ensure that the welding rod's end has been trimmed so that it's in pencil point form.

The welding gun manual (hand-held) welding tools are used for small fabrication work, detailed projects and repair work and should not be used for thicknesses beyond 10mm for larger fabrications using extrusion welding tools.

A welding Kit- Plastic welding kits and a plastic repair kit are a great option because they are fully equipped kits come with a welder varying welder rods plastic welding tips and a geode to help welding process.

Fig 1



PLASTIC WELD KIT

WL20N181104J1

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Exercise 1.7.104

Make a plastic tank with plastic sheet of PVC dimension 150x100x100

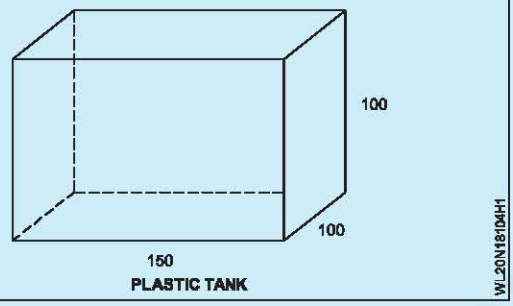
Objectives: At the end of this exercise you shall be able to

- **prepare the plastic sheet as per drawing**
- **explain plastic weld test**
- **maintain temperature range and preheat the welding gun**
- **tack weld the plastic tank**
- **weld the tank by using 12-grit sand paper**
- **clean and inspect the job.**

Job Sequence

- **Procedure for welding**
- Set up your working space in a well-ventilated area

Fig 1



- Remove debris from the plastic by washing it with soap and warm water
- Label the plastic you have chosen
- Use a welding rod test kit
- Use a piece of 80-frit sandpaper to extract any apintings from the plastic
- Cut the plastic sheet as per the diagram
- Clamp and tape the plastic pieces together to hold the joints in place
- Preheat the welding gun for at least 2-3 minutes.
- The recommended temperature ranges from 200°C to 300°C
- Tack-weld the plastic ends to secure them togather.
- When thermoplastics have not been treated with a UV protective coating, they absorb the rays of light, which causes discoloration and makes them brittle.
- All polyethylene materials, depending on the type, are subject to some form of cracking
- A difficult part of installing a plastic tank is determining the effects of the surrounding conditions.
- **Plastic tank**
- Use pliers to trim the ends of the welding rods.
- Insert a welding rod at the wedding gun speed nozzle
- Gradually move the spread gun over the plastic
- Swing the nozzle within a distance of about 2.5cm above the joint or crack.
- Tilt the gun at and angle of 54-degrees while positioning the welding rod at the same angle but from the opposite side. Repeat this procedure until you finish welding.
- Allow the plastic to cool for a minimum of 5 minutes
- For consistency, smooth out the rough ridges with 12-grit sandpaper. Sanding will ensure the plastic and joint are levelled.
- Rod will be place. After these operations are completed, the welding can be done.
- The process of plastic welding is an economical way to keep a plastic tank in good repair and useful.
- The main benefit of plastic welding is a tighter and more secure seal that will last longer and be more durable.

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