Pipe joints

Objectives: At the end of this lesson you shall be able to
- **explain the advantages of welded pipes**
- **state different methods of pipes welding**
- **explain the types of pipe joint and pipe welding positions**
- **describe the methods of welding pipes in '1G' position.**

Specification of Pipes

- In a pipe its size is measured by nominal diameter (or) nominal outside diameter (OD).
- It is also mentioned as nominal pipe size (NPS).
- Pipe is normally used to transport gases or liquids in a process.

Tube is normally used for standard purpose and it is mentioned as outside diameter and its wall thickness as tube.

As per Indian standard 1161-1998, it is specified as steel tubes of nominal force, and thickness having outside diameter in mm under light, medium and heavy class.

Refer Table 1 as per IS 1161:1998.

Table 1

Sizes and Properties of Steel Tubes for Structural Purposes

(*Clauses* 3.1, 6.1, 6.1.1 *and* 6.1.2)

Nominal Bore	Outside Diameter	Class	Thickness	Mass	Area of Cross Section	Internal Volume	Surface		Moment of Inertia	Modulus of Section	Radius of Gyration	Square of Radius of Gyration
							External	Internal				
mm	mm		mm	kg/m	cm^2	cm^3/m	cm^3/m	cm^3/m	cm^4	cm^3	cm	cm^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
15	21.3	Light	2.0	0.947	1.21	235		543	0.57	0.54	0.69	0.47
		Medium	2.6	1.21	1.53	203	669	506	0.69	0.64	0.66	0.44
		Heavy	3.2	1.44	1.82	174		468	0.75	0.70	0.55	0.42
20	26.9	Light	2.3	1.38	1.78	390		700	1.36	1.01	0.87	0.76
		Medium	2.6	1.56	1.98	370	845	681	1.48	1.10	0.86	0.74
		Heavy	3.2	1.87	2.38	330		644	1.70	1.26	0.84	0.71
25	33.7	Light	2.6	1.98	2.54	638		895	3.09	1.83	1.10	1.21
		Medium	3.2	2.41	3.06	585	1 059	857	3.61	2.14	1.08	1.17
		Heavy	4.0	2.93	3.73	518		807	4.19	2.48	1.05	1.11
32	42.4	Light	2.6	2.54	3.25	1 086		1 168	6.47	3.05	1.41	1.98
		Medium	3.2	3.10	3.94	1 017	1 332	1 130	7.62	3.59	1.39	1.93
		Heavy	4.0	3.79	4.82	929		1 080	8.99	4.24	1.36	1.86
40	48.3	Light	2.9	3.23	4.13	1 418		1 335	10.70	4.43	1.61	2.59
		Medium	3.2	3.56	4.53	1 378	1 517	1 316	11.59	4.80	1.59	2.54
		Heavy	4.0	4.37	5.56	1 275		1 265	13.77	5.70	1.57	2.47
50	60.3	Light	2.9	4.08	5.23	2 332		1 711	21.59	7.16	2.03	4.13
		Medium	3.6	5.03	6.41	2 213		1 667	25.88	8.58	2.00	4.02
		Heavy	4.5	6.19	7.88	2 066		1 611	30.90	10.2	1.98	3.92
65	76.1	Light	3.2	5.17	7.32	3 814		2 189	48.79	12.82	2.58	6.66
		Medium	3.6	6.42	8.20	3 727	2 391	2 163	54.02	14.20	2.57	6.60
		Heavy	4.5	7.93	10.1	3 534		2 107	65.12	17.1	2.54	6.43
80	88.9	Light	3.2	6.72	8.61	5 343		2 591	79.23	17.82	3.03	9.19
		Medium	4.0	8.36	10.7	5 138	2 793	2 540	96.36	21.68	3.00	9.00
		Heavy	4.8	9.90	12.7	4 936		2 490	112.52	25.31	2.98	8.88
90	101.6	Light	3.6	8.70	11.1	6 995		2 964	133.27	26.23	3.47	12.03
		Medium	4.0	9.63	12.3	6 877	3 192	2 939	146.32	28.80	3.45	11.91
		Heavy	4.8	11.5	14.6	6 644		2 889	171.44	33.75	3.43	11.76

Nominal Bore	Outside Diameter	Class	Thickness	Mass	Area of Cross Section	Internal Volume	Surface		Moment of Inertia	Modulus of Section	Radius of Gyration	Square of Radius of Gyration
							External	Internal				
mm (1)	mm (2)	(3)	mm (4)	kg/m (5)	cm^2 (6)	cm^3/m (7)	cm^3/m (8)	cm^3/m (9)	cm^4 (10)	cm^3 (11)	cm (12)	cm^2 (13)
100	114.3	Light	3.6	9.75	12.5	9 004		3 363	192.03	33.60	3.92	15.36
		Medium	4.5	12.2	15.5	8 704	3 591	3 306	234.3	41.0	3.89	15.10
		Heavy	5.4	14.5	18.5	8 409		3 250	274.5	48.0	3.85	14.86
110	127.0	Light	4.5	13.6	17.3	10 930		3 705	325.3	51.2	4.33	18.78
		Medium	4.8	14.5	18.4	10 819	3 990	3 686	344.58	54.27	4.32	18.69
		Heavy	5.4	16.2	20.6	10 599		3 649	382.0	60.2	4.30	18.52
125	139.7	Light	4.5	15.0	19.1	13 410		4 104	437.2	62.6	4.78	22.87
		Medium	4.8	15.9	20.3	13 287	4 389	4 085	463.44	66.35	4.77	22.76
		Heavy	5.4	17.9	22.8	13 043		4 047	514.5	73.7	4.75	22.58
135	152.4	Light	4.5	16.4	20.9	16 142		4 503	572.2	75.1	5.23	27.37
		Medium	4.8	17.5	22.2	16 008	4 788	4 484	606.92	79.65	5.22	27.25
		Heavy	5.4	19.6	25.0	15 740		4 446	674.5	88.5	5.20	27.05
150	165.1	Light	4.5	17.8	22.7	19 128		4 902	732.6	88.7	5.68	32.27
		Medium	4.8	18.9	24.2	18 981	5 187	4 883	777.32	94.16	5.67	32.14
		Heavy	5.4	21.3	27.1	18 690		4 845	864.7	105.0	5.65	31.92
150	168.3	Light	4.5	18.2	23.1	19 921		5 002	777.2	92.4	5.79	33.56
		Medium	4.8	19.4	24.7	19 771	5 287	4 983	824.78	98.01	5.78	33.42
		Heavy 1	5.4	21.7	27.6	19 473		4 946	917.7	109.0	5.76	33.21
		Heavy 2	6.3	25.2	32.0	19 030		4 889	1 053	125.0	5.73	32.85
175	193.7	Light	4.8	22.4	28.5	26 606		5 781	1 271.71	131.31	6.68	44.63
		Medium	5.4	25.1	32.0	26 260	6 085	5 743	1 417	146	6.66	44.36
		Heavy	5.9	27.3	34.8	25 974		5 712	1 535.2	158.65	6.64	41.11
200	219.1	Light	4.8	25.4	32.3	34 454		6 578	1 856.51	169.47	7.58	57.45
		Medium	5.6	29.5	37.5	33 930	6 883	6 528	2 141	195	7.55	57.02
		Heavy	5.9	31.0	39.5	33 734		6 509	2 247	205	7.54	56.86
225	244.5	Heavy	5.9	34.7	44.2	42 507	7 681	7 307	3 149	258	8.44	71.21
250	273.0	Heavy	5.9	38.9	49.5	53 557	8 578	8 202	4 412	323	9.45	89.30
300	323.9	Heavy	6.3	49.3	62.8	76 073	10 177	9 775	7 992	493	11.2	125.44
350	355.6	Heavy	8.0	68.6	87.3	90 533	11 173	10 663	13 111	737	12.3	151.29

Welded pipe joints

Pipes of all types and sizes are used in great deal today in transporting oil, gas, water etc. They are also used extensively for piping systems in building, refineries and industrial plants.

Advantages of welded pipe

Pipes are mostly made of ferrous and non-ferrous metals and their alloys. They possess the following advantages.

– Improved overall strength.
– Ultimate saving in cost including maintenance.
– Improved flow characteristics.
– Reduction in weight due to its compactness.
– Good appearance.

Method of pipes welding

The following are the methods of pipe welding by arc.

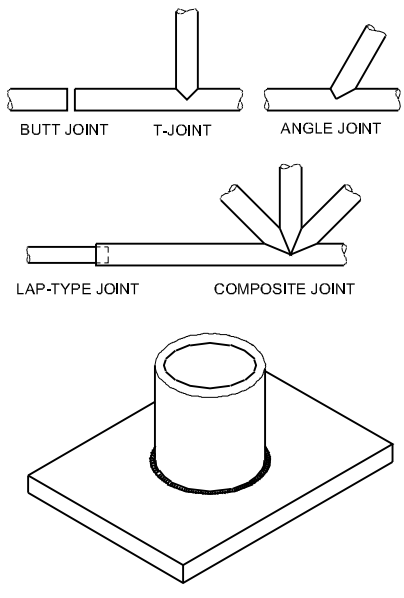
– Metallic arc welding
– Gas metal arc welding
– Tungsten inert gas welding
– Submerged arc welding
– Carbon arc welding

All these methods, except carbon arc welding are commonly used and the choice of welding depends upon the size of the pipe and its application.

Types of pipe joints

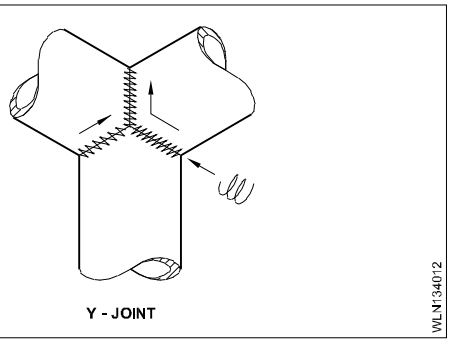
1 Butt joint
2 'T' joint
3 Lap joint (Fig 1)
4 Angle joint

Fig 1



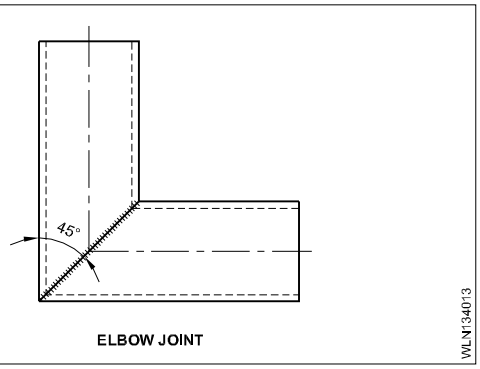
5 composite joint
6 Pipe flange joint
7 Y joint (Fig 2)

Fig 2



8 Elbow joint (Fig 3)

Fig 3



Welding of pipe butt joints: Normally joints in pipes and tubes cannot be welded from the inside of the bore. Hence before starting to learn pipe welding, a person should be proficient in welding in all positions i.e. flat, horizontal, vertical and overhead.

All these positions are used to weld pipes.

Pipes welding positions (Figs 4 and 5)

Fig 4

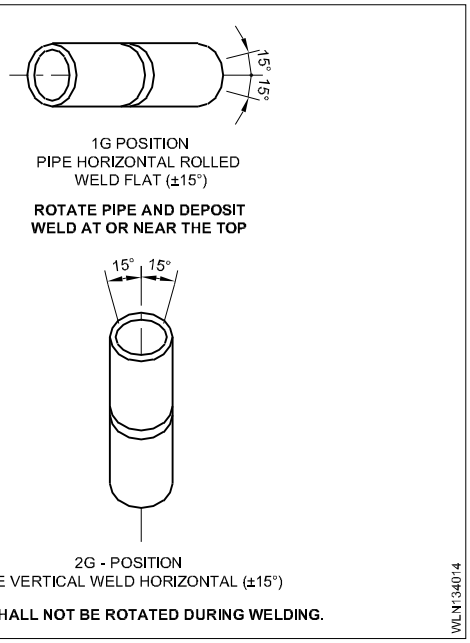
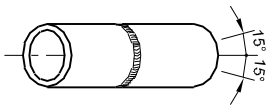
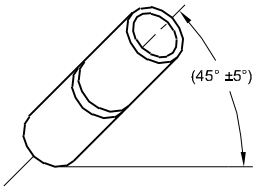


Fig 5



5G POSITION
PIPE HORIZONTAL FIXED (±15°)
WELD FLAT, VERTICAL, OVERHEAD

PIPE SHALL NOT BE ROTATED DURING WELDING.



6G - POSITION
PIPE INCLINED FIXED (45° ±15°)
WELD FLAT, VERTICAL, OVERHEAD

PIPE SHALL NOT BE ROTATED DURING WELDING.

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1 G - Pipe weld in flat (roll) position i.e. pipe axis is parallel to the ground.

2 G - Pipe weld in horizontal position i.e. pipe axis is perpendicular to the ground.

5 G - Pipe weld in flat (fixed) position i.e. pipe axis is parallel to the ground.

6 G - Pipe weld in including (fixed) position i.e. pipe axis is including to both horizontal and vertical planes.

During the welding of butt joints the pipe may be

1 rolled or rotated (1G position)

2 fixed (2G, 5G and 6G position).

Welding of pipe butt joints by arc can be done in 1G position by

a Continuous rotation method and

b Segmental method.

1a Pipe welding by arc (in 1G position) by continuous rotation method: Satisfactory welding of butt joints in pipes depends upon the correct preparation of pipe ends and careful assembly of the joint to be welded. Ensure that the bores and root faces are in correct alignment and that the gap is correct.

Clean the edges. Prepare an angle of bevel 35° by gas cutting and filing. A root face 1.5 to 2.5 mm is to be provided.

Setting the pipes for welding: Tack weld together with 4 small equally spaced tacks. The gap should be equal to the root face dimension plus 0.75 mm. Support the tacked assembly on V blocks or rollers so that the assembly can be rolled or rotated with the free hand.

Select a 2.5 mm rutile electrode for 1st run and a 3.15 mm rutile electrode for 2nd run.

Set a current of 70-80A for 1st run and 100-110 for the 2nd run.

Rotate the assembly as welding proceeds. (Fig 6) keeping the welding arc within an area between vertical and 10° from the vertical in the direction of welding Fig 7. (Use a helmet type screen).

Fig 6

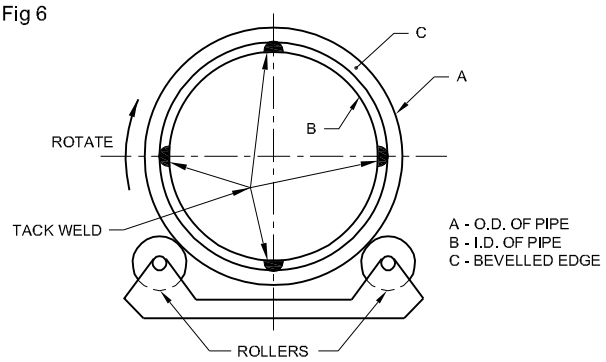

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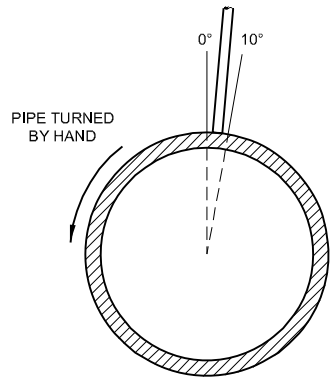
Fig 7



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– Direct the electrode centrally at the root of the joint and in line with the radius of the pipe at the point of welding.

– Strike the arc near the top dead center and hold the arc length as short as possible. Continue to weld as the pipe is rotated manually at steady speed.

– Deposit first run by weaving the electrode very slightly from root face to root face.

– Adjust the speed of rotation to obtain full fusion of the root faces without excessive penetration.

– Chip out tack weld as they are approached. Do not weld over tacks otherwise loss of penetration at the tacking points may occur.

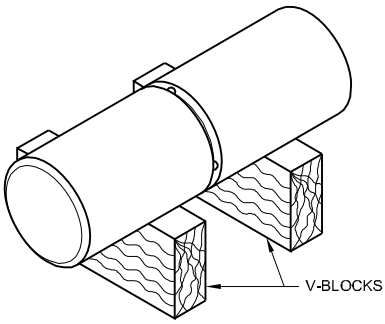
– Complete the weld with the second run. Adjust the speed of rotation to secure fusion to the outer edge of each fusion face. The amount of reinforcement should be even around the edge of the joint.

1b Welding of a pipe butt (IG position i.e. by rotation) by segmental welding.

– The edges of the pipe are beveled to 35 to 40° angle with a root gap of 2.5 mm.

– Tack the pipe as before and support the assembly on two 'V' blocks. (Fig 8)

Fig 8



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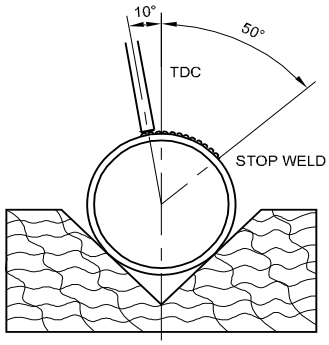
– Strike the arc at 10° from Top Dead Centre (TDC) and deposit the root run. Use a small weaving motion to achieve fusion of the root faces. Adjust travel speed to control root penetration. (Fig 9)

Fig 9



WELDING FIRST SEGMENT

WLN134019

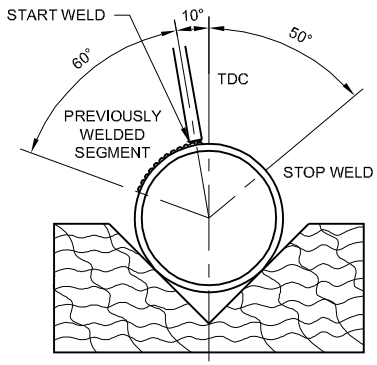
– When a segment equivalent to 60° has been welded, terminate/stop the weld run. Avoid the formation of a crater.

– Move the pipe until the end of the segment is at 10° before TDC.

– Strike the arc on the end of the previous weld run and establish a weld pool.

– Weld a further 60° segment. (Fig10)

Fig 10



WELDING SECOND SEGMENT

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– Continue welding in segments until the root run has been completed.

– Move the pipe until the mid point of the segments is at TDC.

– Strike the arc and deposit the second (filling) run, use a side-to-side weaving position to fill the preparation and to achieve fusion of the pipe edges.

– Complete the filling run in 60° segments.

Pipe welding by arc in fixed positions

Objectives: At the end of this lesson you shall be able to
- **state different fixed pipe welding positions**
- **explain different methods of pipe welding in 5G position**
- **explain the welding producer of M.S. pipe butt joint by arc in fixed (5G) position.**

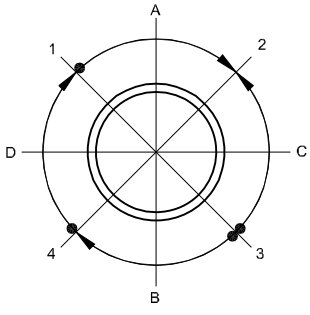
Whenever the pipes to be welded cannot be rotated or whenever the pipes are to be welded in the field i.e. at work site, then they are welded in fixed position. If the fixed pipe axis is horizontal, then the welding position is called 5G position.

The other pipe welding positions in which the pipes are fixed during welding are 2G and 6G positions. If the axis of the fixed pipes to be welded are vertical then this position is called 2G position. If the axis of the fixed pipes in inclined at 45° to both horizontal and vertical planes, then the welding position is called 6G position.

In 5G position, a pipe butt joint can be welded by the following method.

Method 1: The pipe joint circumference is divided into four positions as A, B, C and D. First portion 'A' is welded from 1 to 2 in more or less in flat position. Then portion B is welded from 3 to 4 in overhead position. Next portion C from 3 to 2 and then portion D from 4 to 1 are welded in vertical up position. (Fig 1)

Fig 1



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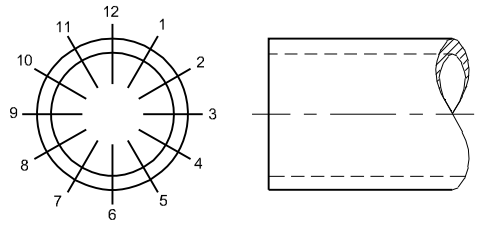
It is important that a key hole is maintained throughout the welding operation to ensure proper root penetration. Also the electrode position is continuously changed as the joint surface is curved. In addition, the starting and ending of each weld portion i.e. A, B, C and D properly done so that they merge with the previous portion.

Method 2: The pipe outer circumference is divided into 12 equal divisions as in a clock.

The top of the pipe is 12 O'clock position and the bottom is in 6 O'clock position. (Fig 2)

Fig 2

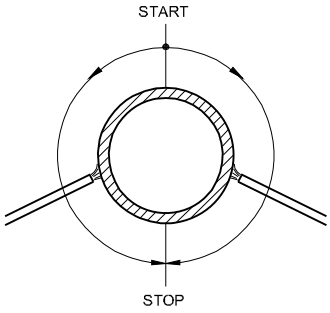


THE IDENTIFICATION OF THE WELDING POSITION AROUND THE THE PIPE JOINT BYTHE NUMBERS ON THE FACE OF A CLOCK.

WLN1:34022

The weld is started from 12 O'clock position to 6 O'clock position on the right side vertically downwards. Then welding is done again from 12 O'clock to 6 O'clock position on the left side (Fig 3). This method is called down hill method and is normally used for thin walled pipes with wall thickness of 3 to 4 mm.

Fig 3



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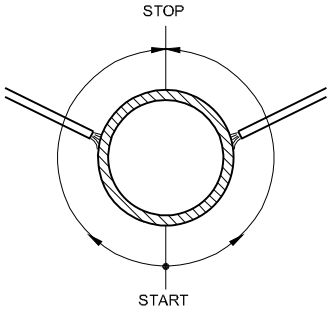
Method 3: The weld is started from 6 O'clock to 12 O'clock position on the right side first and then again from the 6 O'clock to 12 O'clock position on the left side (Fig 4). This method is called uphill method or vertical up method. This uphill method is used to weld pipes of 5 mm and above wall thickness.

Fig 4



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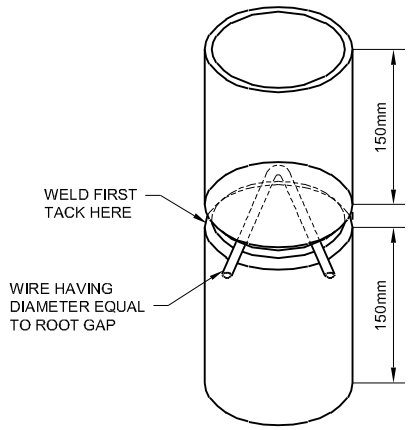
Welding in 2G and 6G positions are done based on the position of the pipe axis.

In the 2G position, the horizontal pipe welding with its axis being vertical, the weld joint connecting the two pipes is in the horizontal position. The weld must be made around the pipe. (Fig 5)

In the 6G position welding is usually done by using one of the methods i.e. uphill or downhill welding. (Fig 6)

Fig 5



USE OF BEND WIRE OF SPACER TO SET ROOT GAP

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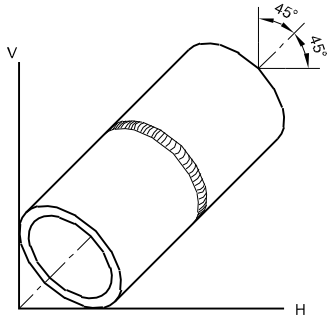
Fig 6



POSITION 6 G

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Use electrodes specially manufactured for pipe welding to get good penetration, appearance and strength, (low hydrogen electrodes, deep penetration electrodes etc.)

Welding procedure of M.S. pipe butt joint by arc in fixed (5G) position.

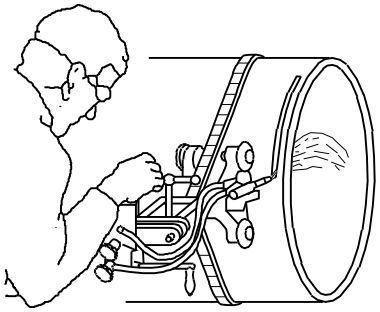
Edge preparation and cleaning: If the wall thickness is 3 mm and below the edges of the pipe end is filed square i.e. perpendicular to the pipe axis. The welding of the joint is complete in one pass using the down hill method or by segmental method i.e. welding the top quarter in flat, bottom quarter in overhead and the two side quarter portion in vertical up position. The electrode has to be held at angles as shown in Fig 14 for welding the root pass of a thicker pipe explained later in this lesson.

For welding pipes with higher wall thickness the following procedure is to be followed.

Edge preparation: The pipe ends are beveled by flame cutting or machining in the shop (Figs 7 and 8) The including angle is 75° the root face and root gap are 2.5 mm to 3 mm. All traces of oxide from and other contaminations must be removed before starting the weld. (Fig 9)

Setting of pipe: Pipe to be joined together must be accurately aligned prior to welding. The inside surface of the pipe must be blended together smoothly as in the outer surface. Maintain the root opening 2.5 mm, use a M.S. angle and strength bar for checking the alignment of the pipe. (Fig 10)

Fig 7



ROTATED PIPE CUTTING HEAD

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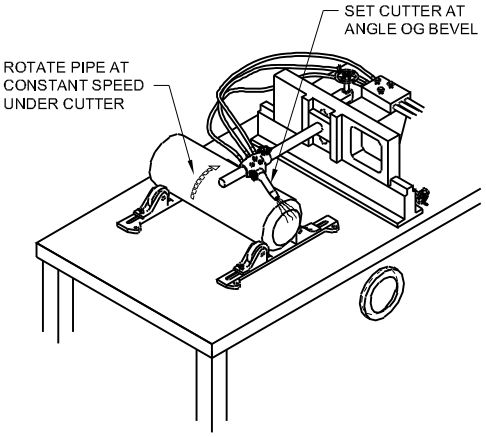
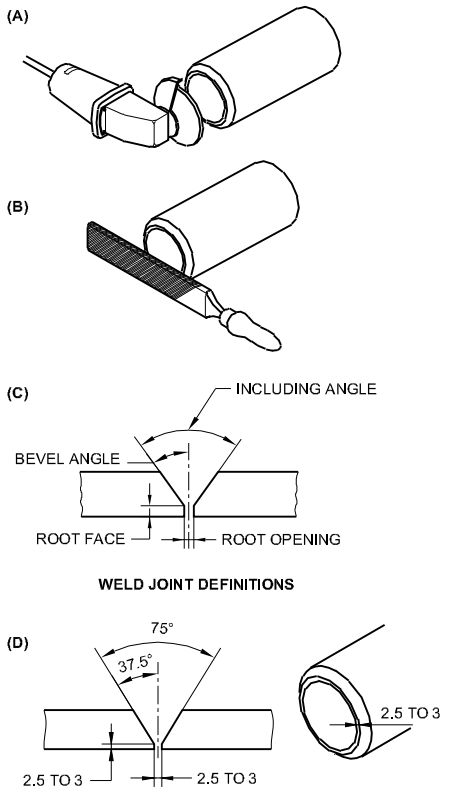
Fig 8



CUTTING BEVEL ON PIPE

WLN134028

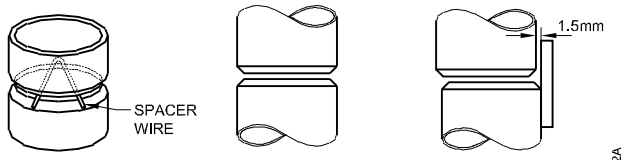
Fig 9



WELD JOINT DEFINITIONS

WLN134029

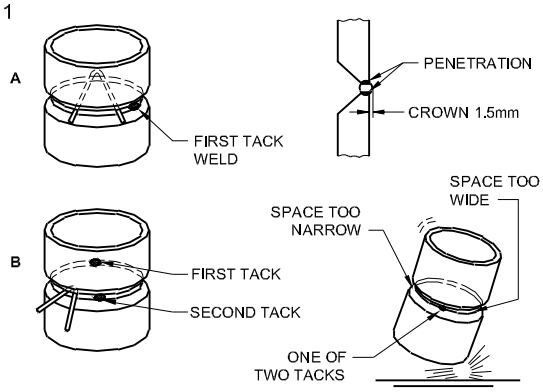
Fig 10



WLN134024A

Tacking: Place a 2.5 mm bend wire between the edges. The tack length should be 3 times the metal thickness. Put the first tack at the root side and the second tack at the opposite side of the first tack. Arrange the third and fourth tacks at 90° from the first and second tacks. (Fig 11)

Fig 11



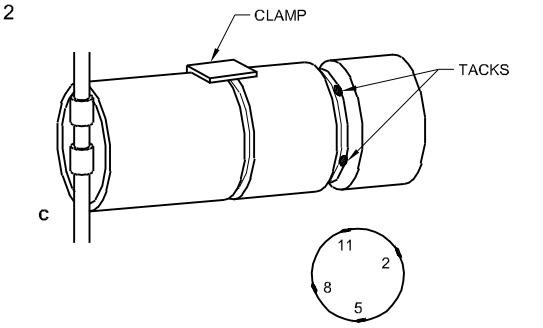
A. FIRST TACK WELD WITH WIRE SPACERS IN PLACE.
B. SECOND TACK WELD OPPOSITE TO FIRST TACK.

WLN134024B

Root pass: Fix the job in the clamp and adjust the height to a position convenient to you. The position of tack weld should be fixed as in Fig 12. The keyhole is an essential part in the welding of the root pass. (Fig 13) It should be about $\sqrt{1\frac{1}{3}}$ of the diameter of the electrode. Maintain the electrode angle as shown in Fig 14 Weld the root pass on side 2 of the pipe joint. (Fig 14)

The side 1 of the root pass is started at 6½ hrs position and stopped at 11½ hrs position. The side 2 is started at 5½ hrs position and stopped at 12½ hrs position.

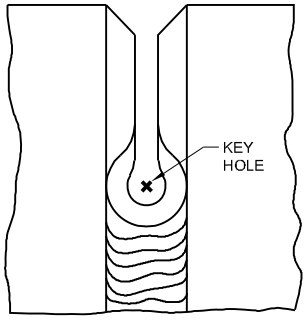
Fig 12



PIPE CLAMPED IN PLACE AFTER TACK WELD.

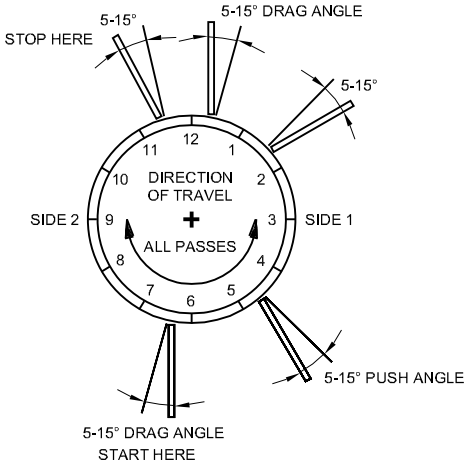
WLN134024C

Fig 13



WLN13402D

Fig 14



EECTRODE DRAG AND PUSH ANGLES.

WLN13402E

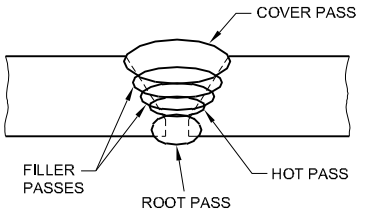
The weld beads on side 1 and side 2 will overlap for a short distance at the start and at the stop positions.

After completing the root pass, depending on the wall thickness of the pipe there will be further weld deposits either 2 or 3 or more passes. These passes can be a mixture of stringer beads and weaved beads by vertical up/uphill method.

The names of each pass is given in Fig 15. Usually the second weld bead after the root pass is deposited keeping the joint hot. So it is called hot pass.

For hot pass and cover pass maintain the electrode angle as shown in the Fig 14. Each pass should start at a different place of the joint. The second pass should fill the groove by using side-to-side movement. The final cover pass should be made wider than the second pass. The third pass should be smooth and of uniform appearance, and must have minimum reinforcement. (Fig 15)

Fig 15



THE SPECIFIC NAMES FOR THE VARIOUS PASSES IN A PIPE WELD

WLN13402F

Advantages of H/P pipe welding

– The joint is permanent.
– Saving of material.
– Reduction of joint weight.
– Less expensive.
– Multiple lines grouped together more closely.
– Repair and maintenance cost is less.

Welding of M.S. pipe

Objectives: At the end of this lesson you shall be able to
- **classify and specify mild steel pipes**
- **state and explain different methods of welding M.S. pipes**
- **state the method of edge preparation, tacking and necessary of key hole maintenance**
- **explain the pipe welding procedure by gas welding.**

Welding of M.S. pipe: Mild steel pipes are classified into two groups.

1 Seamless pipes manufactured by piercing a hot solid round billets/rods. (Fig 1)

2 Resistance welded pipes manufactured by continuously feeding a strip of metal through a machine which rolls the strip into cylindrical shape and the seam is electrically resistance welded. (Fig 2)

Based on the wall thickness, these pipes are further categorised as "Standard pipes", "Extra Strong pipes" and "Double extra strong pipes". Also the pipes are specified by first the material then by the diameter followed by the wall thickness. (Fig 3) For example a M.S. pipe 100 mm long with 50 mm inside diameter and 3 mm wall thickness is specified as M.S. ø 50 WT3 × 100 mm.

In the actual usage of pipes in various applications like transmitting water, oil, chemical, air, gases, etc. it is necessary to weld them as a butt, elbow and Tee joints as well as branch pipe joints at various angles.

The welding of smaller diameter pipes and bigger diameter pipes inside a welding shop can be done by rotating the pipes on roller or manually by a helper using an angle iron and tongs. (Fig 4 and Fig 5)

Fig 1

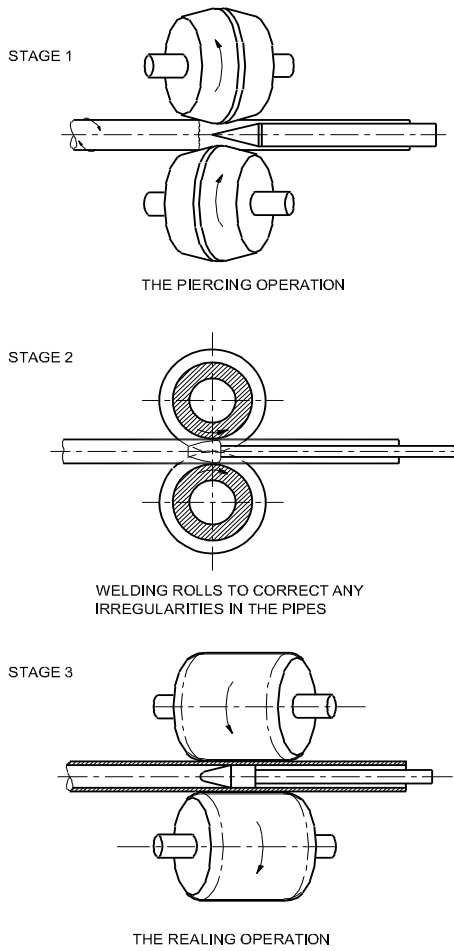


Fig 2

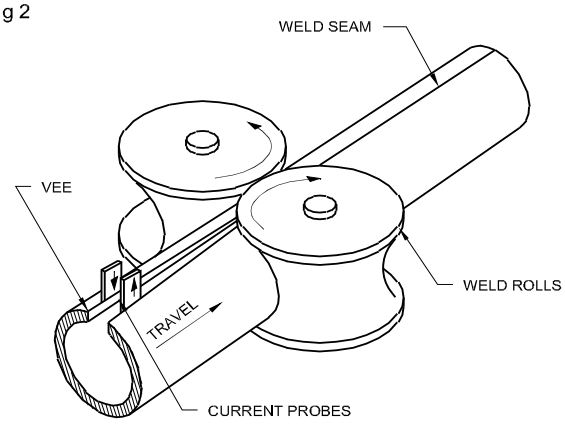


Fig 3

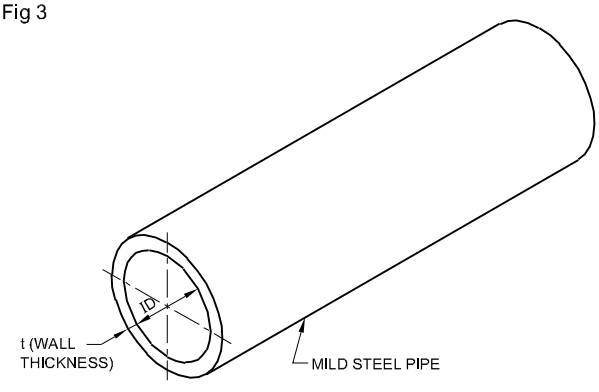
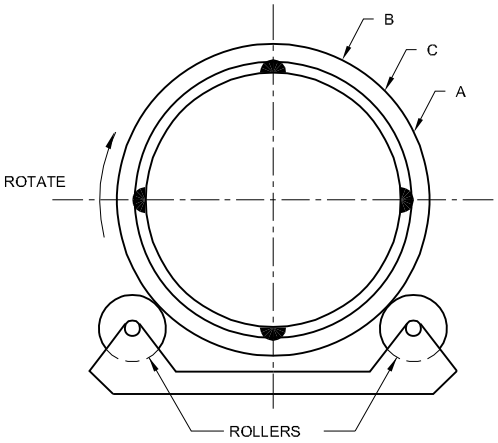
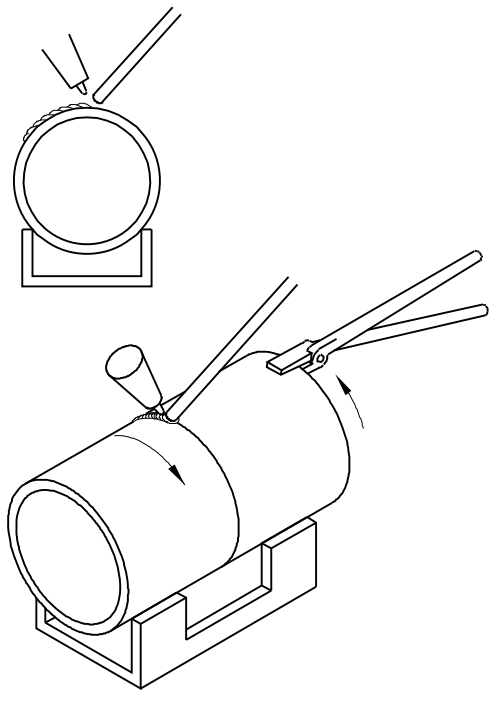


Fig 4



If the pipes are larger and are to be welded in the field/ work site or if the pipes cannot be rotated, then in such cases, the pipes are welded in fixed position i.e. the pipe will not be rotated, but the welder has to move the blowpipe and filler rod along the curved line of the joint around the pipe to complete the weld.

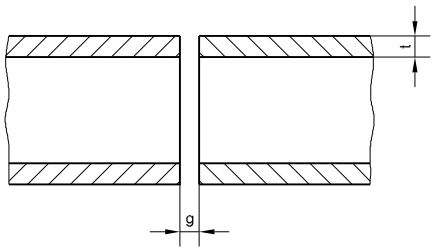
Fig 5



The edges of the pipe joints are prepared depending on the type of joint and the wall thickness of the pipe. For a pipe flange joint and for pipe butt joint with 1.5 to 3 mm wall thickness, the pipe edges are filed or ground square (Fig 6) for pipe butt joints above 3 mm wall thickness, the pipe edges are beveled as shown in Fig 7 with 1.5 mm root face.

Weld defects like incomplete or lack of root penetration cannot be rectified from inside small diameter pipes. Hence slightly larger root gaps are given while welding pipe butt joints to ensure proper root penetration. (Table 1) Fig 6 and Fig 7 gives the details of edge preparation.

Fig 6



PIPE ENDS SQUARE

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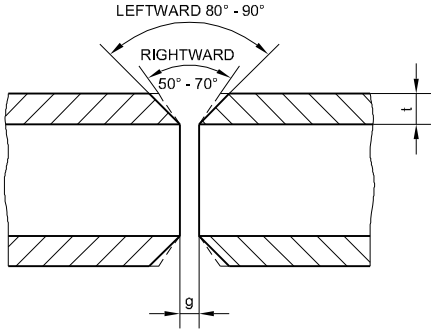
Fig 7

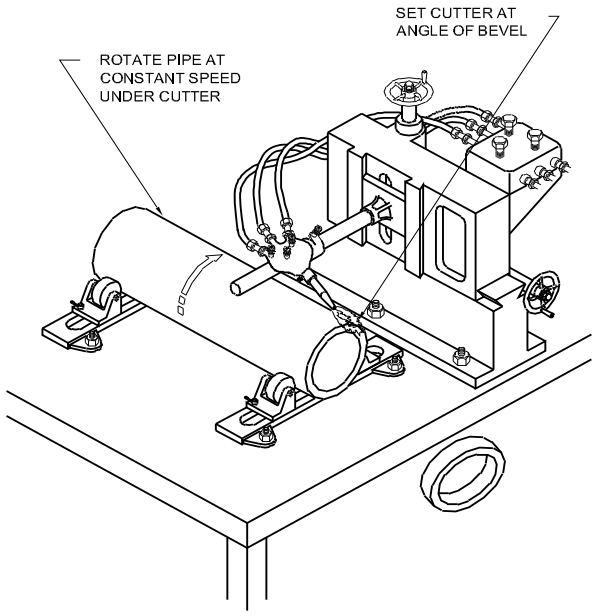


PIPE ENDS BEVELLED

WLN1340037

For pipes with wall thickness 3 mm and below, the edges are prepared by a file. If the wall thickness is more than 3 mm then the beveling is done by gas cutting (Fig 8) and the root face is prepared by filing/grinding. (Fig 9)

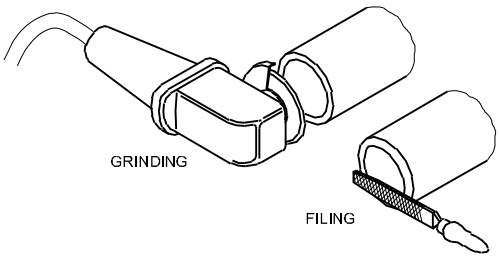
Fig 8



CUTTING BEVEL ON PIPE

WLN1340038

Fig 9



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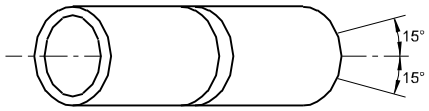
As welding of pipes is done either by rotating the pipe or by the fixed method, the pipe welding procedure also differs accordingly.

The different positions used to weld pipe butt joints are named as 1G, 2G, 5G and 6G as shown in Fig 10 to Fig 13. These positions are decided based on the position of the pipe axis and whether the welding is done by rotating the pipe or by keeping the pipe fixed.

Fig 10

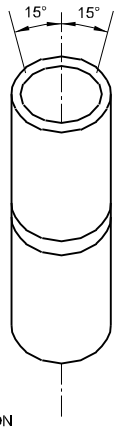


1G POSITION
PIPE HORIZONTAL ROLLED
WELD FLAT (±15°)

ROTATE PIPE AND DEPOSITE WELD AT OR NEAR THE TOP

WLN1340A

Fig 11

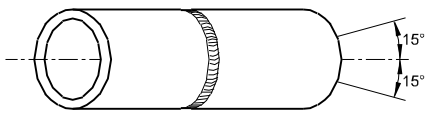


2G POSITION
PIPE VERTICAL WELD HORIZONTAL (±15°)

PIPE SHALL NOT BE ROTATED DURING WELDING

WLN1340B

Fig 12

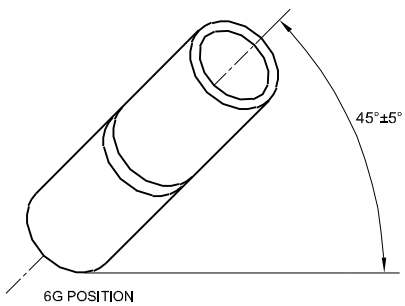


5G POSITION
PIPE HORIZONTAL FIXED (±15°)
WELD FLAT, VERTICAL, OVERHEAD

PIPE SHALL NOT BE ROTATED DURING WELDING

WLN1340C

Fig 13



6G POSITION
PIPE INCLINED FIXED (45°±5°)
WELD FLAT, VERTICAL, OVERHEAD

PIPE SHALL NOT BE ROTATED DURING WELDING

WLN1340D

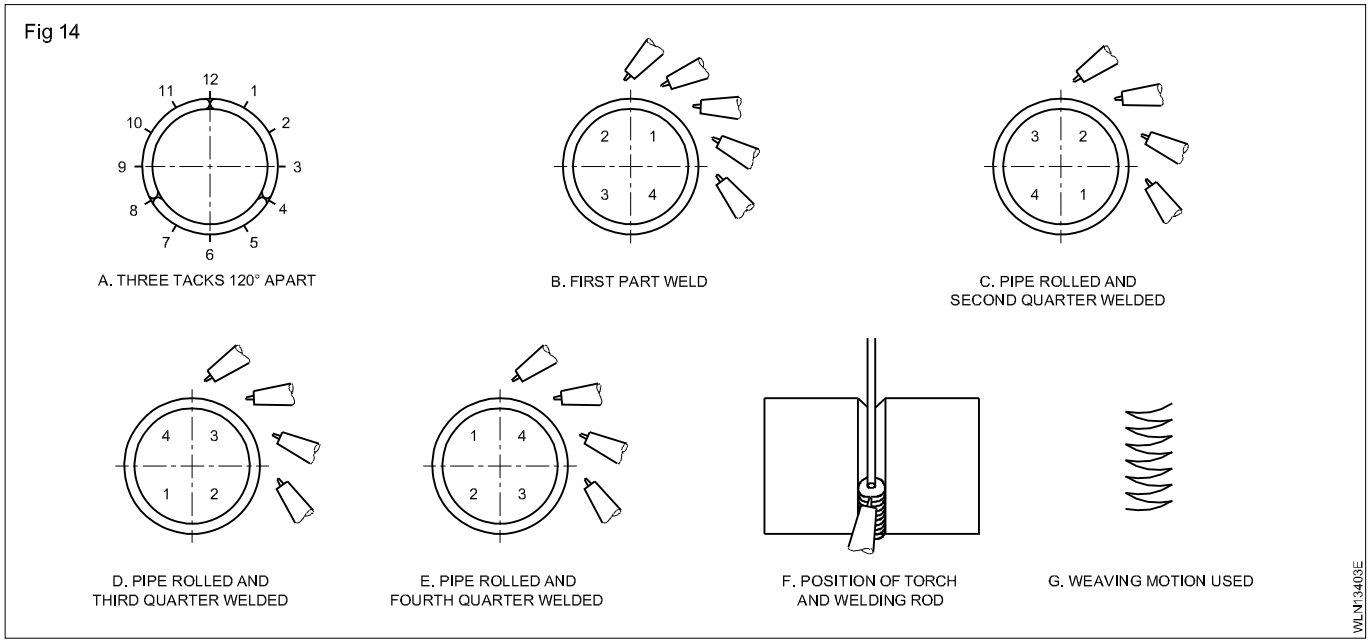
But in gas welding only 1G, 2G and 5G position are used. The 6G position welding is done by arc welding and it is usually used to test the skill/ability of a welder in pipe welding.

Pipe welding by rotation method (Position 1G): The method of welding pipes using pipe rotation is shown in the Fig 14. The two pipes after cleaning and preparing the edges, are set with proper root gap on an angle iron or channel so that the axes of the pipes are properly aligned. Then tack weld them at 3 places at 120° intervals. (Fig 14A)

Table 1

Wall thickness (t)	Pipe and preparation	Welding technique	Root gap (g)
3 mm or less	Square	Leftward	2.5 - 3 mm
5 mm or less	Square	Rightward or all-positional rightward	2.5 - 3 mm
3 - 5 mm	Beveled	Leftward	1.5 - 2.5 mm
5 - 7 mm	Beveled	Rightward or all-positional rightward	3 - 4 mm

Fig 14



Start the weld at 3 O'clock position and finish at 12 O'clock position. Now the first ¼ portion of the pipe joint, marked as 1 in Fig 14B is welded. Rotate the pipe joint by 90° in clockwise direction so that the 12 O'clock position on the pipe comes to 3 O'clock position. Weld the portion marked as 2 in Fig 14C as done in welding portion 1 already. Now rotate the pipe by 90° and weld portion 3 (Fig 14D). On completing welding of portion 3 rotate the pipe again by 90° so that the portion 4 can be welded (Fig 14E). The position of blowpipe/torch and filler rods is shown in Fig 14F and the blowpipe weaving motion is shown in Fig 14G. It is very important to continuously maintain a key hole both while tacking Fig 15 and during welding (Fig 16).

In this method leftward technique is used and the metal deposition starts in vertical at 3 O'clock position and ends with flat position at 12 O'clock position. Care should be taken to properly overlap the previous weld deposit while starting the 2nd, 3rd and 4th segments.

Fig 15

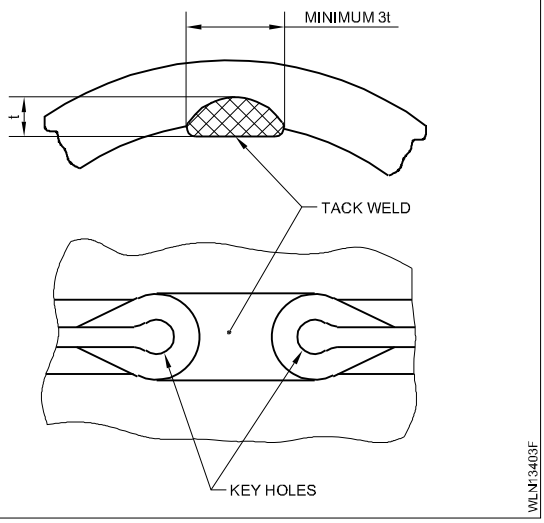
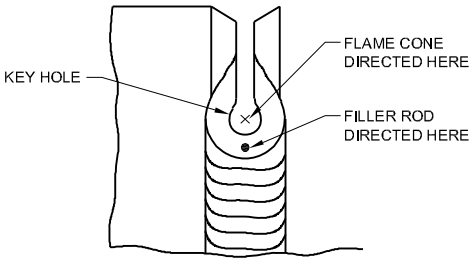


Fig 16



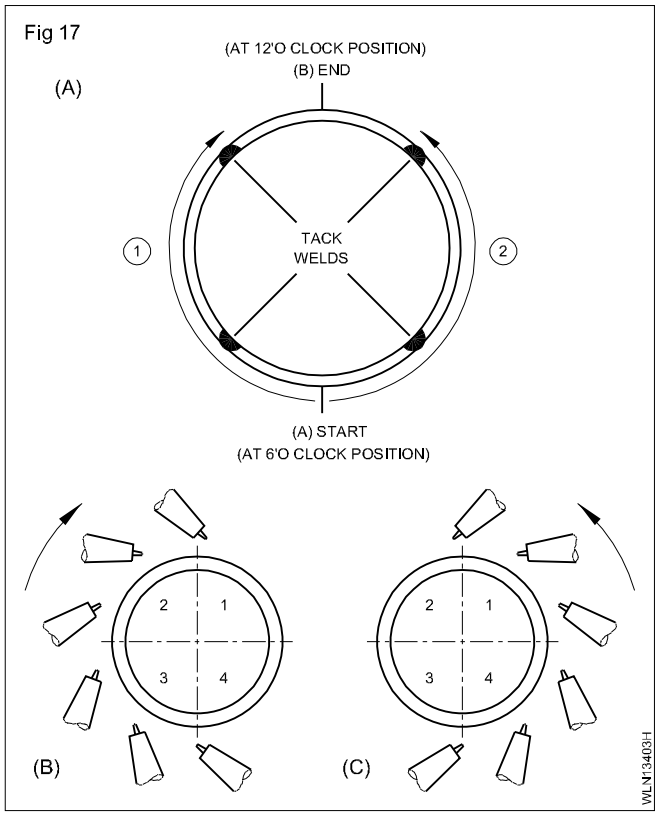
LEFTWARD WELDING

Pipe welding in fixed position (position 5G): The welding of the pipeline without rotating the pipe during welding is called fixed position welding. (5G) In this position the welder has to move according to the condition of the pipeline in different positions, such as vertical, down hand and overhead positions.

In fixed position pipe welding, the welder has to weld according to the conditions of the pipeline.

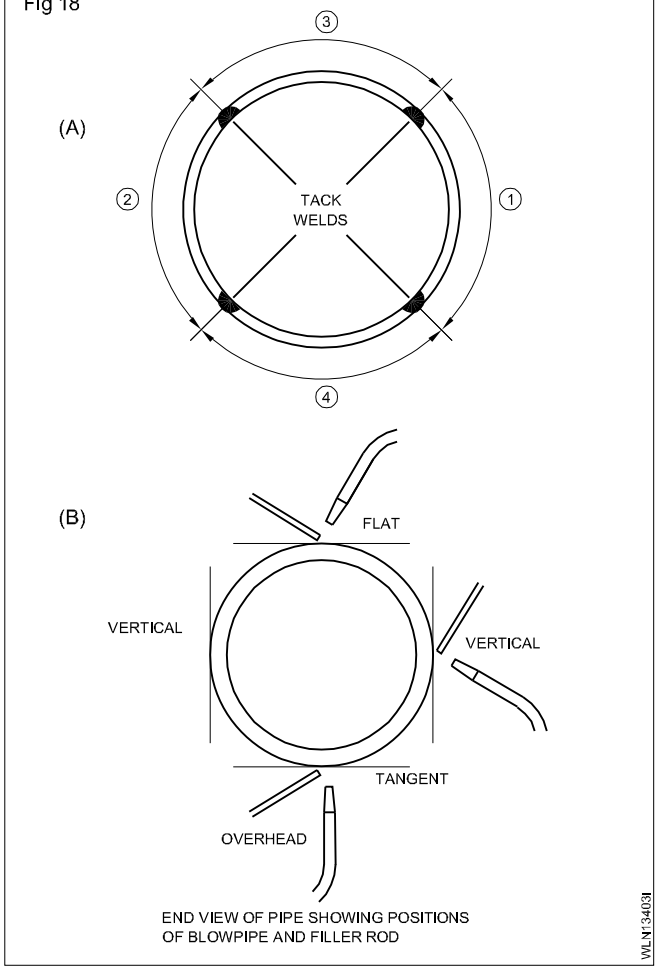
In this system, the welding should be started from 6 O'clock position and move to 12 O'clock position on either side by moving the blowpipe and the filler rod from bottom in the upward direction as shown in Fig 17a, 17b, 17c.

Fig 17



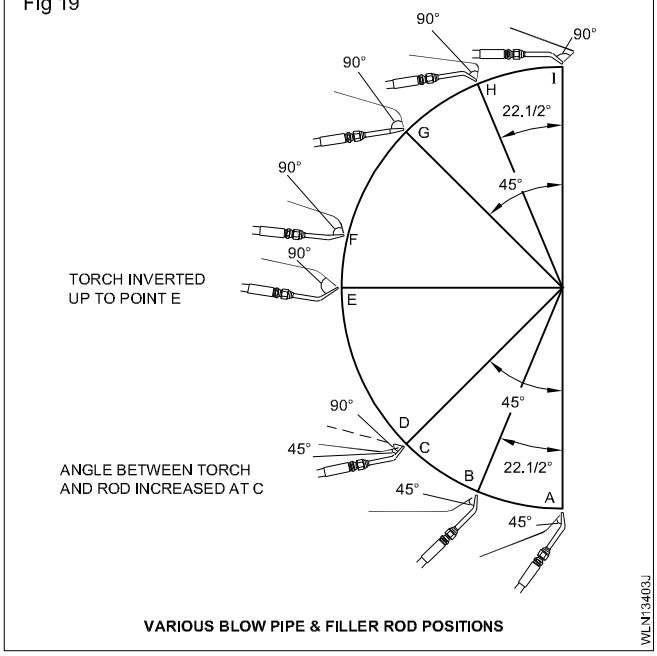
This also can be welded by the four quarter method, first by welding two quarter distance (opposite to each other) by moving the blowpipe in the upward vertical direction. (Fig 18a and Fig 18b) Then weld the top quarter distance in the down hand position. Finally weld the bottom quarter distance in the overhead position. The clock face and its relationship to pipe welding and various blowpipe and filler rod positions are illustrated in Fig 19.

Fig 18



END VIEW OF PIPE SHOWING POSITIONS
OF BLOWPIPE AND FILLER ROD

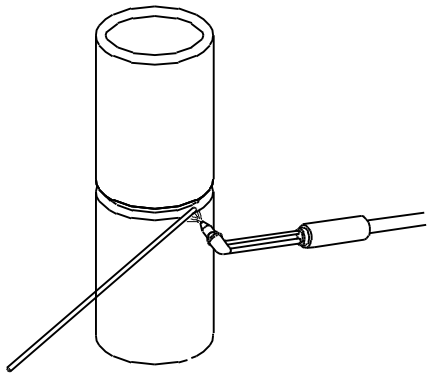
Fig 19



VARIOUS BLOW PIPE & FILLER ROD POSITIONS

Pipe welding in 2G position (Pipe axis is vertical): In a pipe butt joint if the axis of the pipes is vertical and the weld joint is in the horizontal plane then it is called pipe welding in 2G position. (Fig 20) It is a fixed position welding and the blowpipe and filler rod are to be moved around the pipe surface. The position of blowpipe and the filler rod are given in Fig 20. To avoid sagging of weld metal the blowpipe is given a motion as shown in Fig 21 and the filler rod is fed at the top half of the molten pool.

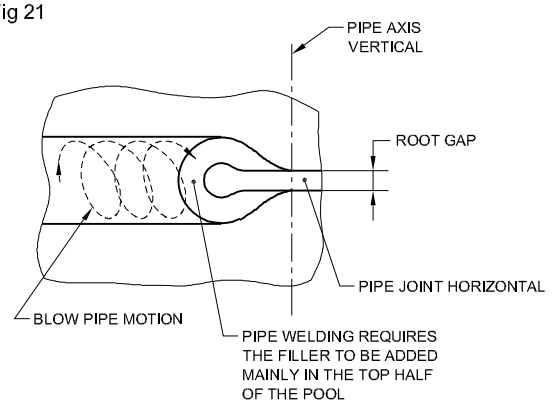
Fig 20



2G POSITION
SINGLE "V" GROOVE PIPE JOINT
(PIPE AXIS VERTICAL)

WLN13403K

Fig 21



WLN13403L

Difference between plate welding and pipe welding

Objectives: At the end of this lesson you shall be able to
- **describe plate welding**
- **explain pipe welding**
- **explain the differences between plate welding and pipe welding.**

Plate welding: Plate welding is a fusion welding process. It joins plate metals using the combustion of oxygen and fuel gas. The intense heat that is produced melts and fuses together the edges of the parts to be welded generally with the help of a filler metal.

Plate welding by gas can be done in two ways. One is leftward welding and the other rightward welding.

All the-position rightward welding is used for all position of welding. (Fig 1) The path travelled by the flame and the filler rod varies with the welding position. The angles at which the flame and the filler rod are held also vary.

Metal thickness and related techniques

Position	Material thickness range	Method
Flat	Not exceeding 5 mm Exceeding 5 mm	Leftward Rightward
Horizontal-vertical	1 mm to 5 mm 5 mm and above	Leftward All-position Rightward
Vertical (single operator)	1 mm to 5 mm 5 mm and above	Leftward All position rightward
Vertical (two operators-technique)	5 mm and above	Leftward
Overhead	1 mm to 5 mm 5 mm and above	Leftward All-position rightward.

Pipe welding: When welding the circumference of a mild steel pipe, the angles of the rod and the blowpipe are given in relation to the tangent to the pipe at the point of welding.

The welding position can be seen in relation to the plane of the joint.

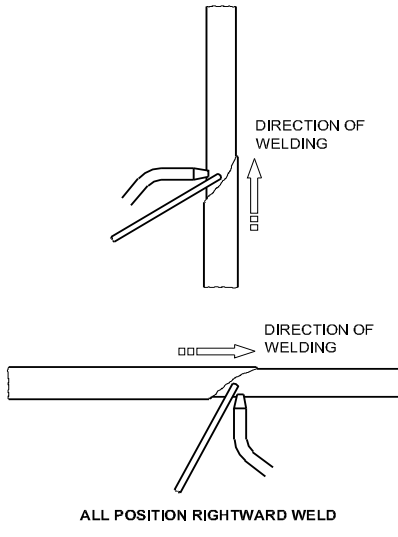
The techniques used will depend upon:

– the pipe wall thickness

– the welding positions

– whether the pipe is fixed or can be rotated.

Fig 1



When the pipe remains stationary, the following techniques are used.

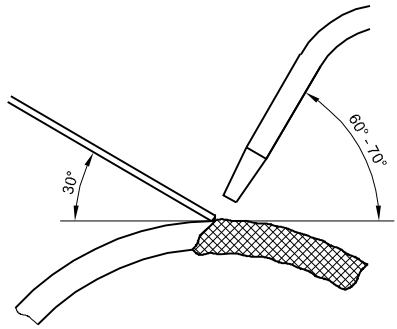
Position	Method
At the top of the pipe, flat position.	Leftward or rightward
At the flank of a set on branch when both pipe axes are in horizontal flat position.	Leftward or rightward
The weld is made along the vertical sides of the pipe.	Leftward or rightward or all-position rightward
The weld at the bottom of a pipe is made in the overhead position.	Leftward or rightward or all-position rightward

The techniques used for the positional welding of plates are also applied when welding pipes.

For thin walled pipes up to 5 mm, the leftward technique is used in any position. (Fig 2)

The leftward, rightward or all-position rightward techniques are used as appropriate on sections of 5 mm and above. (Fig 3)

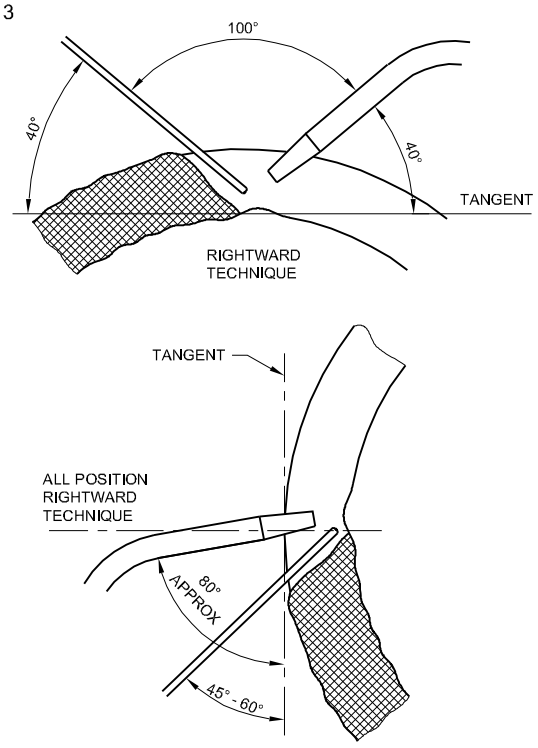
Fig 2



LEFTWARD TECHNIQUE

WLN134112

Fig 3



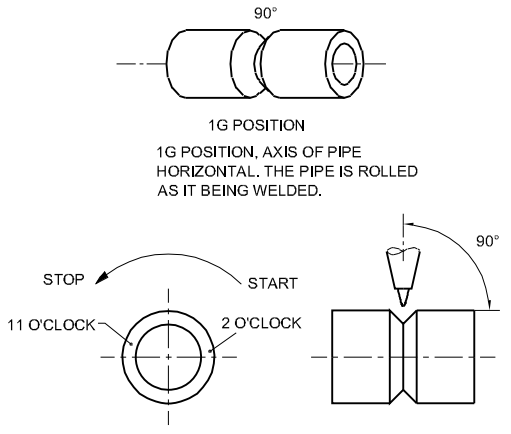
WLN134113

Differences between plate welding and pipe welding

In the plate welding the total welding line can be seen at any time. In pipe welding only a portion of the welding line can be seen at any time.

In plate welding, the line of weld is in only one position. In pipe welding, welding can be done in one position when it can be rotated. (Fig 4) Otherwise all-position welding can be done in the pipe when the pipe is in fixed position. (Fig 6) Sometimes the pipe may be in a fixed position and only one position of welding will be done. E.g. 2G Position. (Fig 5)

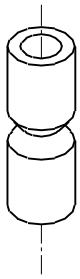
Fig 4



WELDING PIPE IN THE 1G POSITION

WLN134114

Fig 5



2G POSITION

2G POSITION, AXIS OF PIPE VERTICAL

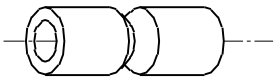
WLN134115

In plate welding the sealing run can easily be deposited when needed. In pipe welding the sealing run cannot be deposited in small pipes. Sealing run can be deposited only when the pipe has so large a diameter as to allow the welder to enter into the pipe.

Possibility of distortion is higher in plate welding. Possibility of distortion is less in pipe welding.

Tip travel and hand travel will be equal in plate welding. Tip travel will be less and hand travel will be more in pipe welding.

Fig 6



5G POSITION

5G POSITION, AXIS OF PIPE HORIZONTAL.
THE PIPE IS HORIZONTALLY FIXED AND CANNOT
BE ROLLED IN THE WELDING PROCESS.

WLN134116