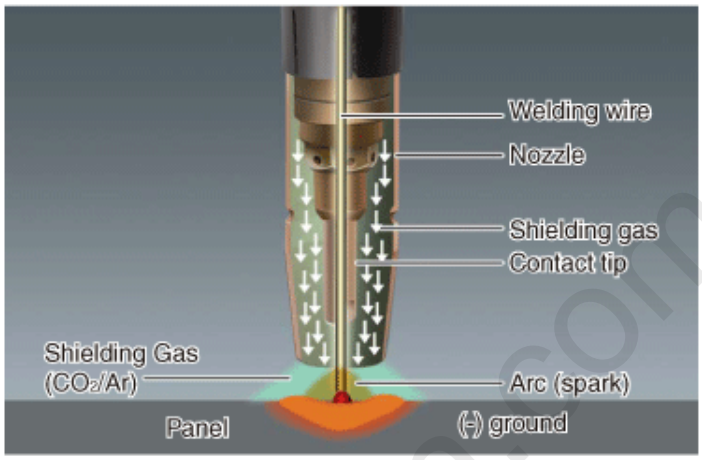
MIG/MAG WELDING

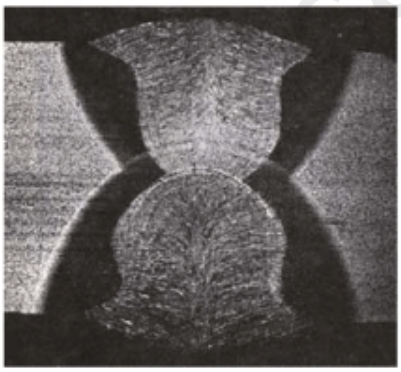
SUMMARY

1. Principle
   When the wire continuously supplied by wire transportation roller of welder passes through the (contact) tip, resistance heat at high temperature between wire and panel generates an arc (spark).
   This arc is used to melt thin welding wire that adheres to panel.

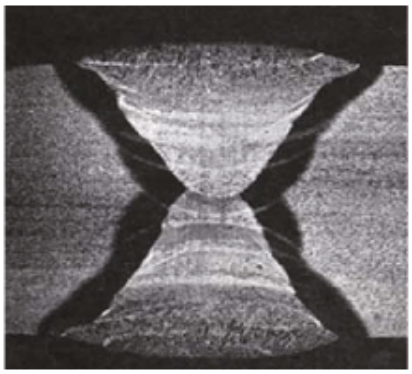


2. Shielding Gas
   Once released from the nozzle, shielding gas blocks off the air (oxygen and nitrogen in the air) around the arc (spark) to create quality welding bead. The welding itself is classified into MIG / MAG welding according to the shielding gas used.
   ※ MIG (Metal Inert Gas): Inert gas such as Argon (Ar) or Helium (He) is used.
   ※ MAG (Metal Active Gas): Active gas such as CO_2 is used.

3. MIG (Metal Inert Gas) Welding
   100% Argon (Ar) or a mixture of Argon (82% Argon) and carbon dioxide (18% CO_2) is used.
   As the welding zone is not affected by shielding gas, even bead (welding zone) and deep penetration can be achieved.
   It is used for areas requiring constant strength such as vehicle members, various fillers and hot stamped parts.



4. MAG (Metal Active Gas) Welding
   100% carbon dioxide (CO_2) is used as the shielding gas.
   Due to the influence of shielding gas, the welding zone instantaneously cools down resulting in shrinkage of bead (welding zone) and thin penetration.
   It is mainly used for welding thin panels such as outer panel.



NOTICE

MIG / MAG welding is classification according to shielding gas rather than the type of welder. Although there are differences in adjustment (setting) for each shielding gas, the same welding method is used.

WELDER COMPONENT

In relation with welding performance, a welder consists of essential components requiring adjustment (setting) for each welding operation, welding wire and welding wire feeder.

1. Essential Component
   The essential components include voltage control switch for controlling the bead depth (penetration) and wire feeder speed control lever for controlling the amount of bead (penetration area and width) by controlling welding wire feeding rate. Also, a welding torch and shielding gas are supplied.

Welder

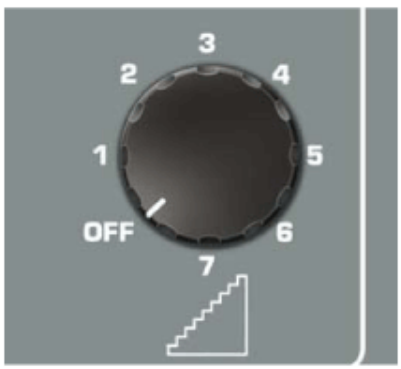
Welding voltage control switch

Wire feeder rate control lever

Shielding gas (Gas mixture)

Welding torch

- Welding Voltage Control Switch
  This switch determines the welding bead depth (penetration).
  Higher dial gauge means higher output voltage of welder to determine the penetration of welding zone.
  Welding voltage control switch must be controlled with the feeder speed control lever.



- Wire Feeder Speed Control Lever
  This lever controls the amount of bead (penetration area, width) according to the feeding speed of welding wire.

Wire feeding speed must be raised when the welding voltage is raised.

- Welding Torch
  When the torch connected with the main welder is switched on, welding wire and shielding gas are discharged.
  Torch consists of consumable parts such as the nozzle and contact tip.

Welding torch

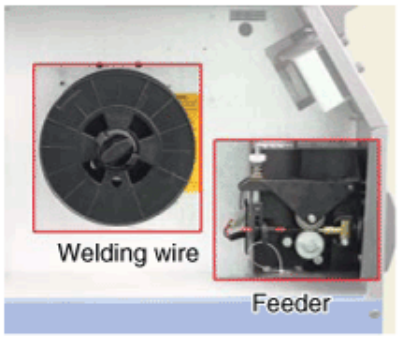
Nozzle

Contact tip

NOTICE

- Nozzle
  Insulator is inserted in the area where torch is fixed.
  If insulator is damaged from impact, the nozzle will be ground to the vehicle body resulting in higher bead as in low voltage. To prevent this, replace damaged nozzle immediately.
- Contact tip
  This is an important component that gives positive charge (+) to welding wire when it is discharged through the contact tip. Immediately replace any damaged contact tip.

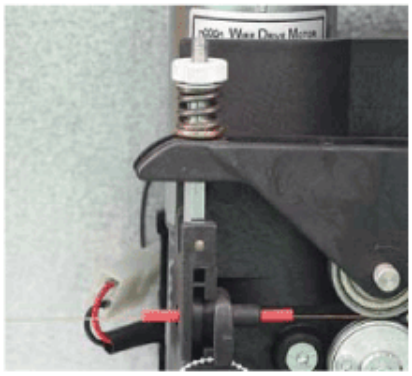
2. Wire Feeder Component
   Wire feeder consists of welding wire and feeder (feeding roller and pressure roller/lever), and its main purpose is continuous supply of welding wire.



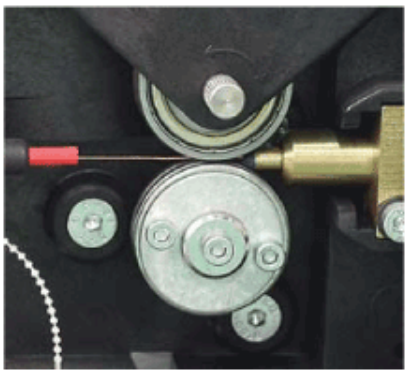
Inside welder
(welding wire/feeder)

Wire feeder

- Pressure Lever and Pressure Roller
  This unit consists of roller and lever that pressurize the feeder roller for continuous supply of welding wire.
  If the lever pressure is high, wire may tangle during welding, and if pressure is low, wire may not be supplied continuously.



- Feeder Roller
  Feeder roller has grooves between rollers for continuous supply of welding wire. If the specification of feeder roller does not match that of welding wire, welding wire supply may become unstable.

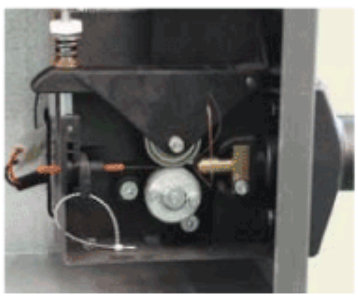


WELDER INSPECTION & ADJUSTMENT

1. Welder Inspection
   Inspect for twisting (tangling) of welding wire due to problem in wire feeder, and inspect contact tip and nozzle of torch before welding.
   (1) Feeder Inspection
   If wire supply is blocked during welding process, twisting (tangling) of welding wire can occur from rotating feeder. To prevent this, adjust the wire feeder.

Faulty wire feeder

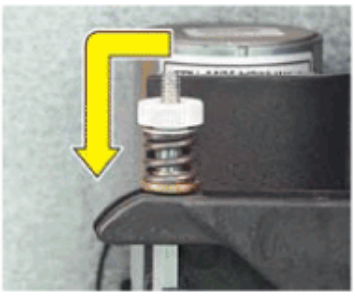
Check feeder (roller)



Twisted wire inside welder
due to defective wire supply

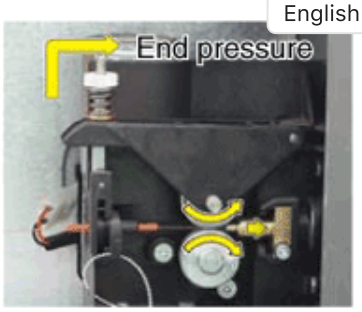
※ If the welder is operated with supply of welding wire stopped, the feeder should rotate and welding wire should not be discharged.

- Adjustment
  Adjust in the following order.



Release pressure lever

Remove twisted wire and discharge wire inside welding torch



Connect new wire to feeder and switch on the welding torch to discharge wire

(2) Nozzle and Contact Tip Inspection

Spatter (metallic parts generated from welding) can adhere easily on nozzle and contact tip.
Large amount of adhering spatter may interfere the flow of shielding gas, causing welding defect such as pores (air holes).
Therefore, apply anti-spatter compound before welding process to maintain clean state.

- Inspection Method

  Inspect in the following order.

Adherence of spatter onto nozzle and contact tip after welding

Weld after applying anti-spatter compound

2. Welder Adjustment

Welder adjustment (setting) aims to minimize welding defect by determining in advance the welding form (bead) resulting from actual welding.

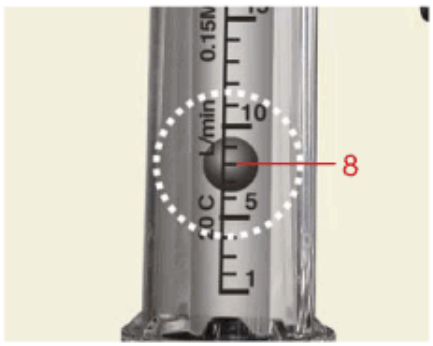
(1) Shielding Gas Flow Adjustment

Shielding gas flow is controlled by adjusting the actual flow of shielding gas released during welding. It is calculated by multiplying the diameter (Ø) of welding wire by 10 with the condition that there is no effect of wind.
In the event of interference factor such as wind, use a welding screen or raise shielding gas flow.

- Adjustment

  If welding wire with diameter of Ø 0.8 mm is used, 0.8×10=8 L/min is the standard flow of shielding gas.

Control flow rate by turning pressure control lever. (Based on Ø 0.8 mm)



Check the location of pressure gauge ball.

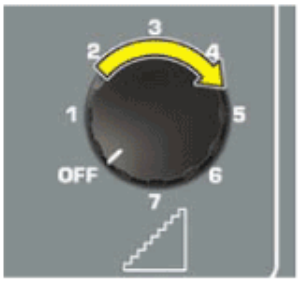
NOTICE

Shielding gas flow must be controlled with welding wire and shielding gas released from the torch. If welding operation is performed with a fan in operation, shielding gas may disperse into the air and cause welding defect such as pores in the bead due to insufficient shielding gas. To prevent this, install a welding screen to shield the wind

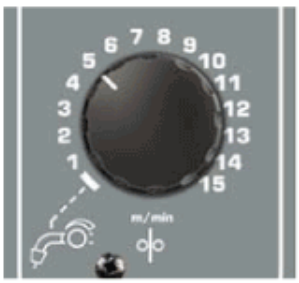
(2) Welding Voltage Adjustment

Welding voltage is the ability to melt welding wire and panel. Voltage is adjusted according to the thickness of panel.

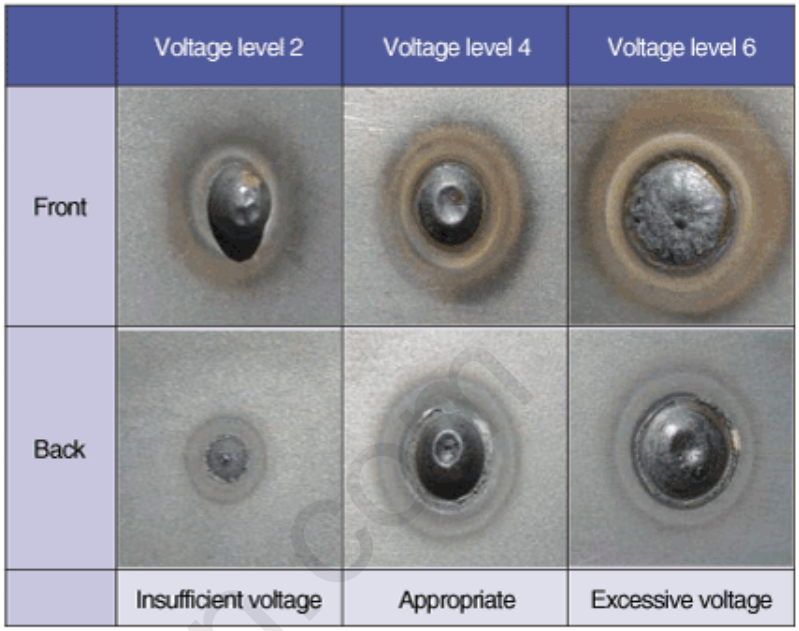
- Adjustment
  In high welding voltage, the welding zone gets high and narrow.
  In low welding voltage, the welding zone gets low, wide and flat.



Control voltage



Fix feeding rate to 5 m/min



※ Condition: Compare bead shapes when welding voltage is varied with feeding rate fixed to 5 m/min.

NOTICE

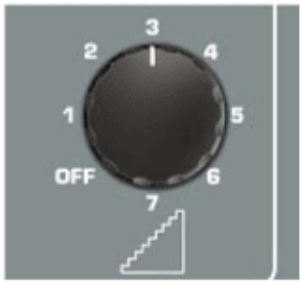
The controlling range differs according to panel thickness. If test welding is conducted on 0.8mm panel and regular welding is conducted on vehicle filler area (1.2 mm), it will result in welding defect (overlap/piling up of bead) Therefore, when adjusting welding voltage and wire feeding rate, adjust (set up) on an equivalent panel.

(3) Wire Feeder Speed Adjustment

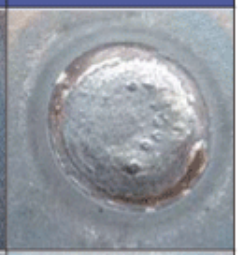
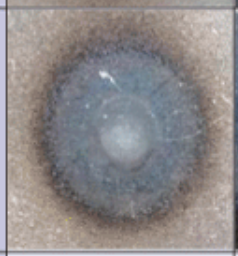
Wire feeding speed affects the shape of welding bead. Feeding speed needs to be controlled based on change in welding voltage.

- Adjustment
  In fast wire feeding speed, the overall bead will have wide and deep penetration.
  In slow wire feeding speed, the overall bead will have narrow and shallow penetration.

Control feeding speed



Fix welding voltage to level 3

	Feeding speed 3	Feeding speed 4	Feeding speed 5
Front			
Back			
	Slow	Appropriate	Fast

※ Condition: Compare shapes of bead when feeding speed is varied with welding voltage fixed to dial 3.

NOTICE

Welding current and wire feeding speed must be controlled at the same time.
Adjust wire feeding speed so that the bead height (of welding zone) after welding does not exceed 2 m from the panel surface.

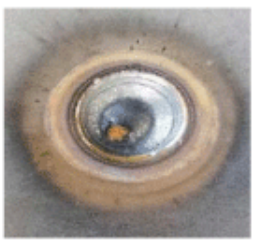
(4) Test Welding

Test welding is performed to determine the welding strength by conducting test on an equivalent panel with varying welding current, wire feeding speed and shielding gas pressure.

- Adjustment
  In fast wire feeding speed, the overall bead gets higher.
  In slow wire feeding speed, the overall bead sinks in.

Control feeding speed

Control voltage



Front bead

Back bead

※ Condition : Welding current at level 3 and wire feeding speed at 4 m/min for panel thickness of 1.0 mm

NOTICE

The most frequent mistake is when vehicle panel is welded after conducting test welding on a panel of different material/thickness.
This can result in welding defect. Reprocess the defective area and adjust the welder, and then weld again on the defective area.

VEHICLE WELDING

English

As the welding quality may vary according to welding posture and method, take caution during welding operation.

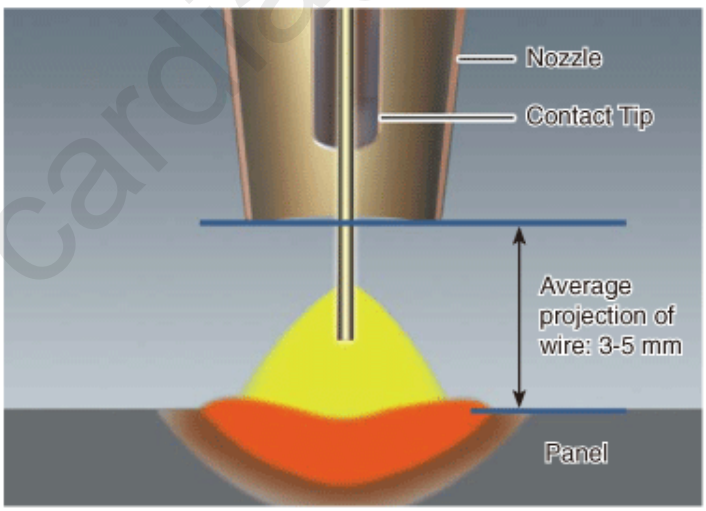
1. Welding Posture
   Check for arc (spark from welding) whenever welding is conducted. Keep the torch steady at all times during welding operation.
   - Posture Adjustment
     Technician should take position so that the arc (spark) is well visible.
     During welding operation, hold torch in one hand, and support with the other hand so that the torch is held steady.

Check for arc during welding

Support welding torch

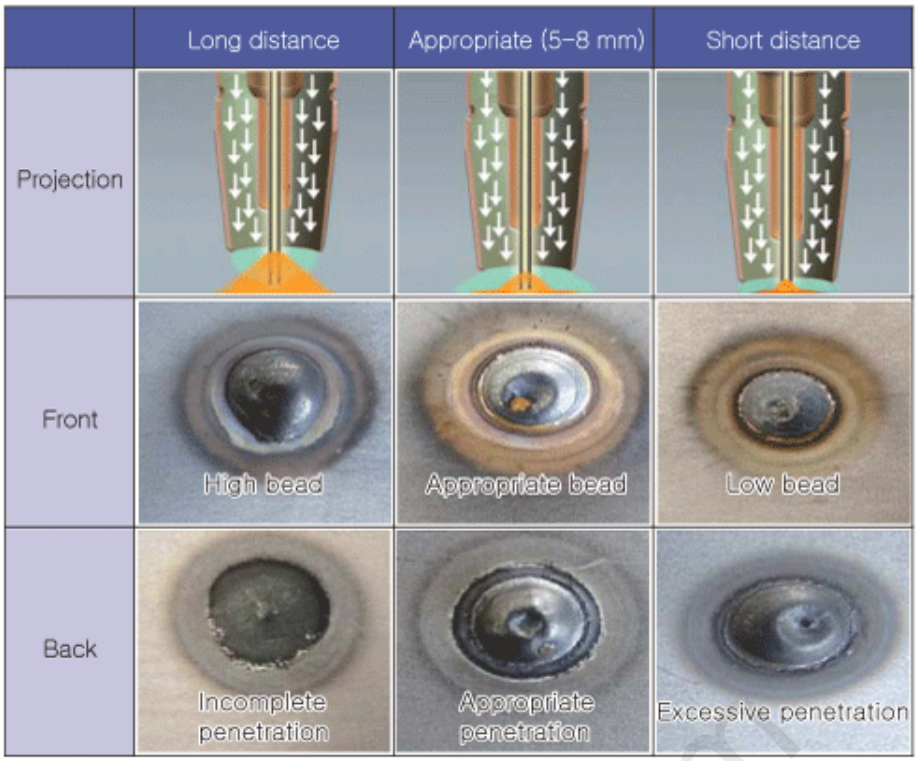
> **NOTICE**
>
> As a protective gear for welding operation, it is recommended to wear the automatic darkening helmet (with darkening level adjustment) that darkens when arc is detected.

2. Distance between Torch and Panel
   The distance between torch and vehicle panel is the distance from contact tip to vehicle panel.
   - Distance Adjustment
     Generally, contact tip is approximately 3-5 mm inside the nozzle.
     The projection from nozzle to welding wire is 3-5 mm on average. This is where welding operation is performed.



> **NOTICE**
>
> If the projection of welding wire is shorter than average, the welding wire can easily adhere to contact tip during welding operation.

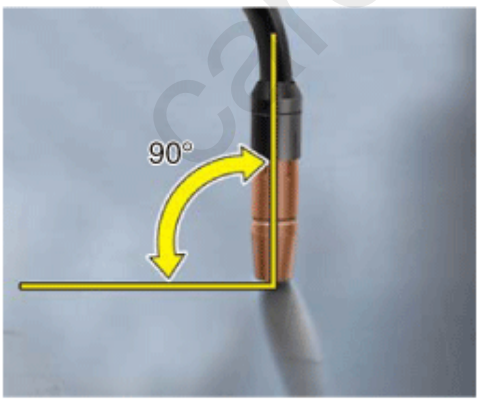
   - Bead Shape according to Wire Protrusion Length
     The bead shape varies according to projected length of wire.
     Short distance results in low bead and deep penetration, and long distance results in high bead and almost no penetration.



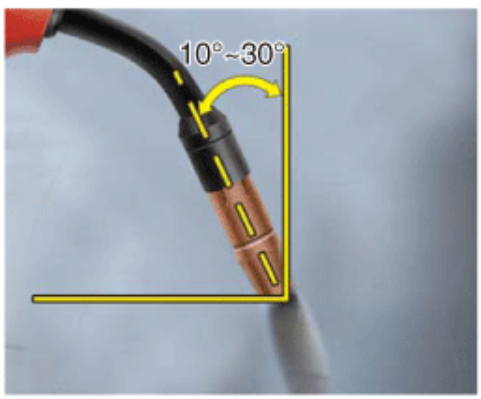
NOTICE

Bead shape change according to projected length of wire is an important factor in butt welding as it is the only way of adjusting the bead shape (width, height).

3. Torch Angle
   Exercise caution during welding operation as panel and torch angle may affect the bead shape and welding quality.
   - Torch Angle Adjustment
     Torch angle is important in plug welding. If the angle between torch and angle is excessively inclined, the welding quality may decrease due to bead shape defect and incomplete penetration.
     During butt welding, if the torch angle is close to 90º, panel may be perforated due to deep penetration. Therefore, weld at an angle of 10°-30° between torch and panel.



Torch angle for plug welding



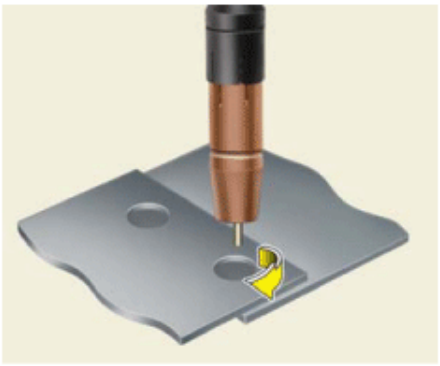
Torch angle for butt welding

NOTICE

The welding quality of plug welding and butt welding may vary greatly according to the torch angle.
In butt welding, keep the torch angle at 90° for tack welding. If the panel is thick, the welding torch angle can be maintained at 90°.

4. Plug Welding
   Plug welding is an important welding operation in vehicle welding that is used to fill the holes (perforations) on panel.
   - Welding Procedure

Satisfactory welding quality can be expected if the torch is held by both hands. (Press the switch with one hand a... rotate the torch with the other hand.)
For hole over 8 mm of diameter, weld around the hole first.



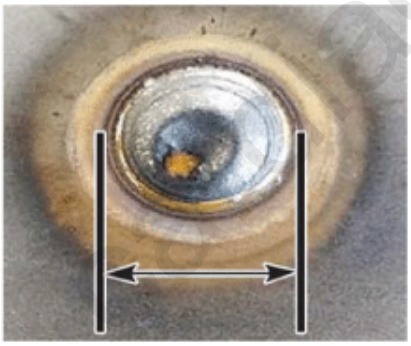
For a hole over Ø 8 mm, weld around the hole first.

Keep the torch steady.

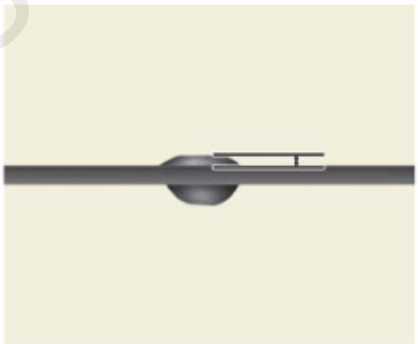
NOTICE

Test welding must be performed before welding vehicle body. Perform test welding on a panel equivalent to the actual panel to check the welding performance.
Always check the welding zone (arc zone) during welding operation, and weld around the hole first when welding a hole over Ø 8 mm to minimize unfilled area (incomplete penetration).

- Welding Specifications
  When welding only the outer panel, process hole of approximately Ø 6 mm, but for pillars and members, process hole of approximately Ø 8 mm.
  Adjust the specifications so that the width does not exceed hole (perforation) diameter x 1.5 and the height does not exceed 2 mm irrelevant of the hole (perforation) diameter.
  ※ When the hole diameter for plug welding is Ø 8 mm, maintain welding bead width below 12 mm and height below 2 mm.



Width: Below hole diameter x 1.5



Height: Below 2 mm

NOTICE

If the height of welding bead is almost flat (less than 1 mm), welding binding strength defect may occur from undercut (on boundary of panel and welding zone). Therefore, maintain bead height of at least 1 mm.

5. Butt Welding
   Butt welding is performed to connect the edges of two panels with continuous welding. It is an important welding method in vehicle welding along with plug welding.
   - Adjustment (Setting)
     For the initial adjustment (setting) of butt welding, it is important to configure the same condition as the panel to be welded.
     Adjust the welding condition as per the manufacturer standard.

Control feeding speed

Adjust welding voltage to level 3

Condition	Ø0.6mm welding wire / Gas mixture (82% Ar, 18% CO_2)			
Panel thickness (mm)	0.8	0.8	1.0	1.5
Welding voltage (level)	1	2	3	4
Wire feeding speed (m/mim)	3.0	4.0	5.5	8.6

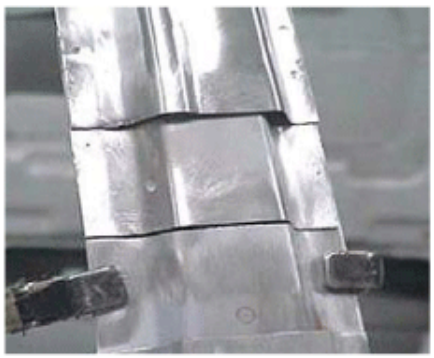
※ Example of adjustment conditions with change in panel thickness for butt welding

NOTICE

In vehicle body welding, butt welding is an important welding method along with plug welding.
Unlike plug welding that melts and fills two or three sheets of panels, butt welding binds by melting welding wire between cut-off panel and the main panel.
When welding with welding voltage capable of melting two or more panels like plug welding, carefully adjust the welder as the panel can be easily perforated from welding.

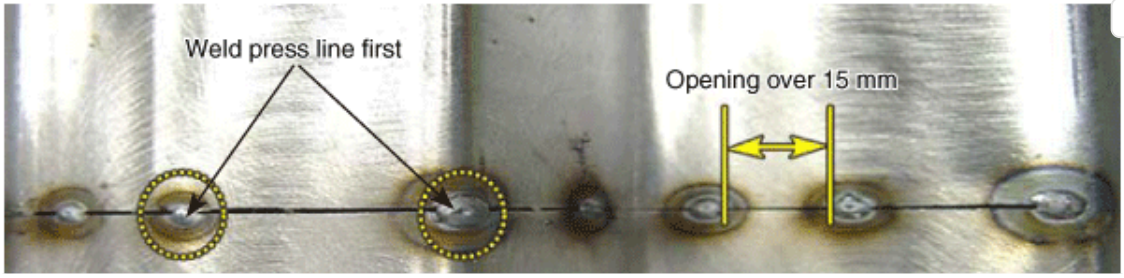
- Opening
  Maintain even opening between panels, and do not exceed 1 mm for outer panel.

Below 1 mm for outer panel



Opening for filler and reinforcement panel is the same as panel thickness.

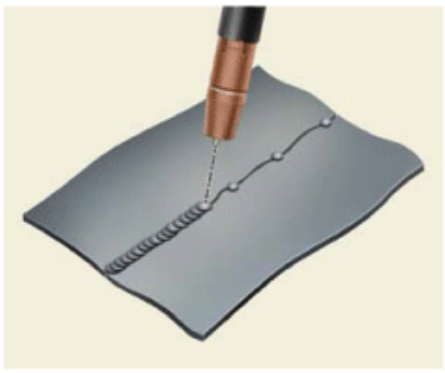
- Tack Welding
  Tack welding is the temporary welding of panel to prevent thermal deformation and maintain shape of welding zone.
  Perform tack welding after adjusting the speed of press line. Perform every 15-30 mm on average according to the shape of panel.
  ※ Tack weld press line first with opening of within 15-30 mm.



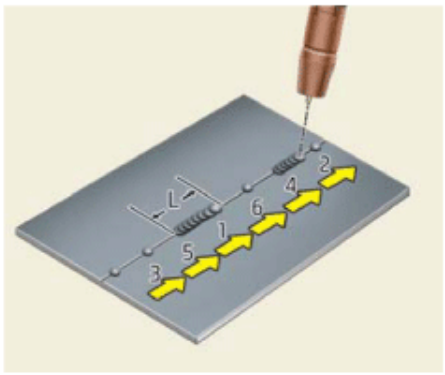
- Torch Movement
  There are forehand and backhand welding methods according to welding torch movement.
- Forehand Welding
  Maintain torch angle of 15°-30° to the opposite direction of welding movement.
  Advantages : Torch can be accurately moved as the welding line is well visible, and there is less thermal deformation.
  Disadvantages : The bead width is uneven if the torch is inclined, and a lot of spatter occurs.
  ※ This welding method is suitable for thin panels in passenger vehicles.

- Backhand Welding
  Torch moves in the opposite direction to forehand welding.
  Advantage : Bead shape can be adjusted as it is revealed during welding operation.
  Disadvantages : It is hard to move torch as the welding line is hidden by the nozzle, and it can result in severe thermal deformation as the panel is excessively heated.
  ※ This welding method is suitable for thick panels in commercial vehicles.

- Welding Method
  During butt welding, approximately 15 mm is continuously welded. If welding is performed longer than necessary, it may result in increased thermal deformation on panel requiring additional correction.
- Welding Procedure
  Continuously weld within the range of tack welding (15-30 mm).
  Set the welding sequence to minimize thermal deformation.
  Control the height and width of bead during welding operation by adjusting the height of torch.



Forced continuous welding can result in excessive thermal deformation.



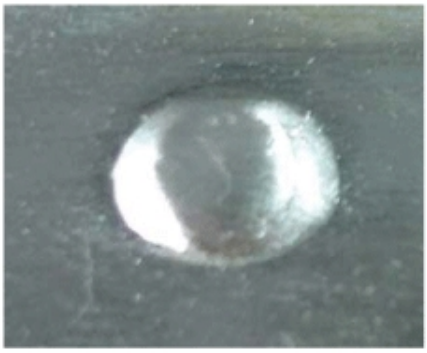
Set up welding sequence for continuous welding.

NOTICE

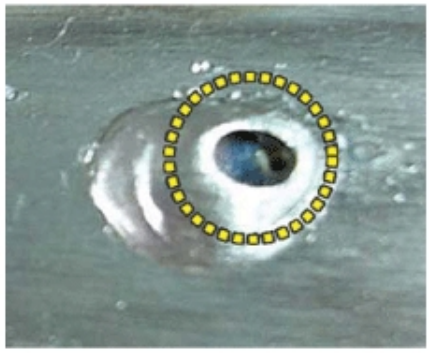
Adjustment of welder is important in butt welding. In high welding voltage, bead can easily burst during welding. Therefore, sufficiently grind off the edge between two panels before performing welding operation.
y adjusting the wire projection length (torch height), the width and height of welding bead can be controlled. The bead width and height can be adjusted during continuous welding, by adjusting the torch height.

- Welding Wire Edge Processing
  If the end of wire has melted in rounded shape, it is hard to generate arc (spark).
- Measures
  Cut off the end of wire into an appropriate length (5-8 mm) from contact tip by using cutting pliers.
  Aim the wire downward to prevent the cut off piece from flying off.

6. Welding Defect
   The major causes of welding defect are incorrect use of shielding gas, incorrect adjustment of welder and incomplete removal of impurities from welding panel. Therefore, prevent welding defect by inspecting and adjusting (setting) welder prior to welding operation.
   - Occurrence of Pores
     The major reasons for pores are related with shielding gas, incorrect inspection of welder and influence of external factors (wind) during welding operation.
   - Inspection Method
   – Insufficient gas flow: Check pressure of shielding gas.
   – Excessive adherence of spatter on nozzle: Check and remove spatter.
   – Contamination of welding zone: Check that the panel is clean from paint and rust.
   – Distance between panel and tip: Check that the distance is 5-8 mm.



Normal bead

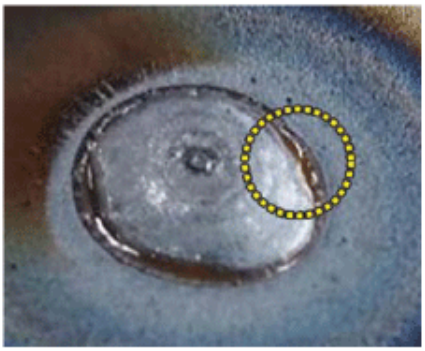


Bead with pores (air holes)

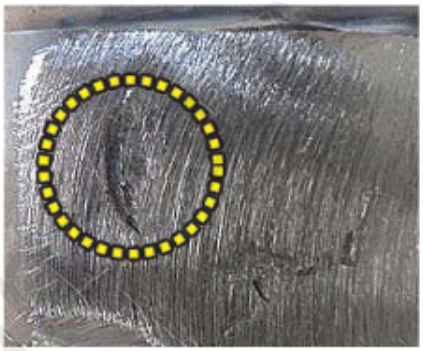
- Undercut
  Undercut is where the boundary between panel and bead is sunk in. The major cause of undercut is excessively high welding voltage (welding control defect).
  ※ Cause and Shape

– Long ark (spark) length due to high welding voltage

– Excessively inclined torch
  * In vehicle body welding, undercut can cause insufficient welding strength.



Front bead



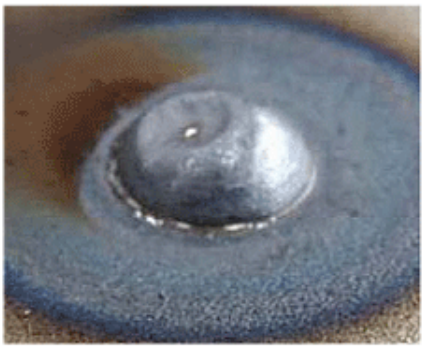
Welding mark after grinding off front bead

- Overlap
  Overlap is a formation of bead piled up after welding. It is mainly caused by low welding voltage (welding adjustment defect). It is accompanied by incomplete penetration.
  ※ Cause and Shape

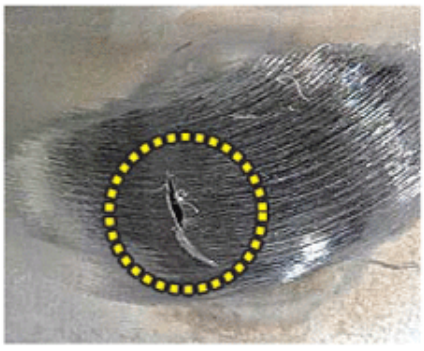
– Low welding voltage

– Low welding speed

– Short arc (spark) length
  * Overlap is mainly caused by incomplete penetration.



Front bead formation



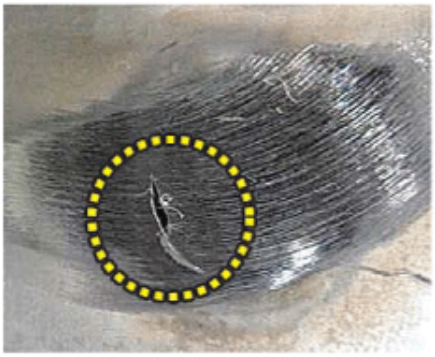
Crack after grinding off front bead

- Incomplete Penetration
  In case of incomplete penetration on welding zone, there is almost no back bead at the back of welded panel, and when the welding surface is checked after grinding off the front bead, in most cases, incomplete filling will be shown.
  ※ Cause and Shape

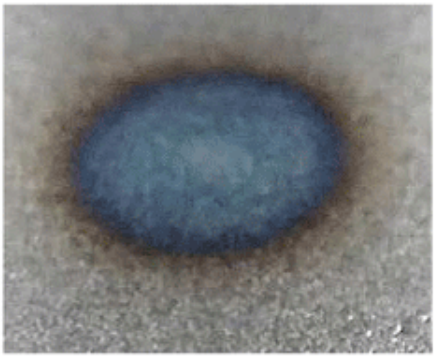
– Low welding voltage

– Long welding wire

– End of welding wire contacting with panel
  * Overlap is generally accompanied with incomplete penetration.



After grinding off front bead



Back bead

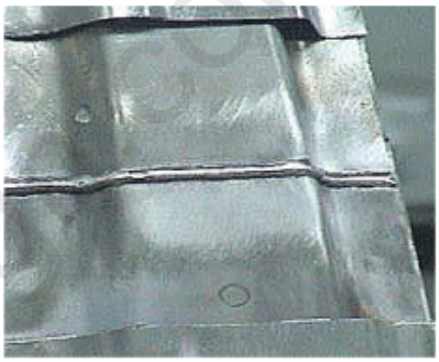
- Bead Defect
  Overall defect during butt welding is mainly caused by incorrect adjustment (setting) of welder and torch feeding speed.
  ※ Cause and Shape

– Uneven torch speed during welding

– Relatively high or low welding voltage

– Wide panel opening

Defective welder voltage and torch speed



Normal bead shape

7. Protective Gear
   Before starting to weld, protective helmet, gloves and mask must be worn. In particular, as the effectiveness of protective mask can vary based on how it is worn, check wearing instruction at all times.
   - Welding Helmet
     To protect the eyes of technician from the arc (spark) and various rays from welding and for effective welding operation, automatic darkening welding helmet must be worn that instantly darkens when arc (spark) is detected.
   - Welding Mask
     "Fume" is small odorless metallic particles generated from welding that is invisible to eye and threatens the safety of technician. During welding operation, wear class 1 welding mask at all times.
     * Fume : Metallic particles generated when metal oxidizes at high temperature. It is not blocked by general mask. As the effectiveness of blocking hazardous substance may vary according to how it is worn, follow the manufacturer instruction.
   - Welding Gloves
     Wear special heat resistant gloves and leather gloves to protect hands from spatter (metallic particles) and welding heat.
     ※ Protective Welding Gear

English

Automatic darkening welding helmet

Class 1 welding mask

Welding gloves

APPENDIX

1. MIG Welding
   MIG is short for Metal Inert Gas and refers to the gas that does not react (inert gas) with metals. MIGs include Argon (Ar) and Helium (He). A mixture of small amount of carbon dioxide (CO_2) and Argon (Ar) may also be used.
2. MAG Welding
   MAG is short for Metal Active Gas and refers to the gas that reacts (active gas) with metals. The representative MAG is carbon dioxide (CO_2). It is Commonly referred to as CO_2 welding.
3. Bead
   Bead refers to the welded form or status.
4. Penetration
   Penetration refers to the welding status from panel surface to end of bead.
5. Incomplete Penetration
   Incomplete penetration is a phenomenon in which crack is visible on welding zone due to incomplete welding.
6. Basic Metal
   Basic metal is the panel to be welded.
7. Root Opening
   Root opening is the distance between panels.
8. Spatter
   Spatter is the metallic particles flying off at high temperature during welding.
9. Arc
   Arc is the strong light (spark) emitted when voltage is applied between electrodes.
10. Tack Welding
    Tack welding is the temporary welding to set the shape and position of panel before performing regular welding.

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