

Plasma and TIG processes. Automatic welding applications

Performance and high productivity in boiler
and pipe work.



2013-665

Plasma and TIG processes used in automatic applica



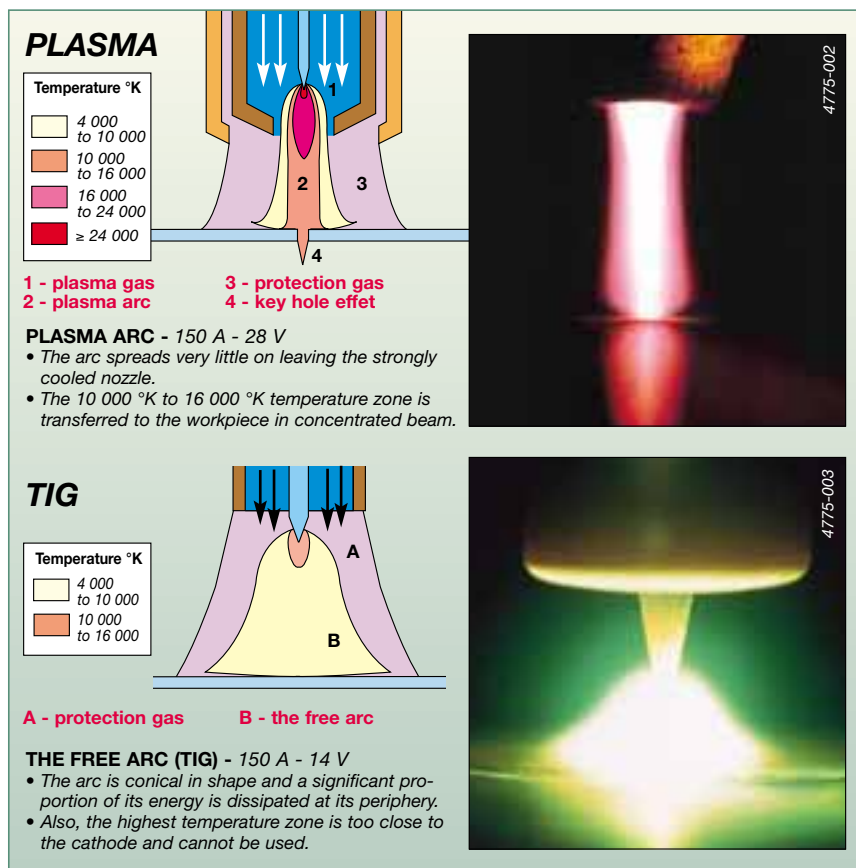
The plasma arc: a natural phenomenon tamed by Air Liquide Welding. The term plasma applies to gases at temperatures exceeding 3000 °C at atmospheric pressure. On the temperature scale, it can be regarded as the fourth state of matter after the solid, liquid and gaseous states.

The plasma arc is now widely used in the steel, chemical and mechanical engineering industries. As market leader in this sector, Air Liquide Welding has turned it into a powerful cutting and welding tool. It is generally accepted that the plasma welding process is the major technological advance from inert gas shielded free arc welding (the TIG process).

The isotherm diagram opposite shows clearly that the energy distribution is strongly modified within the plasma arc :

- the 16 000 °K to 24 000 °K temperature zone is outside the nozzle,
- the 10 000 °K to 16 000 °K temperature zone is entirely transferred to the workpiece and causes the "key hole" effect (penetration of the workpiece).

Plasma arc: high temperatures, a concentrated beam, better productivity.



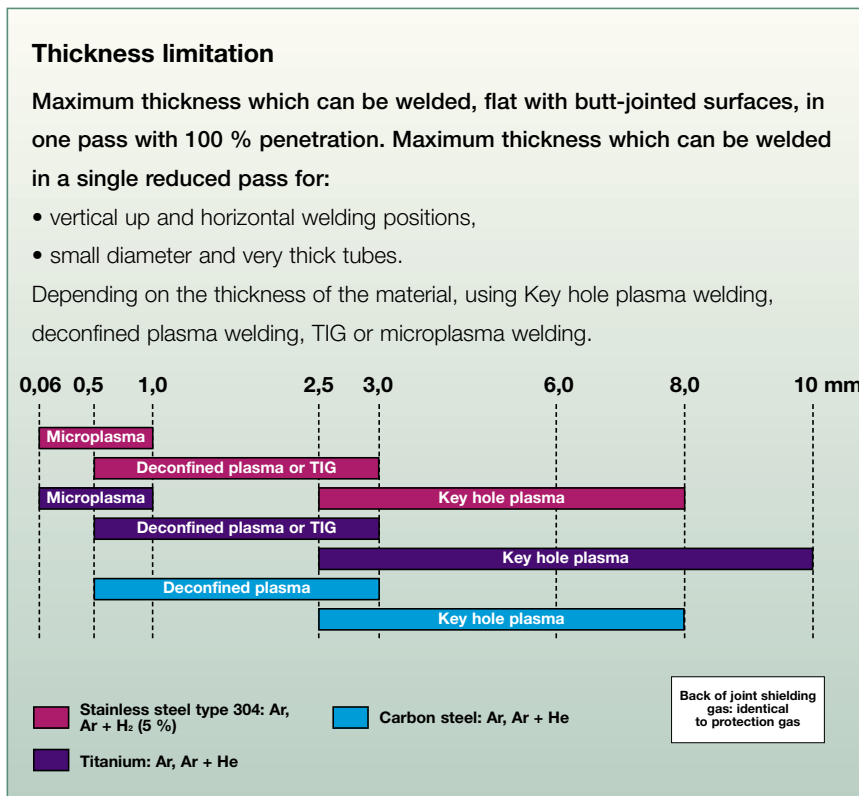
With a free arc (TIG process) the highest temperature zone is too close to the cathode to be usable.

The 4 000 °K and 10 000 °K temperature zone is narrow in plasma welding compared to TIG welding where the zone is much wider with characteristic "bell" shape. This zone is not without its uses: it causes surface melting of decreasing depth relative to the plane of the joint, providing a gentle transition from the welded area to the basic metal.

This zone is excessively wide in TIG welding and the excess limits performance.

The plasma is made up of excited ions, electrons, atoms or molecules; it occurs in nature, generated by lightning, for example.

Since about 1960, and largely due to Air Liquide Welding, the word plasma has gained a new meaning, referring to the high-energy state caused by constricting an electrical arc by means of a diaphragm or nozzle.



Thickness	Electrode (S.M.A.W)	Manual TIG (G.T.A.W.)	Plasma (P.A.W.)
3 mm			
8 mm			
> 8 mm			

Welding in one pass without preparation:
carbon steel and stainless steel, austenitic up to 8 mm, titanium up to 10 mm.

Example of productivity gain with carbon steel (5 mm):

- Electrode: preparation + 2 passes at 15 to 20 cm/min grinding.
- Manual TIG: preparation + 2 passes at 10 cm/min.
- Key hole plasma: 1 pass at 40 cm/min.

Advantages of plasma

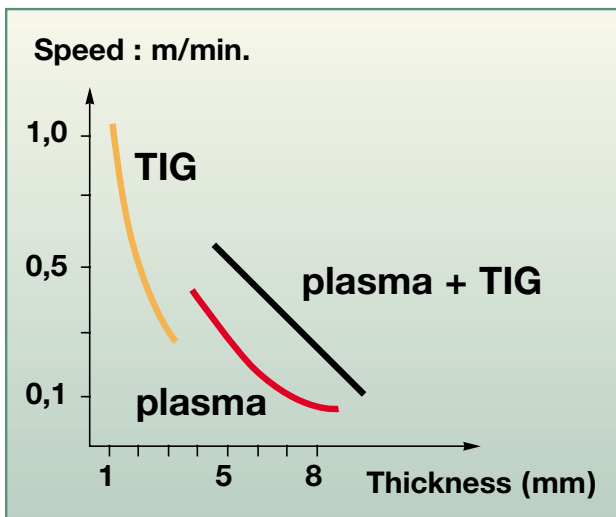
- **Rapidity of operation** and **low deformation** to avoid or reduce reconforming operations as well as **low buildup** to eliminate polishing procedures with **respect for the chemical composition of the base material** to avoid problems of corrosion.
- **Excellent visual appearance** which is a quality factor as more and more welds are visible, with **repeatability of the quality** obtained and **a reduction in the preparation times for assemblies** by eliminating bevelling for thicknesses up to 8 mm.
- **4- or even 5- fold reduction in welding times** in comparison with manual welding, with **assurance of complete and regular penetration** by virtue of the traversing jet technique on butted joints.
- **High quality** proof against stringent inspections **with excellent reproducibility.**
- **Produces a faultless weld bead overlap** due to perfect control of the relevant parameters.

Plasma + TIG welding process



When the length of the panels to be assembled reaches 3 to 4 meters, a boiler-making or tube fabrication workshop using a discontinuous forming process (rolling mill or press) can be restricted by the welding speed obtained with a single-torch plasma process.

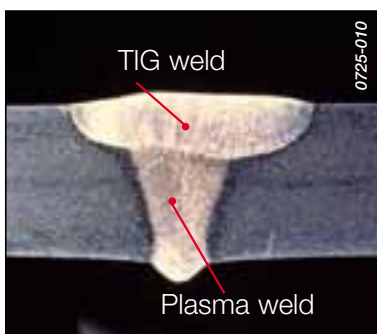
Air Liquide Welding, an innovative specialist in TIG and plasma processes, has been able to integrate the two processes into a single installation which can improve productivity by 30 to 50 %.



Welding speed (cm/min.)		
Thickness (mm)	plasma	plasma + TIG
3	50	65
4	35-40	50-60
6	25-30	40
8	15-20	25

Advantages of the plasma + TIG process

- High quality of plasma weld.
- 30 to 50 % increase in productivity.
- Can be adapted to varied boiler-making processes due to its great flexibility.



In the plasma + TIG process, the plasma arc first melts the entire thickness of the joint by using a strongly confined plasma which only affects the appearance of the back of the joint.

250 to 300 mm away, the TIG arc equipped with filler metal and a magnetic oscillation system prepares the final appearance of the surface. By virtue of the magnetic oscillation and a 120 mm gas shield, this gives a perfect finish.

The plasma + TIG process works on thicknesses between 3 and 8 mm.

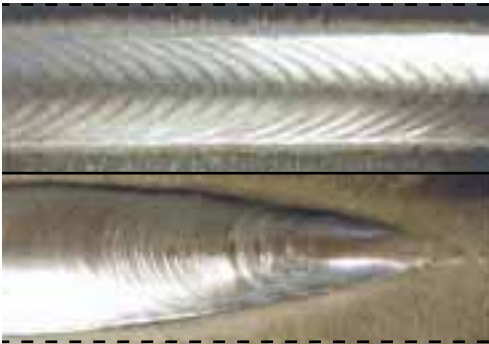
Thicknesses less than 3 mm can also be welded perfectly but only a single-torch TIG process is used.

Thicknesses greater than 8 mm require an additional single-torch TIG filling pass.

The plasma + TIG process is specially designed for large capacity stainless steel boiler work:

- length > 3 meters,
- diameter > 2.2 meters,
- or manufacture of large stainless steel tubes welded in one piece.

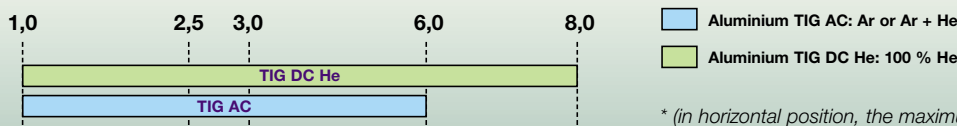
Aluminium welding using the automatic TIG process



Air Liquide Welding have developed a variation of the TIG process to guarantee success in your automatic welding work. Variable polarity TIG ensures continuous decoating, a high-quality weld bead, total control of the weld pool and perfect fading for finishing off the weld bead.

Thickness limitation for the TIG process used for aluminium welding.

Maximum thickness which can be welded, flat* with butt-jointed surfaces, in one pass with 100 % penetration:



* (in horizontal position, the maximum thickness is reduced)

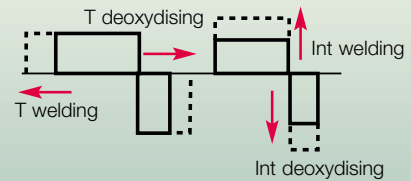
Alternating variable polarity TIG

The flexibility of variable polarity lies in the total independence of the welding and deoxydising parameters. This means it is possible to optimise the welding and deoxydising phases independently.

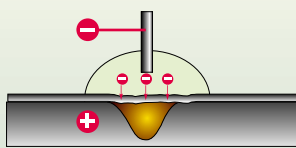
This results in better control of the weld pool and better weld bead appearance.

The alternations improve weld bead compactness as aluminium and its alloys only too easily show inclusions ($Al_2 O_3$) and blisters (H_2).

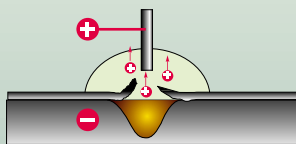
Variable polarity: parameter independence



Electronic deoxydising



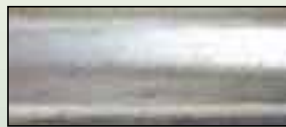
Direct polarity for welding



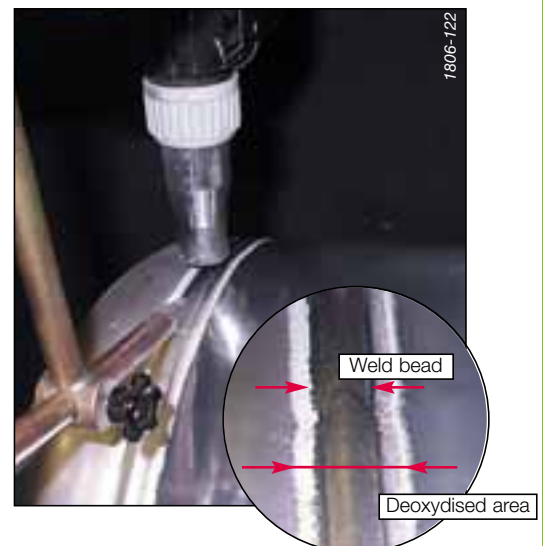
Inverse polarity for deoxydising

Weld bead comparison

Variable polarity weld bead smooth weld



Weld bead with variable polarity welding pulsed at low frequency



DC TIG under helium

This process can also be used to weld aluminium with the advantage that, for thicknesses up to 8 mm, it needs only one pass with no preparation.

Operations to be carried out:

- mechanical oxide loger,
- mechanical support using a backing bar is required for the weld pool.

Current application: longitudinal on seamer bench.

Indicative parameters for DC TIG helium

Thickness (mm)	Current (A)	Voltage (V)	Weld Speed (cm/min)	Wire Speed (cm/min)	Gas flow rate (l/min)
1,6	100	13	75	110	30
2,0	150	13	75	110	30
2,5	210	13	75	130	30
3,0	220	14	65	200	30
4,0	250	14	45	200	30
5,0	250	14	45	220	30
6,0	300	15	30	220	30
8,0	360	15	18	140	30

One pass with 100% penetration, butt-jointed, position flat.

Plasma welding in the workshop

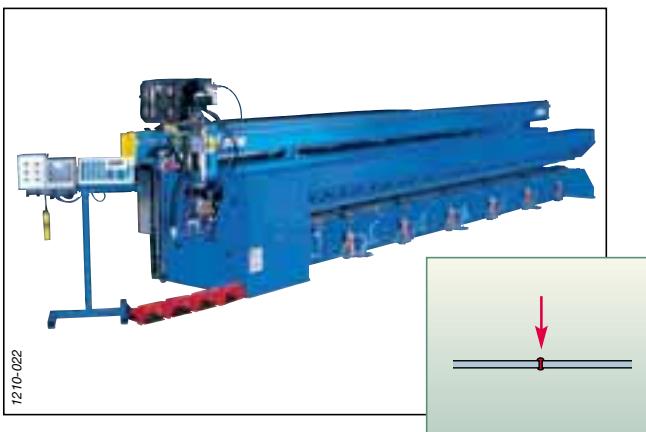
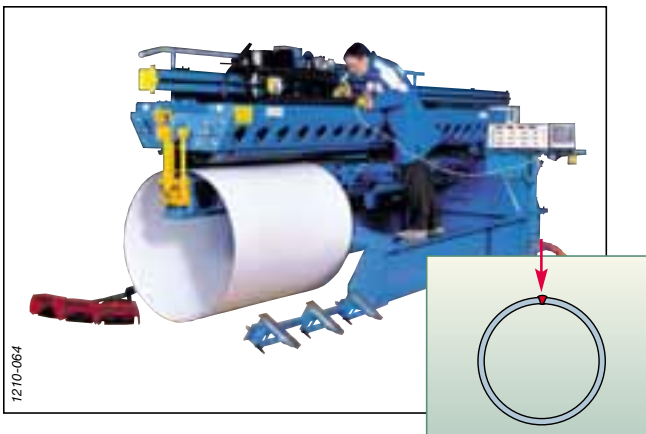
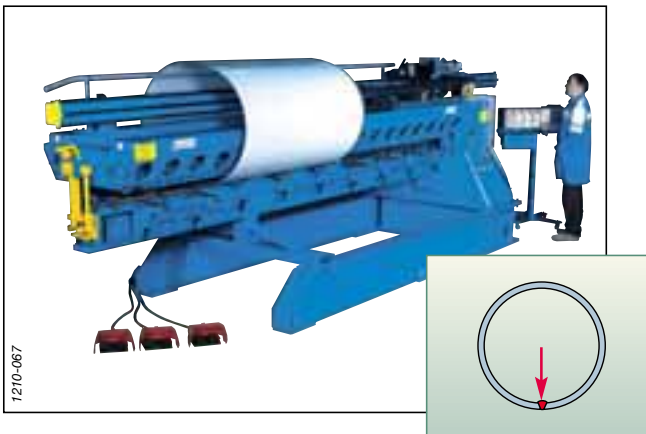


Use of plasma or TIG processes or flat longitudinal or circular welding of stainless steel, noble metals, steels or aluminium. Manufacture of all types of product for the petrochemical, agriculture/food processing, aeronautical industries etc.

Longitudinal welding on seamer bench

Closing the vessel and even butt-jointing

Start and end of weld on root face.



Standard example of welding in boiler making



Welding with column and boom

- Maximum standard travel: 4.3 m horizontal, 6.2 m vertical.

For other requirements please do not hesitate to contact us.

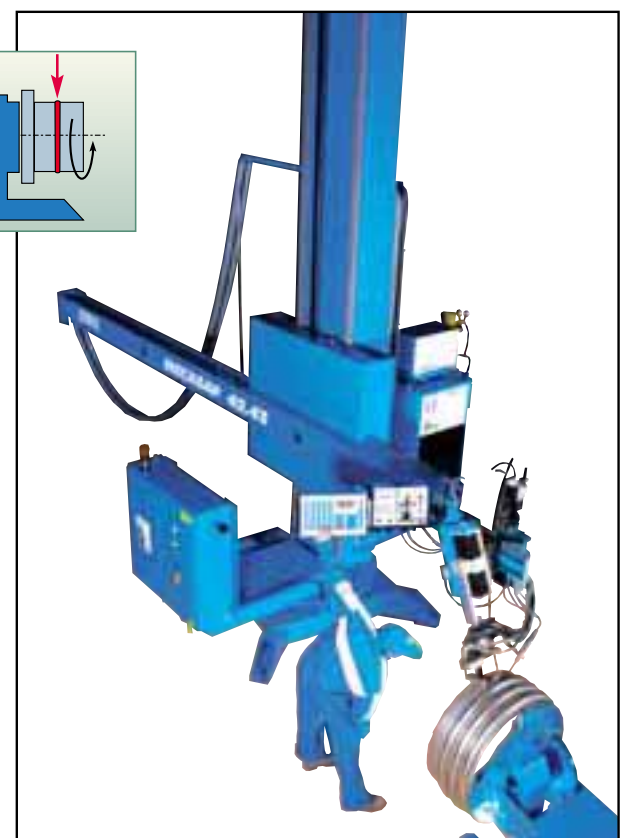
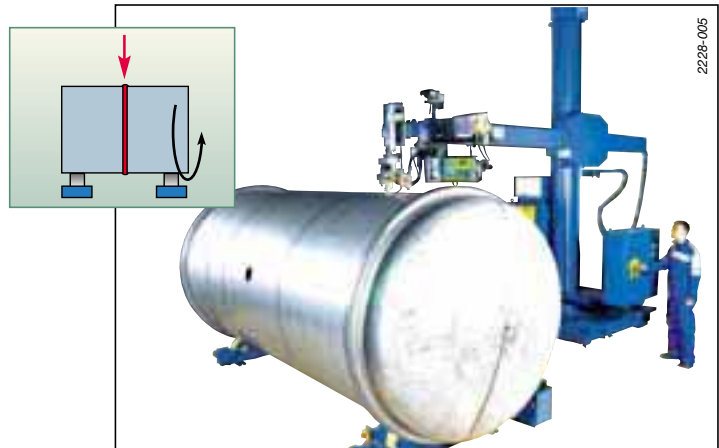
Welding on seamer bench

- Allowable thickness up to 10 mm,
- Maximum weldable length according to type of bench: 4 m (exter), 6 m (exinter) or 7 m (inter).

For other requirements please do not hesitate to contact us.



Circular welding with column and boom on rotator or positioner.



Elliptical welding with column and boom on rotator.



Vertical boiler work



Use of plasma or TIG processes for horizontal welding of stainless steel, noble metals, steels or aluminium. Manufacture of storage equipment for agriculture/food processing, petrochemical industries etc...



Vertical welding

In order for a workpiece to be welded on a rotator it has to be rigid enough (relationship between diameter, thickness and dimensions) to ensure satisfactory stability while welding takes place. For cases where rigidity is not sufficient, or costly (vessel sizing tools), difficult or even impossible to improve because of the large variety of parts used, Air Liquide Welding has produced equipment enabling welding to be carried out

"in the vertical axis" where the workpiece is rotated using a horizontal turntable and the torch remains static in the horizontal welding position.

This allows very large dimension workpieces to be produced without the use of complex tools.



**Turntable capacities:
5T, 10T and 15T.
For other requirements please
do not hesitate to contact us.**



Plasma welding for prefabricated pipe work



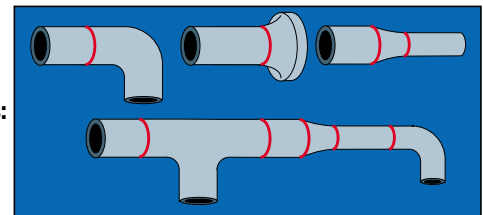
Prefabrication of pipe work is carried out upstream of installation. It enables sub-assemblies to be prepared and welded from basic components (pipes, flanges, elbows etc...) in the workshop. It is used in a variety of industrial sectors:

- shipbuilding and off-shore platforms,
- refineries and power stations,
- chemical and agriculture/ food processing plants,
- gas expansion and distribution stations etc.

The materials used are as follows:

- carbon steels,
- stainless steel,
- noble metals and titanium.

Plasma welding is suitable for prefabricating pipe work of diameter greater than 1.5 inch. Parts with smaller diameters can be TIG welded using the same equipment.

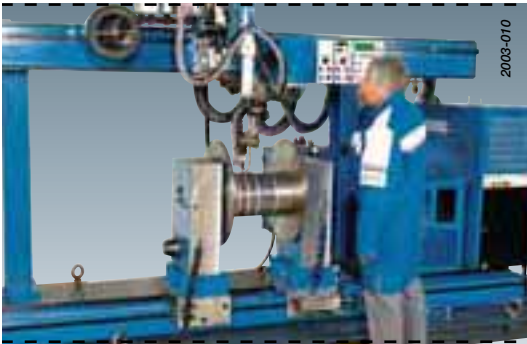


Example of welding times, assemblies are pre-tacked using manual TIG.

Exterior tube Ø	Thickness of wall in mm	Type of steel	Joint preparation	Time taken for plasma welding not counting positioning of assemblies	Time taken for same operation carried out manually
60	2,9	carbon		2 min (2 consecutive passes)	15 min
133	3,8	carbon		4 min (2 consecutive passes)	24 min
406	9,52	carbon		14 min (2 consecutive passes)	24 min
114	8	AISI 304		4,15 min (2 consecutive passes)	38 min
170	3,2	AISI 304		2 min (1 pass)	55 min



NERTAMATIC 450



Multi-purpose welding installation to enable the following processes to be used in automatic applications:

- DC TIG with smooth or pulsed current
 - AC TIG with variable polarity,
 - DC plasma with smooth or pulsed current,
- This equipment is offered in several versions.**

Process control

- 50 welding programs (voltage, current, wire speed, movement)
- Cleartext LCD screen display
- Parameter modification while welding
- Cycle start/stop, manual control of gas/wire, AVC

TIG/plasma direct current basis

- PC 104 central unit and interface
- Pulser 450 A/100 %
- Control arc circuit 25 A/100 %
- Primary three-phase power supply 50/60 Hz - 230/400/415/440 V

Optional alternating module

- Variable polarity TIG operation on aluminium
- Variable polarity current 450 A/100 %
- Variable polarity frequency from 50 to 200 Hz

Basic installation:

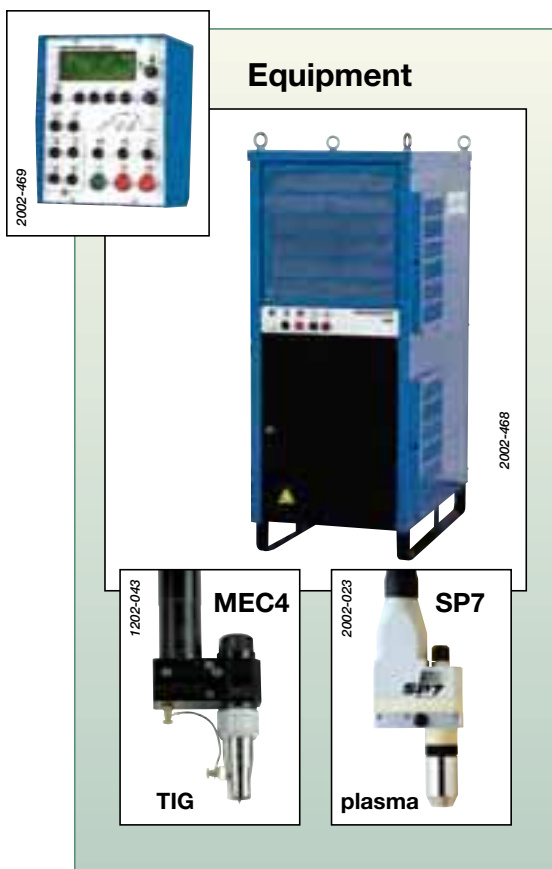
- NERTAMATIC 450 power source
- HF module + torch connection
- Remote control unit box, welding control with 50 memorised programs (display/control of current, voltage, wire speed)
- Diskette drive for uploading or downloading programs
- Parameter print-out
- Power controller module
- Harness length 10, 17 or 22 meters compatible with cable hanger chain

NERTAMATIC 450 add-ons

- Wire, AVC, gas control box

Machine add-ons

- Movements, meccanicycles, PLCs etc



To order:

standard offer LC 03-012

DC TIG and AC/DC TIG versions: this installation can assemble butt-jointed stainless steel panels up to 3 mm thickness and light alloy steels up to 8 mm thickness (DC TIG under helium) and 6 mm (AC TIG under argon) in a single pass.

standard offer LD 04-032

The DC plasma version uses automatic plasma welding and can assemble butt-jointed 8 mm carbon steel, stainless steel, titanium or alloy steel in a single pass without the need for bevelling.

Mixed AC/DC TIG and DC plasma version is possible

NERTAMATIC 450 HPW



640012-101

This installation meets the highest quality standards for welding and productivity for industries as diverse as boiler-making using stainless steels, aeronautics using noble metals, chemical engineering, energy production, transformation and transport as well as prefabrication of gas and petrol pipelines etc.

The system is based on the same components of the NERTAMATIC 450. Only the control unit is changed by an industrial PC allowing the complete management of the machine starting from only one control panel, giving :

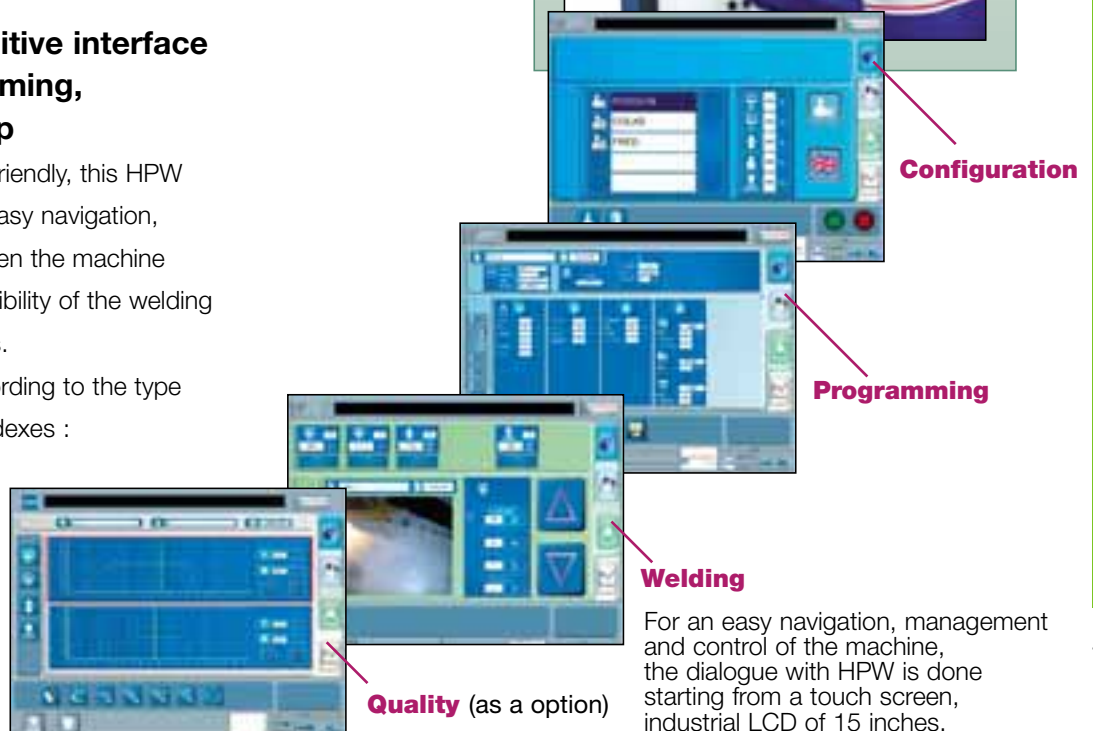
- Numerical management of the welding process, its associated movements and drive units
- Traceability, a program integrates all the parameters allowing the repetitivity of the welding
- Quality follow-up in option, record and storage of the essential parameters of welding (current, voltage, wire feeding, movement)
- User friendly and intuitive interface allowing the programming, controls and follow up
- Intuitive built up of cycle machine thanks to a graphic programming
- Touch screen facilitating the HPW use
- Off line programming on PC, data exchange via USB key
- Optimisation of the machine integration
- Control via industrial PC

User friendly and intuitive interface allowing the programming, controls and follow up

Intuitive, interactive and user friendly, this HPW interface software allows an easy navigation, facilitating the dialogue between the machine and the operator, also the flexibility of the welding to your production constraints.

HPW interface is divided according to the type of work to carry out in four indexes :

- Configuration
- Programming
- Welding
- Quality (as an option)



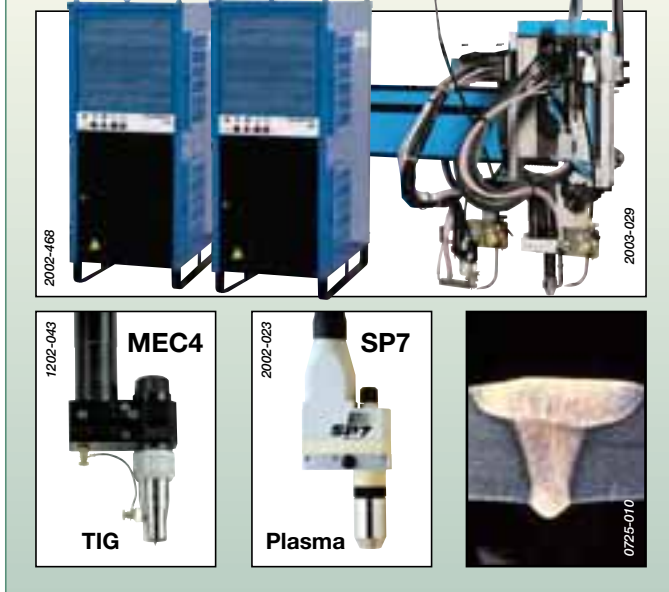
For an easy navigation, management and control of the machine, the dialogue with HPW is done starting from a touch screen, industrial LCD of 15 inches.

NERTAMATIC 450 plasma + TIG bicathode installation



This installation was developed and built for large-capacity stainless steel boiler makers (basic activity transport and storage of chemical products and foodstuffs with series 300 stainless steels, thickness from 1 to 8-10 mm).

Equipment



This tool is ideal for assembling panels for the prefabrication of vessels longer than 4 meters and carrying out circular welds for diameters greater than 2 meters.

It uses Air Liquide Welding's original plasma + TIG process whereby the first "plasma" torch penetrates the butt-jointed panels. The second "TIG" torch equipped with metal filler, electromagnetic arc oscillation and a gas protection carriage produces a perfect surface finish which can often be left without further treatment. This process of using 2 torches in tandem gives a productivity gain of 30-50 % over a single-torch plasma installation.

Welding equipment

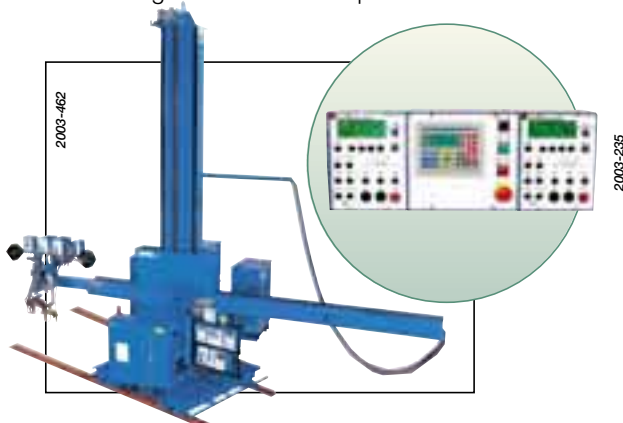
The TIG + plasma installation is made up of two NERTAMATIC 450 installations:

- a plasma installation with SP7 torch and arc voltage regulation,
- a TIG installation with MEC4 torch, arc voltage regulation, wire feed, arc oscillation and gas protection carriage.

Two welding controls are available, the standard or the HPW

Standard

Plasma and TIG get its own control unit which stores all the welding parameters. Then, a PLC unit drives the complete P+T sequence in order to synchronise welding torch starts and stops and to control the speed and length of weld. This digital control memorises and manages the movement parameters.



HPW

Control device for the complete management of the machine starting from only one control panel, allowing:

- Numerical management of the welding process, its associated movements and drive units
- Traceability, a program integrates all the parameters allowing the repetitiveness of the welding
- Quality follow-up in option, record and storage of the essential parameters of welding (current, voltage, wire feeding, movement)
- User friendly and intuitive interface allowing the programming, controls and follow up
- Intuitive built up of cycle machine thanks to a graphic programming
- Touch screen facilitating the HPW use
- Off line programming on PC, data exchange via USB key
- Optimisation of the machine integration
- Control via industrial PC



Add-ons



Suitable for all machine types:

- video surveillance,
- oscillation or magnetic deviation of TIG arc,
- hot wire feed.

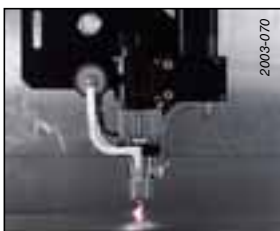
Video system

The TIG/plasma video system can be easily integrated into Air Liquide Welding installations. It uses a greatly enlarged image which enables the precise position of the welding torch to be viewed thus making the operator's work easier and improving the quality of the welding operation.



OSCILLARC 3

Deviation or electromagnetic oscillation of the TIG arc



Arc deviation

This technique is used to electrically deflect the TIG arc which considerably increases the heat affected zone along the weld axis and increases speed

by the order of 30 to 50 % for thicknesses of less than 2 mm. This facility is particularly suited to the continuous welding of thin tubes formed from strip, cable conduit, electrical resistance shielding etc. i.e. all mass-produced parts welded without filler metal.

Arc oscillation

An extension of the arc deviation technique described above, arc oscillation is used to deposit metal over areas up to 20 mm wide to fill bevels or reconstitute surface coating.

Hot wire TIG and plasma

Productivity improvement by increasing the deposition rate

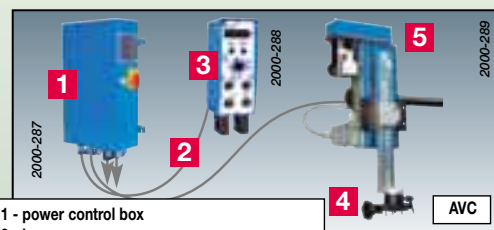
For filling bevels 40 mm deep, the use of hot filler wire provides a good solution and is particularly suited to applications where a high specification of the welded joint is required. This special technique uses an auxiliary current to bring the end of the wire to nearly melting point. Viable for plates of thickness 10 mm and above, the use of hot filler wire enables 2.5 to 3 kg of metal to be deposited per hour for filling bevels using multiple passes



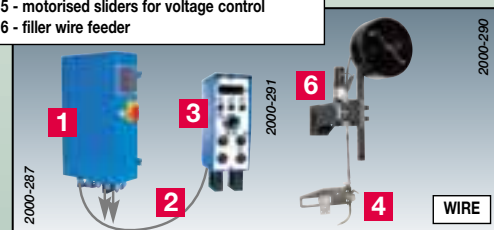
or for quality hard-surfacing.

AVC (Arc Voltage Control) and wire feed autonomous units

These devices can be used to update older automatic TIG and plasma welding installations, but also to create simplified installations for manual welding stations.



- 1 - power control box
- 2 - harness
- 3 - remote control unit box
- 4 - torch location
- 5 - motorised sliders for voltage control
- 6 - filler wire feeder



Microplasma



0608-029

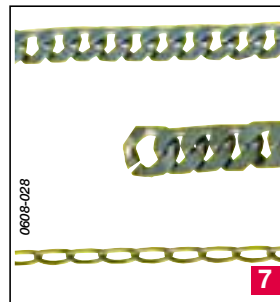
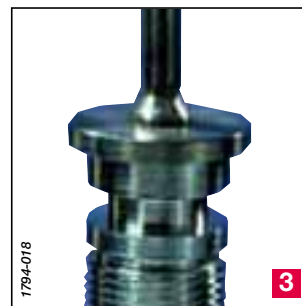
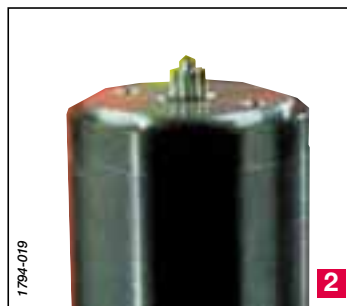
The microplasma process is used for welding fine thicknesses of the noble metals such as stainless steel, inconel, titanium, zirconium, alloys of silver and gold etc. For the electric and electronics components industries, small containers, metal filters and tool repairs as well as sectors of the horology, silversmith and medical industries.

Equipment



Special installation for manual or automatic microplasma or TIG welding

- 100 programs
- Cleartext LCD screen display
- Parameter modification while welding
- Program print-out
- Integrated process control
- Smooth or pulsed continuous welding
 - plasma from 80 mA to 50 A at 100 %
 - TIG from 0.8 A to 50 A at 60 %
- Pulse frequency from 1 Hz to 10 kHz
- Three-phase primary power supply
50/60 Hz - 230/400/440 V



1 - Mould repairs

2 - Motors and transformers

3 - Probes

4 - Measuring instruments

5 - Decompensator bellows

6 - Fine sheet metalwork

7 - Jewellery

8 - Filters

Deconfined plasma

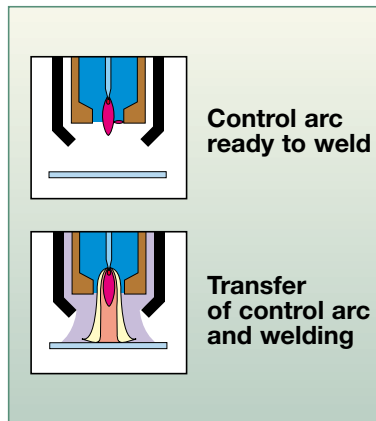


The SP150 torch is specially built for automatic welding using the deconfined plasma process. It is used for intensive production and is suitable for all machine types. The most recent applications are the production of melt-runs, small weld beads or very repetitive welding.

The installation can also use the control arc double-flux TIG process using smooth or pulsed current. Plasma is an evolution of the TIG process which brings many opportunities for increasing your productivity.

Using a permanent control arc

- No more HF priming for each weld bead, only the transfer of a control arc which guarantees repeated priming with less waste and client peripherals protected.
- Reduction of slack time between two welds.



By using an electrode protected by the nozzle,

The lifetime of the electrode is increased with a consistency of weld maintained over 8 hours (sometimes more depending on the material and weld types) resulting in a reduction of machine stoppages for grinding.

Applications of deconfined plasma

In boiler making and sheet metalwork

Fine thicknesses from 0.4 to 2 mm.

In mass production

Household appliances, radiators, automobile engine air liquide welding points, electrical construction (welding electrical sheets for alternators or transformers).



- 1 - Alternator or motor cores,
- 2 - Automobile pipe work,
- 3 - Welding gates onto radiator segments,
- 4 - Deburring beer barrel handles by plasma refusion.

Basic installation:

- SP150 welding torch equipped for plasma or double-flux TIG,
- torch connection block,
- harness of length 10 m specific to plasma,
- one power source for the pilot arc,
- one power source for welding.





Contacts

AIR LIQUIDE WELDING FRANCE
13 rue d'Epluches
BP 70024 Saint Ouen l'Aumône
95315 Cergy Pontoise Cédex - France
Tél. : + 33 1 34 21 33 33
Fax : + 33 1 34 21 31 30
www.saf-airliquide.com

For England only:
AIR LIQUIDE WELDING Ltd
Low March / London Road - Daventry
Northants NN11 4SD
Tel.: +44 1 327 70 55 11
Fax: +44 1 327 70 13 10
www.saf-wp.co.uk

For other countries, contact our export departments

ALW Export Department Italy

Via Torricelli 15/A
37135 Verona - Italy
Tel: +39 045 82 91 511
Fax: +39 045 82 91 536

ALW Export Department France

13, rue d'Epluches - BP 70024 Saint Ouen l'Aumône
95315 Cergy-Pontoise Cedex - France
Tel: +33 1 34 21 33 33
Fax: +33 1 30 37 19 73

www.airliquidewelding.com

