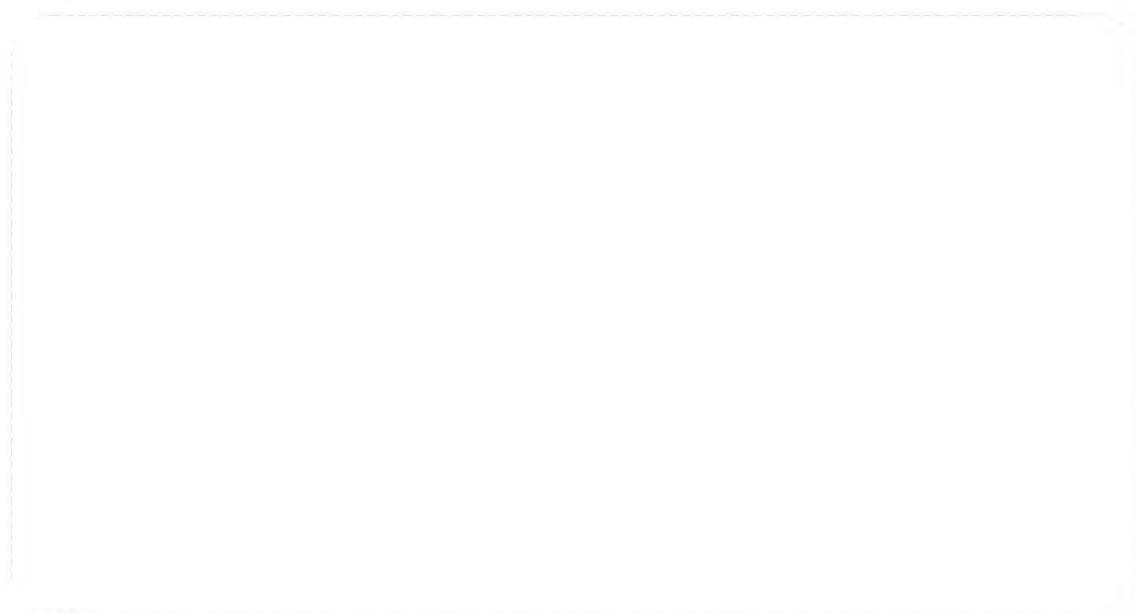


# HUAHENG



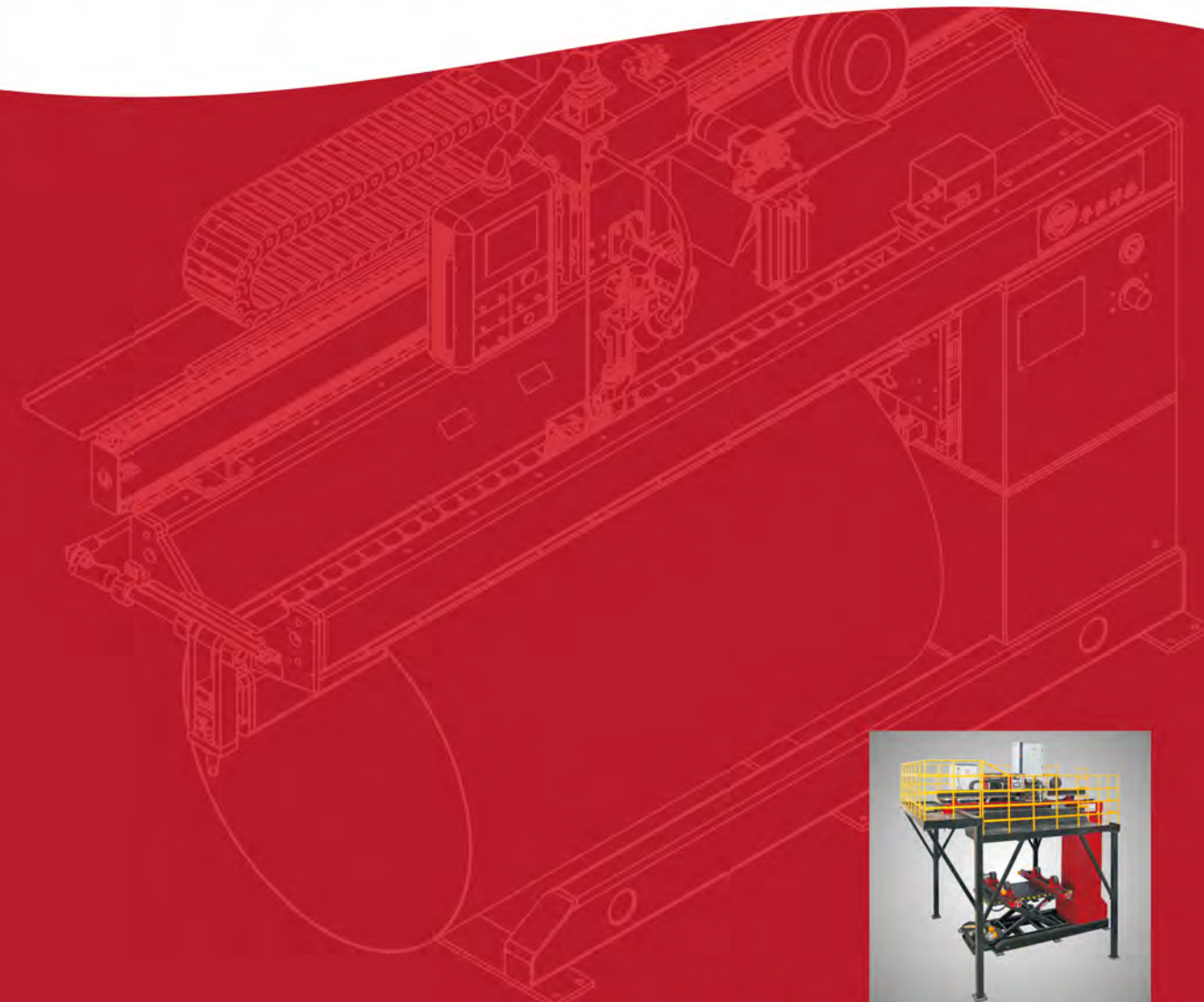
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# HUAHENG



## 自动化 焊接装备 AUTOMATION Welding System



昆山华恒焊接股份有限公司  
HUAHENG WELDING CO., LTD.

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昆山华恒焊接股份有限公司成立于1995年，总部位于江苏省昆山市，是国内最早从事焊接自动化装备研发制造的国家火炬计划重点企业，致力于在弧焊、热切割、工业机器人、自动化与智能化装备领域为客户提供行业领先的一体化解决方案。

公司在昆山、徐州、长沙建有总占地面积逾18万平米的生产制造基地，主要产品包括自动化焊接生产线、智能物流仓储系统和自动化焊接与切割装备与行星减速器等。业务涉及方案规划、研发、设计、成套设备生产、装配、调试集成、销售等各环节，可提供整体解决方案的交钥匙工程服务。

公司产品广泛应用于工程机械、船舶制造、轨道交通、航空航天、海洋工程、军工核电等高端装备制造领域和石油化工、食品医疗等国民经济重要行业，并出口美国、欧洲、印度、巴西和东南亚等国家与地区。

Huaheng Welding Co., Ltd. is one of the earliest enterprises in China engaged in the integration of automatic welding equipment and welding system. It is a leading enterprise in China providing integrated solutions in the field of arc welding technology, industrial robot cutting equipment, automation and intelligent equipment.

The company has established production facilities in Kunshan, Xuzhou, and Changsha, with a total area of over 180,000 square meters. Its main products include automated welding production lines, intelligent logistics and warehousing systems, automated welding and cutting equipment, as well as planetary gear reducers. The business covers various stages such as project planning, research and development, design, complete equipment production, assembly, integrated debugging, and sales, providing turnkey engineering services for overall solutions.

The company's products are widely used in the high-end equipment manufacturing fields of engineering machinery, shipbuilding, rail transportation, aerospace, marine engineering, military, and nuclear power, as well as important industries in the national economy such as petrochemicals, food, and healthcare. They are also exported to countries and regions such as the United States, Europe, India, Brazil, and Southeast Asia.

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- 纵缝  
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- 环缝  
Circumferential
- 综合  
Other solution



# 纵缝系列焊接工装

## Longitudinal Seam Welding System Series

### 概述 Summary

纵缝工装分为固定纵缝和可升降纵缝两种方式，可升降纵缝方便实现筒体和平板拼接功能。

纵缝系列工装主要用于中薄壁筒体的内、外纵缝焊接，可配备PAW、TIG、MIG/MAG的焊接工艺。适用于碳钢、不锈钢、铝及其合金、钛及其合金等材料焊接，用于食品机械、染整设备、电力开关母线筒体、医疗机械、特材化工容器、电力管道、空调机组壳体等产品的焊接，并可根据工件的具体情况对该类纵缝工装加高及增加安全防护装置。焊接过程可靠、高效，整个焊接过程程序化控制。

Longitudinal joint tooling is divided into fixed longitudinal seam and can be vertical and vertical slag in two ways, can be vertical and vertical slit to facilitate the realization of the cylinder and plate splicing function. Longitudinal seam welding system is used weld inside and outside seam for middle wall thickness tank, it could use PAW, TIG, MIG/MAG welding process. The material could be carbon steel, stainless steel, aluminum alloy, titanium and other material. It is widely applied to weld food machinery, dyeing and finishing equipment, tank of power switch busbar, medical instrument, special material pressure vessels for the chemical industry, pipeline for electric power, the shell of air condition and so on. The fixture could be added with height block and protection device. The system is reliable with high efficiency.



### 性能特点

Performance characteristics

- 采用琴键式夹紧方式，焊接时散热效果好，工件变形小，焊接质量高；
- 可适用厚度在0.4-12mm范围内中薄壁筒体或板材纵缝焊接；
- 适合于TIG、MIG/MAG、PAW等焊接工艺方法；
- 可焊接碳钢、不锈钢、钛合金、铝合金等材质；
- 根据工件的结构，可选择标准系列的工装，也可根据要求特殊定制。
- Use cooper made finger clamp for small welding distortion and welding quality
- Suitable for 0.4mm-12mm wall thickness tank and plate welding longitudinal seam
- Suitable for TIG, MIG/MAG, PAW welding process
- Suitable for various materials such as carbon steel, stainless, titanium alloy and aluminum alloy etc.
- Optional choice for standard or customized size, per customer requirement

### 技术参数

Technical Specification

型号 Model	小型纵缝 HL small size outside seam			升降纵缝 HLN inside seam	
	HL1500	HL2000	HL3000	HSJ2000	HSJ3000
筒体单枪最大有效焊接长度 (mm) Maximum welding length for single torch(mm/in)	1500	2000	3000	2000	3000
筒体双枪最大有效焊接长度 (mm) Maximum welding length for double torch(mm/in)		1600	2600	1600	2600
可夹持最大长度 (mm) Maximum clamping length (mm/in)	1590	2100	3075	2100	3075
可夹持最大直径 (外焊mm) Maximum clamping diameter for outside welding length(mm/in)	Φ850	Φ1100	Φ1200	Φ3000	Φ3000
可夹持最小直径 圆芯轴 Minimum clamping diameter Circular mandrel (外焊mm) 方芯轴 for outside welding (mm) Quadrate mandrel	Φ110	Φ180	Φ200	Φ280	Φ330
可夹持最小直径 (内焊mm) Minimum clamping diameter for inside welding(mm/in)		Φ2000	Φ2000		
可夹持最小厚度 (mm) 0.4 Minimum clamping wall thickness(mm/in)	0.4	1.0	1.0	1.0	1.0
可夹持最大厚度 (mm) Maximum clamping wall thickness(mm/in)	3.0	12	12	12	12
压指间宽可调范围 (mm) Adjustable fingers distance(mm/in)	7 ~ 33	5 ~ 40	5 ~ 40	5 ~ 40	5 ~ 40
压板最大压紧力 (单边kgf/cm) Maximum single side pressure(kgf/cm)	15	30	30	30	30
行走小车速度 (mm/min) Welding trolley speed (mm/in)/in/min)	50 ~ 5000	50 ~ 5000	50 ~ 5000	50 ~ 5000	50 ~ 5000
可升降行程 Stretchable travel				3000	3000



# 拼板和内纵缝系列焊接工装

## Puzzle and inner longitudinal seam series of welding tooling

### 概述

#### Summary

拼板和内纵缝系列工装适用于碳钢、不锈钢、钛合金、铝及其合金的平板对接和筒体内纵缝焊接，可配备PAW、TIG、MIG/MAG等焊接工艺。

Paint and the longitudinal seam series Tooling for carbon steel, stainless steel, titanium alloy, green army and its alloy plate and the inner tube longitudinal seam welding, can be equipped with PAW, TIG, MIG / MAG welding process



### 技术参数

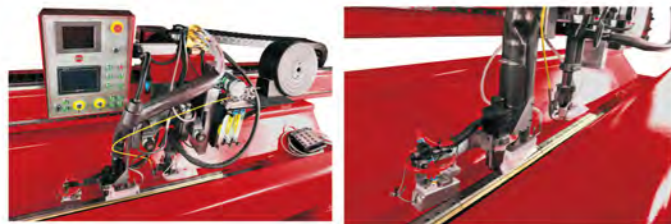
#### Technical Specification

型号 Model	HP3000	HP6000	HP8000	HP10000	HLN4000	HLN6000	HLN7500
单枪可焊接有效最大长度 (mm) Maximum welding length for single torch(mm/in)	3200	6160	8160	10160	4240	6460	8000
双枪可焊接有效最大长度 (mm) Maximum welding length for double torch(mm/in)	2700	5700	7700	9700	3700	6000	7500
可焊板料厚度 (mm) Sheet wall thickness (mm/in)	1.0 - 12	2.0 - 12	2.0 - 12	2.0 - 12	2.0 - 12	2.0 - 12	2.0 - 12
琴键单边最大压紧力 (kgf/cm) Maximum single side pressure(kgf/cm)(in)	30	30	30	30	30	30	30
压指间宽度可调范围 (mm) Adjustable fingers distance (mm/in)	10 - 40	10 - 40	10 - 40	10 - 40	10 - 40	10 - 40	10 - 40
焊接小车行走速度 (mm/min) Welding trolley speed (mm/min)(in/min)	50 - 5000	50 - 5000	50 - 5000	50 - 5000	50 - 5000	50 - 5000	50 - 5000
衬垫垂直调整方式及行程 (mm) Cushion vertical traverse(mm/in)	电动60 Motor driven 60/2.36"	电动60 Motor driven 60/2.36"	电动60 Motor driven 60/2.36"	电动60 Motor driven 60/2.36"	电动60 Motor driven 60/2.36"	电动60 Motor driven 60/2.36"	电动60 Motor driven 60/2.36"
外形尺寸 (长 × 宽 × 高) (mm) Dimension(LxWxH) (mm)	6120x1200x1650	9200x1200x1650	11150x1200x1700	13150x1200x1800	13150x1200x1800	13150x1200x1800	13150x1200x1800
最小内焊直径(mm) Minimum internal welding diameter (mm)					Φ1600	Φ1600	Φ1600

### 性能特点

#### Performance characteristics

- 采用琴键式夹紧方式，焊接时散热效果好，工件变形小，焊接质量高；
- 可适用厚度在1.0-12mm范围内中薄板筒体或板材纵缝焊接；
- 适合于TIG、MIG/MAG、PAW等焊接工艺方法；
- 可焊接碳钢、不锈钢、钛合金、铝合金等材质；
- 根据工件的结构，可选择标准系列的工装，也可根据要求特殊定制。
- Used bronzed finger clamp for small welding distorting and high welding quality
- Suitable for 0.4mm-12mm wall thickness sheet welding
- Used the TIG, MIG, MAG and PAW welding process
- Use various materials such as carbon and stainless steel, titanium and aluminum and aluminum alloys
- Choice of standard or customized



# 环缝系列焊接工装

## Circumferential Seam Welding Series System

### 概述

#### Summary

操作机系列工装是锅炉、压力容器、管道和金属结构件自动焊接的主要工艺装备之一，可与滚轮架、变位机、翻转机等配套构成自动焊接系统，可用于各种压力容器筒体或大直径管道内外纵环缝焊接、球形封头拼缝焊接、筒体及封头内壁的堆焊、封头开孔加强区的堆焊等场合。可配以TIG、MIG/MAG、PAW、SAW等焊接工艺方法。

Our Column and Boom equipment is designed with an automatic welding system that includes the roller, positioner and rotation mechanism. This type of equipment is used in many manufacturing industries such as, pressure vessels, spherical heads, boilers and pipelines and many more types. It also offers multiple welding processes - TIG, PAW, MIG/MAG and SAW.

### 性能特点

#### Performance characteristics

- 模块化设计，可根据客户要求快速方便地组合成所需的焊接系统；
  - 适合于各类型工件的纵缝、环缝等结构形式；
  - 根据工件的结构要求，可选择TIG、MIG/MAG、PAW和SAW等工艺方法；
  - 可适用于碳钢、不锈钢、钛合金、铝合金等材料的焊接；
  - 可根据用户工件结构要求进行定制。
- Modular design, easy to customize the circumferential seam welding according to customer requirements
  - Suitable for circumferential seam edge joint welding and angular joint welding structure etc
  - Suitable for TIG, MIG/MAG, PAW, and SAW welding process
  - Suitable for various materials, such as carbon steel, stainless steel, titanium alloy and aluminum alloy etc
  - According to work piece size, optional to choose standard or customized mechanism



### 概述

#### Summary

环缝系列工装适用于直径小于 $\Phi 1000$  mm以下圆形工件的环缝焊接，主要由精密回转头架，可移动尾座、工件托架、焊接小车和导电机构等组成，根据需要可以选择单枪或双枪焊接，其它可选配工件加热、整体防护和焊烟除尘设备。

Girth series of tooling used in less than  $\Phi$  below 1000 mm diameter circular workpiece girth welding, mainly by the precision turret, mobile tailstock, workpiece bracket, welding carriage and conductive mechanism and so on, according to the need can choose single or double gun, welding gun and other optional heating workpiece, overall protection and welding smoke dust removal equipment.

### 性能特点

#### Performance characteristics

- 模块化设计，可根据客户要求快速方便地组合成所需的焊接系统；
  - 适用于筒体及油缸等工件的环缝焊接；
  - 根据焊接工艺要求，可选择TIG、MIG/MAG、PAW等焊接方法，并可根据要求配备单枪/双枪焊接方式；
  - 可适用于碳钢、不锈钢、铝合金等材料的焊接；
  - 可根据产品特点配备气动上料、液压顶紧等装夹工装。
- Option to customize system per customer requirements/needs
  - Suitable for barrel and hydro-cylinder circumferential seam welding
  - Option to choose TIG, MIG/MAG welding process and single or double torches
  - Suitable for various materials, such as carbon steel, stainless steel, titanium alloy and aluminum alloy etc
  - Suitable for pneumatic load material, hydraulic pushing fixture



### 技术参数

#### Technical Specification

项目	基本参数
Item	Parameters
可焊工件直径 (mm)	$\leq \Phi 1000$
Welding diameter (mm/min)	$\leq \Phi 1000$
可焊工件的最大长度 (mm)	3000
Maximum welding length (mm/in)	3000
主轴回转速度 (rpm)	0.05 - 1.0/0.1-2
Rotation speed (rpm)	0.05 - 1.0/0.1-2
主轴电机	变频电机/伺服电机可选
Rotation motor	Frequency conversion motor
调速方式	无级调速
Speed regulation	Step less speed regulating
液压尾座液压缸行程 (mm)	500
Distance of hydraulic pump movement (mm/in)	500
托架方式	气动
Support type	Pneumatic
垂直电动滑架行程 (mm)	450
Distance of slider vertical movement	450
主轴离合方式	手动
Clutch type	Manual
电动弧长横摆滑架行程 (mm)	60
Distance of oscillation slider movement (mm/in)	60



### 技术参数

#### Technical Specification

型号	H CJ2000	H CJ3000	H CJ4000	H CJ5000
Model	H CJ2000	H CJ3000	H CJ4000	H CJ5000
横梁垂直行程 (mm)	2000	3000	4000	5000
Beam vertical traverse (mm/in)	2000	3000	4000	5000
横梁水平行程 (mm)	2000	3000	4000	5000
Beam horizontal traverse (mm/in)	2000	3000	4000	5000
横梁垂直移动速 (mm/min)	850	850	1150	1150
Beam vertical speed (mm/min)(in/min)	850	850	1150	1150
横梁水平移动速 (mm/min)	110~1100	110~1100	120~1200	120~1200
Beam horizontal speed (mm/min)(in/min)	110~1100	110~1100	120~1200	120~1200
立柱回转角度 (°)	电动	电动	电动	电动
Column rotation	Motor-driven	Motor-driven	Motor-driven	Motor-driven
	+/-180	+/-180	+/-180	+/-180
	手动	手动	手动	手动
	Manual	Manual	Manual	Manual
	+/-180	+/-180	+/-180	+/-180
外形尺寸 (长×宽×高) (mm)	2000×3400×4200	2000×4400×5100	2300×5500×6500	2300×6500×7500
Dimension (LxWxH) (mm)	2000×3400×4200	2000×4400×5100	2300×5500×6500	2300×6500×7500
(电动) 台车行走速度 (mm/min)	4000	4000	2100	2100
Welding trolley speed (mm/min)(in/min)	4000	4000	2100	2100

# 滚轮架系列焊接工装

## Roller Welding Series

### 概述

### Summary

滚轮架系列产品广泛用于金属圆形结构环焊缝的自动焊接，是各类压力容器自动焊接必不可少的专用装备之一。该产品具有质量可靠，性能先进，操作简单等优点。

滚轮架根据用途可分为可调式和自调式及液压组对滚轮架。

This Roller Welding System offers a wide range of automatic circumferential seam welding. It is widely used and almost necessary when manufacturing pressure vessels. The roller has many advantages including high quality performance and simple operation.

Rollers can be divided into adjustable and self-commissioning and hydraulic groups for rollers.



# 变位机系列焊接工装

## Positioner Welding Series



### 概述

### Summary

变位机系列工装可用于各种自动焊或手工焊，实现管管对接、管端面焊接及各种轴类、盘类、筒体等多种焊接形式，具有结构紧凑，造型美观，质量轻，操作方便等优点，为压力容器、冶金、电力、化工机械、金属结构等行业理想的焊接辅助设备。根据用途可分为：倾翻式变位机及可升降“L”型变位机等。

The Positioner can be used with either an automatic and or a manual welding process. The Positioner assists with butt joint and end face joint welds. It can also perform welds on shafts, plates, barrels and many other types of metal pieces. The Positioner is considered auxiliary welding equipment that works well for pressure vessels, metal structure, chemical/electric power industries and many more. It can be divided into two types: tilting and elevating "L", etc.

### 技术参数

#### Technical Specification

HGJ-C可调式滚轮架 HGJ-C Adjustable roller	最大承载 (kg) Maximum load (kg)	适应工件直径范围 (mm) work piece diameter (mm)	滚轮线速度 (mm/min) Roller speed (mm/min) (in/min)	速度调节方式 Speed adjustment type
HGJ-2C 径向可调 Radial adjusting 插销式 Bolt adjusting	2000	Φ300-Φ2500	100-1000	变频调速 Variable frequency
HGJ-5C 丝杆式 Screw mandrel adjusting	5000	Φ250-Φ2300	100-1000	变频调速 Variable frequency
HGJ-10C 丝杆式 Screw mandrel adjusting	10000	Φ300-Φ2800	100-1000	变频调速 Variable frequency
HGJ-20C 丝杆式 Screw mandrel adjusting	20000	Φ500-Φ3500	100-1000	变频调速 Variable frequency
HGJ-40C 丝杆式 Screw mandrel adjusting	40000	Φ600-Φ4200	100-1000	变频调速 Variable frequency
HGJ-10S 滚轮倾角90° Wheel dip angle 90° 滚轮倾角120° Wheel dip angle 120°	10000	Φ320-Φ2800 Φ320-Φ3600	100-1000	变频调速 Variable frequency
HGJ-20S 滚轮倾角90° Wheel dip angle 90° 滚轮倾角120° Wheel dip angle 120°	20000	Φ500-Φ3500 Φ500-Φ4300	100-1000	变频调速 Variable frequency
HGJ-40S 滚轮倾角90° Wheel dip angle 90° 滚轮倾角120° Wheel dip angle 120°	40000	Φ600-Φ4200 Φ600-Φ5000	100-1000	变频调速 Variable frequency
HGJ-60S 滚轮倾角90° Wheel dip angle 90°	60000	Φ750-Φ4800	100-1000	变频调速 Variable frequency

液压组对滚轮架可根据客户具体情况定制

### 技术参数

#### Technical Specification

技术参数 Model	HB250	HB500	HB1000	HB2000	HB3000	HB20000
最大承载重量 (kg) Maximum load (kg/lbs)	250	500	1000	2000	3000	20000
翻转速度 (rpm) Overturn speed (rpm)	0.75	0.6	1	0.2	0.2	0.2
翻转角度范围 (°) Range of overturn angle (°)	手动0-120 Manual 0-120	电动0-135 Moto-driven 0-120	电动0-120 Moto-driven 0-120	电动0-120 Moto-driven 0-120	电动0-120 Moto-driven 0-120	电动0-90 Moto-driven 0-120
回转速度 (rpm) Rotation speed (rpm)	0.3-5.0	0.13-1.3	0.12-1.2	0.05-0.5	0.05-0.5	0.05-0.5
回转工作台直径 (mm) Table diameter (mm/min)	Φ 500	Φ 800	Φ 900	Φ 1100	Φ 1200	Φ 3000
最大偏心距 (mm) Maximum eccentricity (mm/min)	50	150	150	150	200	200
最大重心距 (mm) Maximum centre of gravity (mm/min)	150	200	350	300	300	500
大于5吨根据客户工件情况定制 More than 5 tons are customized according to the customer artifacts						

# 边梁系列焊接工装

## Gantry Frame Beam Welding Series System

### 概述

#### Summary

Brief Introduction

边梁系列工装主要用于完成筒体工件环缝或工件直缝焊接，具有占地面积小，工件吊装方便等特点，一般必须与转台，工件支撑架，工装或滚轮架配合使用，对于工件壁厚小于2MM的悬空方式的工件不建议采用该设备。常用的焊接工艺方法为 MIG/MAG或PAW, TIG, SAW。适用于不锈钢焊管，容器罐体等的纵环缝焊接。

This Gantry Frame Beam System is used for welding circumferential and longitudinal seams. It is designed to make loading your material/work piece less labor intensive and takes up only a small amount of floor space. It works in conjunction with the rotation table, support fixtures and rollers. It uses either the TIG, MIG/MAG or PAW welding process. It is suitable for welding stainless steel pipe vessels and much more.

### 性能特点

#### Performance characteristics

- 主要用于大口径管子、筒体等工件的直缝焊接；
- 可结合滚轮架、头架等工装实现工件的环缝焊接；
- 适用于碳钢、不锈钢等材料的焊接；
- 根据焊接工艺要求，可选择TIG、MIG/MAG、PAW等焊接方法；
- 具有占地面积小，工件吊装方便等特点。
- Can weld longitudinal seams on large diameter pipe, vessels
- Welds circumferential seams with rollers and head stock
- Suitable for carbon and stainless steel
- Suitable for TIG, MIG/MAG, PAW welding
- Consumes small floor area and easy to load on work piece/material



### 技术参数

#### Technical Specification

型号 Item	HLM5000	HLM6500
筒体最大有效焊接长度 (mm) Maximum welding length (mm/in)	5000	6500
立柱升降速度 (mm/min) Column speed of up and down (mm/min)(in/min)	560	560
行走小车速度 (mm/min) Trolley speed (mm/min)(in/min)	50 ~ 2000	50 ~ 2000
外形尺寸 (长×宽×高) (mm) Dimension (LxWxH) (mm)	5800 × 1800 × 2500	7600 × 1800 × 2500
重量 Weight	1.6	1.9





### 焊接工艺方法及特点 Welding process and features

根据产品材质、壁厚等工艺特点，非常适合应用等离子“小孔效应”实现单面焊双面成型，针对工件结构特点和规格要求，采用P+T复合焊接工艺，可明显提高生产效率和正反面焊缝成型。

- 采用P+T复合焊，PAW打底，TIG盖面，可以更加有效利用PAW焊的穿透能力和TIG焊的自由电弧有良好的覆盖能力，再搭配上适量的填充金属，达到正面成型美观的效果，是单枪焊接效率的1.3-1.5倍；
- 采用稳定的工控控制平台，以确保焊接系统长时间稳定运行；
- 搭积木模块化设计，减少系统设计和生产周期，利于规模化生产或维护；

- 华恒有十几年等离子应用经验，有专业的培训教材，和完善的工艺指导和服务能力。

Use the plasma keyhole penetration to ensure the stable and high quality backside shaping; in order to get faster welding speed, we combine TIG welding for covering to follow the plasma welding to ensure surface stable and high quality sgaping.

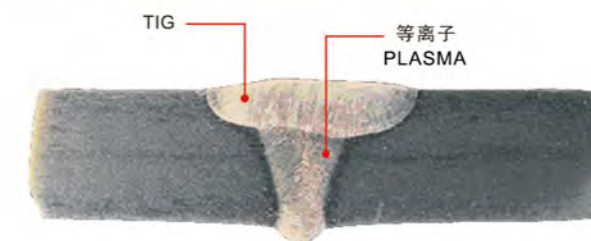
- Use P+T welding process, plasma welding in root pass, then TIG welding in cap pass, two torches welding to ensure higher speed welding faster 1.3-1.5 times than single torch
- Use stable industrial controller, ensure the system running long time
- Module design, reduce the time of designing and producing that good for scale producing and maintaining.
- Otto Arc has more than 10 year experience in using plasma, we have professional teaching material, complete welding process guidance and service ability.

## 罐式集装箱P+T复合自动焊接系统 Tank Container P+T Automatic welding System

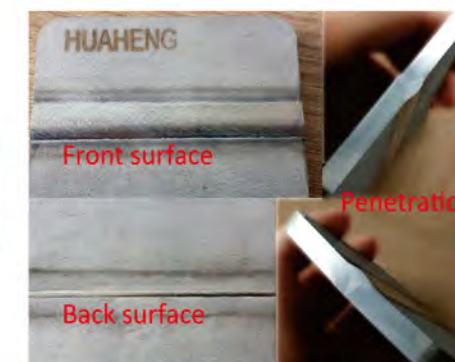
### 罐式集装箱特点

Tank container features

- 用来储运各种气体、液体和干粉料  
Used to store and transport various gas, liquid and powder
- 工件材料：304、316不锈钢  
Material: stainless steel SUS316, SUS304
- 材料厚度：3mm-8mm  
Thickness
- 罐体长度：5000-7000mm  
Tank length
- 罐体筒径：Φ1500-Φ2300mm  
Tank diameter
- 焊接要求：单面焊双面成型，焊缝正、背面成型均匀、美观；通过X光探伤II级以上合格  
Welding requirement: one side welding double side shaping; good penetration and welding quality pass by x-ray



焊缝剖面示意图  
Seam section profile







## 不锈钢罐体自动焊接系统

Stainless Steel Cylinder Welding system

### 产品特点

用于不锈钢壁厚1-8mm，直径Φ300-Φ3000mm，可达到X射线II级以上焊接要求，外观成型美观，焊接变形小，根据结构形式，可采用纵环缝分开或一体式焊接，位置可平焊或横焊。

可采用方法：

1. 传统TIG焊；
2. 单枪PAW焊；
3. PAW+TIG双枪复合焊。

### Features

Normally the wall thickness of cylinder is 1-8mm(0.039"-0.3"), the diameter is Φ300-Φ3000mm(11.8"-118"), it should pass x-ray testing offer welding with good penetration, small welding deformation, it could use flat position welding and horizontal position welding.

Welding process:

1. Traditional TIG welding
2. Single plasma welding
3. Plasma with TIG welding





## 大口径有缝管 自动焊接系统

### Big Diameter Stainless Steel Seamed Pipe Welding System

#### 焊管特点

Stainless steel pipe welding feature

主要采用连续成型机组和UOE方法生产，对于管径在 $\Phi 219\text{mm}$ 以下薄壁管通常采用连续成型方法，对于 $\Phi 219\text{mm}$ 以上管径通常采用UOE方法生产。

连续成型机组通常采用单枪，多枪或P+T复合焊接的工艺方法。UOE方法适用于生产大口径，厚壁不锈钢管，长度在6米或12米。一般采用PAW，PAW+TIG复合，PAW、TIG、SAW相结合的方法，适用于不同壁厚情况下的钢管焊接。

对于内壁要求更高的管道，可通过内壁重熔的焊接工艺获得。

#### UOE焊管情况：

焊管管径： $\Phi 219-\Phi 1200\text{MM}$

焊管长度：一般小于12米（特制除外）

焊管厚度：4-14mm

材料：SUS304、SUS316、SUS316L、SUS321、钛合金等

Stainless steel pipe manufacturing uses a continuous plate and UOE method. For thin wall pipe the with diameter of 219mm(8.6") and below continuous compaction is applied, for pipe above 219mm(8.6") and above the process of UOE is applied. Continuous compaction plant use the single or multi-torch, P+T welding technique, while UOE is used on thick wall pipe approximately 6m or 12m long using plasma welding, P+T welding, plasma, TIG and SAW. For internal shaping of pipe, re-melt is required.

UOE pipe welding:

Diameter:  $\Phi 219-\Phi 1220\text{mm}(8.6"-48")$

Length:  $\leq 6\text{m}$ , excluding customization(20")

Thickness: 4-14mm(0.15"-5")

Material: SUS321, SUS304, SUS316, SUS316L, titanium alloy etc



#### 焊接方法及特点

Welding process

由于壁厚在4mm以上，采用等离子焊接工艺，具有能量集中，穿透能力强（3-8mm可不开坡口，一次焊透）的优点，实现单面焊双面成型。对于8mm以上壁厚管子可以采用板材开坡留钝边的方式，应用等离子打底，等离子盖面/TIG盖面/埋弧焊盖面（根据板厚和焊接工艺进行选择）；还可以采用等离子加TIG同时焊接的工艺，目前应用较多的是前面单枪等离子焊接工艺。

The plasma welding process is used on pipe with a wall thickness of 4mm(0.15") and above, the plasma keyhole creates good penetration which can shape and weld each side of the pipe. For example, a all thickness of 3-8mm(0.11"-0.3") that is not beveled only needs one welding pass. For pipe with a wall thickness of 8mm(0.3") and above, beveling and a land is required for a plasma root pass weld.



## 精密TIG 自动焊接系统

High Precision Tig Automatic Welding System

### 性能特点

#### Performance characteristics

薄壁不锈钢、钛合金、镍基合金等，采用精密TIG自动焊接方式，可实现稳定的焊接成型并有效控制焊接变形。

#### 产品规格：

工件长度：≤1500mm

工件厚度：0.4-3mm

工件材质：一般为奥氏体不锈钢，也有其他材料如钛合金、镍基合金等

The system is suitable for high precision TIG welding for thin thickness stainless steel, titanium alloy, nickel base alloy etc, it is stable and limits welding deformation

#### Product specification:

Length: ≤1500mm(59")

Thickness: 0.4-3mm(0.015-0.12")

Material: austenitic stainless steel and other material such as titanium alloy, nickel base alloy.



### 焊接方法及特点

Welding process feature

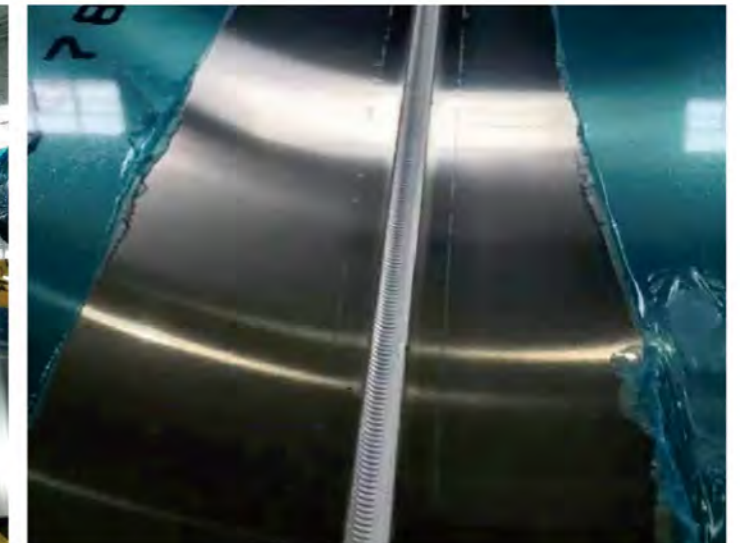
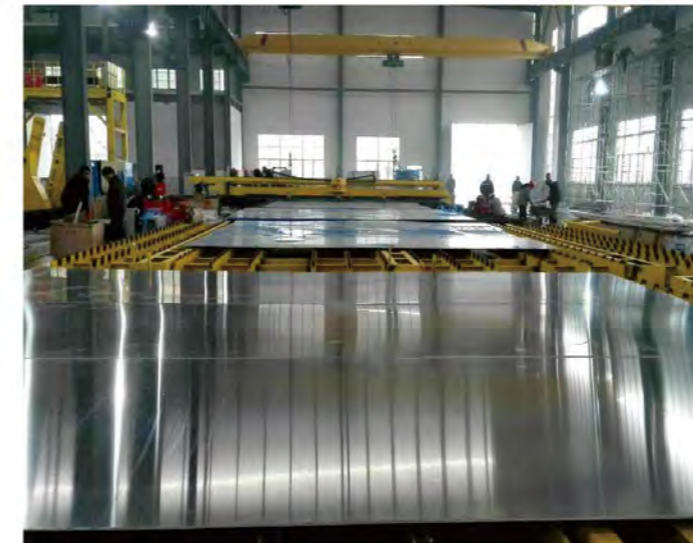
#### 焊接方法：

根据工件小于等于3mm，采用TIG焊接是合理的、科学的，一方面可以实现单面焊双面成型，另一方面可以得到合适、美观的正面成型（焊缝余高小）。由于工件厚度较薄（0.4-3mm），焊接时防止产生波浪变形显得尤为重要，所以采用散热条件好的自动焊工装对该产品的焊接是必要的。根据工件壁厚和具体工件要求，选择填丝或自熔方式。一般情况下采用自熔方式焊接，对于2.5mm以下板材可以实现单面焊双面成型，3mm以上可填丝。

#### Welding procedure:

For wall thickness 3mm(0.118")and below, to use single TIG welding to get one side welding double side shaping is reasonable, on the other hand it is able to get perfect front-side shaping and less welding remaining, in order to minimize the welding distortion during the welding, automatic welding mechanism is necessary and used for better heat elimination. According to work piece wall thickness and particular requirement, it could choose wire feeding or fusion. Fusion is applied wall thickness 2.5mm(0.1")below to get on side welding double side shaping. Wire feeding is applied for wall thickness 3mm(0.118")above.





## 大型拼板 自动焊接系统

### Large-scale Plate To Plate Automatic Welding System

#### 性能特点

Performance characteristics

为了满足环保需求，厢式车、罐式车等等都得到飞跃发展。例如工程基础建设类的自卸车、水泥搅拌机、洒水车、油罐车、化学品车等。

罐式车情况：

工件材质：低碳钢、奥氏体不锈钢、铝合金等

工件长度：小于等于9500mm

工件壁厚：4、5、6、8mm等

焊缝形式：纵缝拼板

The "specially" vehicle industry has been growing quickly within the last year, especially for vans and tank vehicles that are used for environmental purposes. This Large Scale Plate to Plate Welding System can assist with the above vehicles.

Tank car description:

Material: low carbon steel, austenitic steel, aluminum alloy etc.

Length:  $\Phi$  9500mm(374")

Thickness: 4, 5, 6, 8mm etc. (0.15", 0.20", 0.25", 0.31")

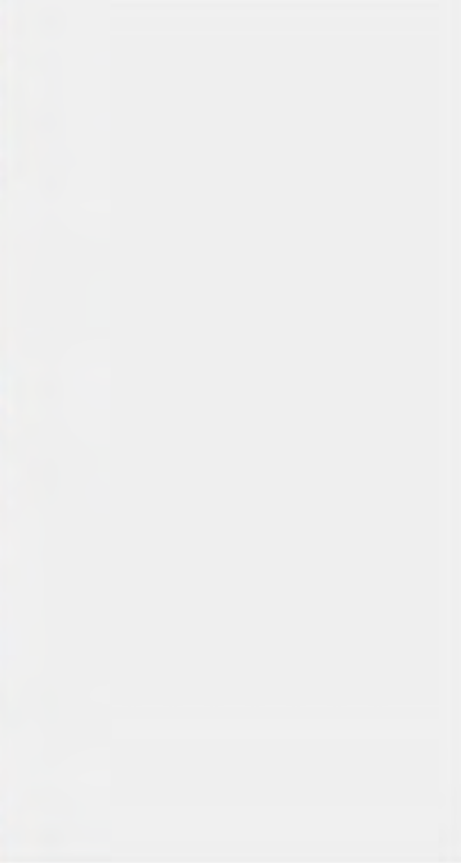
Connection: sheet to sheet longitudinal seam welding

#### 焊接方法与工艺

Welding process

由于该结构材料绝大多数是低碳钢，板厚 $\leq 8\text{mm}$ ，以前的传统工艺是手工电弧焊，为了改变传统的焊接工艺的不足，采用先进的脉冲MAG焊接工艺，不仅提高了焊缝质量，减小了焊接变形，而且大大提高了焊接速度和熔敷效率。采用MAG自动焊比手工电弧焊大约提高效率3-4倍。

The most common way to weld low carbon steel with a wall thickness of 8mm(0.3") and below is to use the stick welding method, but a more advanced welding process is using pulse MAG, which increases the seam quality and minimizes any possible welding distortion. The process also increases the welding speed and welding deposition. Automatic MAG welding is 3-4 times efficient than manual welds.



## 自动堆焊系统

### Automatic Cladding Welding System

堆焊作为改变材料表面性能的一种经济而快速的工艺方法，越来越广泛地应用于各个工业部门零件的制造、修复中。为了最有效地发挥堆焊层的作用，希望采用的堆焊方法有较小的母材稀释、较高的熔敷速度和优良的堆焊层性能，即优质、高效、低稀释率的堆焊技术。

堆焊工艺根据产品特点采用不同的堆焊工艺，自动堆焊常用方法有：

- TIG堆焊
- MIG堆焊
- 等离子送丝堆焊
- 等离子喷粉堆焊
- 埋弧丝/带极堆焊
- TIG cladding welding
- MIG cladding welding
- Plasma spraying cladding welding
- SAW/strip cladding welding

Surfacing is an economical and rapid process for changing the surface properties of materials and is increasingly used in the manufacture and repair of parts in various industrial sectors. In order to maximize the role of the surfacing layer, the desired surfacing method has a smaller base metal dilution, higher welding speed and excellent surfacing performance, ie high quality, high efficiency, low dilution of the surfacing technology.





## 焊接方法及工艺 Welding method and technology

根据工件结构特点,该气瓶焊接从保证焊接质量的角度出发,可采用TIG、MAG或PAW焊接方法;但从生产效率的角度出发,选用MAG焊接工艺更加经济。MAG焊不仅焊接效率高,而且相对来说工件的组对要求可以适当低一些。

外胆工艺(纵缝、环缝): TIG、MIG、PAW

内胆工艺(纵缝、环缝): PAW、MAG

焊接采用单道焊接方式,为了更好的焊缝外观颜色,需要在焊枪后部增加拖罩,对焊后的焊缝进行保护,拖罩气体可以采用氩气或氮气。

According to the structure characteristics of the workpiece, the gas cylinder welding can adopt TIG, mag or paw welding method from the angle of ensuring welding quality. But from the angle of production efficiency, the mag welding technology is more economical. Mag welding not only the high welding efficiency, but also the group of the workpiece to the requirements can be appropriately low.

External biliary process (longitudinal, circumferential seam): TIG, MIG, paw

Tank process (longitudinal, circumferential seam): PAW, MAG

Single channel welding is used in welding. in order to obtain better weld appearance color, the trailing cover is required to be added at the rear of the welding torch, and the welding seam is protected. the drag gas can be used in argon or nitrogen.



## 低温绝热气瓶自动焊接和物流系统 Cryogenic insulated gas cylinder automatic welding and logistics system

### 低温气瓶规格情况:

材料: SS304  
直径范围:  $300 \leq \Phi \leq 950\text{mm}$   
筒体长度:  $< 2500\text{mm}$   
工作壁厚:  $2.5\text{mm} \leq \delta \leq 6\text{mm}$   
焊缝要求: 内胆X射线探伤II级合格

### Specification for cryogenic gas cylinders

Material  
Diameter range  
Length of barrel of cylinder  
Working wall thickness  
Tank x ray flaw detection grade II qualified  
Weld requirement



\* 可根据产能要求,提供生产线规划、布局设计

According to the capacity requirements, provide production line planning, layout design



## 工程机械 专机焊接系统

### Construction Machinery Automatic Welding System

#### ● 水泥搅拌车焊接系统

Concrete mixer production line welding system

工程机械水泥搅拌车罐体由于板材比较薄，常采用MAG焊接，以减小焊接变形。生产线常由三套设备组成：

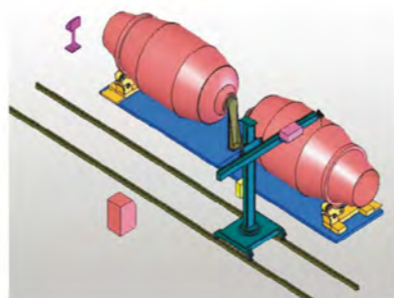
1. 拼板焊接系统
2. 筒体纵缝焊接系统
3. 环缝焊接系统

水泥搅拌车环缝焊接工作量非常大，罐体焊接过程中需要穿插组装等辅助准备工序，因而，系统焊接的时间常常被占用，双工位的设计，大大减少了工位上占用的焊接辅助时间。

The most common way to weld tanks for a concrete mixer is usually through MAG welding which helps to minimize any distortion. These types of production lines are composed of three systems:

1. Sheet to sheet longitudinal seam welding system
2. Barrel longitudinal welding system
3. Circumferential seam welding system

Due to hoe time consuming concrete mixer seams can be it is recommended that two stations are involved in the process to save time and increase productivity.



#### ● 起重机自动焊接系统

Crane components welding system

起重机大臂焊缝为双面对接焊缝，采用高效的链式翻身及定位夹持系统，再结合双丝MAG焊接工艺，生产效率高，双工位设计，效果更是突出。

起重机底盘后段焊接工作量大，传统焊接方法是用焊接小车焊接，焊完后人工吊装翻身再焊接，本系统双枪焊接、翻身一体化。可引伸应用到相关产品的焊接上。

Most crane booms are welded with buff joints. The traditional welding procedure is performing aMAG root pass, but by using our system and doing a double MAG weld, you will achieve a higher quality and sfficient root pass allowing for simultaneous welding.

Welding the back-end for the crane chassis is considered a very large workload. Traditional welding for this type of project is used with a welding cart and is turned manually after each layer. Our system allows dual torch welds with automatic turning which increases productivity and is less labor intensive.



# 制冷行业自动焊接系统

## Automatic Welding System Of Refrigeration Industry

### 性能特点

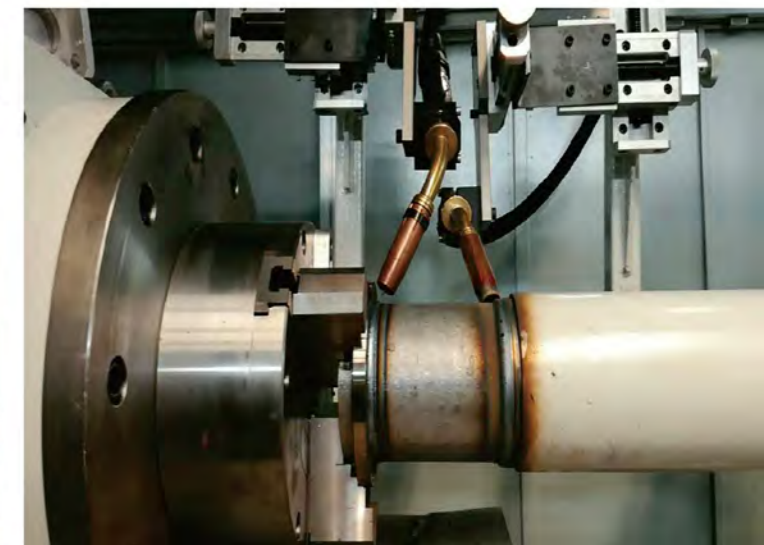
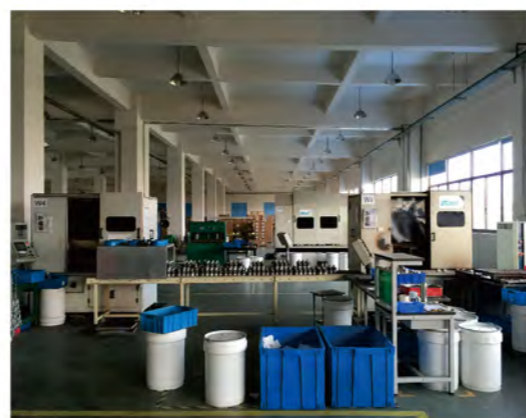
Performance characteristics

主要应用于空调压缩机、过滤器、过滤桶、壳管式换热器、以及溴化锂机组等装配式生产线。

根据结构形式采用：PAW、MAG、SAW等工艺。

It is mainly used in air-conditioner compressor, filter, filter bucket, shell and tube heat exchanger, and the assembly line of lithium bromide.

Adopt technology according to the structure: PAW, MAG, SAW etc.







## 焊接方法及装备

Welding methods and equipment

### 焊接方法:

由于铝合金导热快，所以采用能量集中的脉冲MIG焊接工艺方法，一方面改善工作条件、改善焊缝成型；另一方面大大提高工作效率。有时为了进一步改善焊缝表面成型，采用交流TIG进行修饰盖面。

### 焊接工艺特点:

纵缝在纵缝专机上完成，也可以在焊接中心上完成，焊接中心由焊接操作架、可倾翻滚轮架及变位机组成，既可以完成纵缝焊接，也可以完成环缝、角焊缝的焊接。



### Welding method

With aluminum alloy material the heat conduction is rapid, so its recommended to use a centralized pulseMAG welding process. The pulse MAG process creates a strong seam and works very efficient. To improve the seam by shaping it use the AC/TIG weld process.

### Welding process

Note the longitudinal seam is not only finished on the longitudinal seam system, but also applied using the automatic welding system, which consist of a column and inclined roller and positioner. It is used for longitudinal, circumferential seam welding and corner welding.

# 高压开关GIS铝合金壳体自动焊接系统

## High Pressure GIS Aluminum Alloy Shell Automatic Welding System

### 高压开关GIS铝合金壳体特点

#### Characteristics of High Pressure GIS Aluminum Alloy Shell

随着高压开关行业的持续长久发展，六氟化硫封闭式组合电器，国际上称为“气体绝缘开关设备（Gas Insulated Switchgear）”，简称GIS，在输变电工程上发挥着极其巨大的作用。断路器、母线及其设备外壳通常采用铝镁合金作为母材。铝合金壳体为GIS的成套主力产品之一。

#### 工作特点:

工件材质: 5052、5083等铝镁合金

工件壁厚: 6-16mm

工件直径:  $\Phi 400-\Phi 1200\text{mm}$

结构形式: 壳体纵缝、环缝对接、壳体法兰内、外角焊缝

焊缝要求: PT (渗透检测)、无裂纹、PT X射线探伤达II级以上

The development of the high voltage switchgear industry known as Gas Insulated Switch Gear GIS plays a significant role in transportation. This power busbar system provides support for breakers, busbars and aluminum magnesium alloy based shell. The shell is one of the main components of the GIS production.

#### Job characteristics

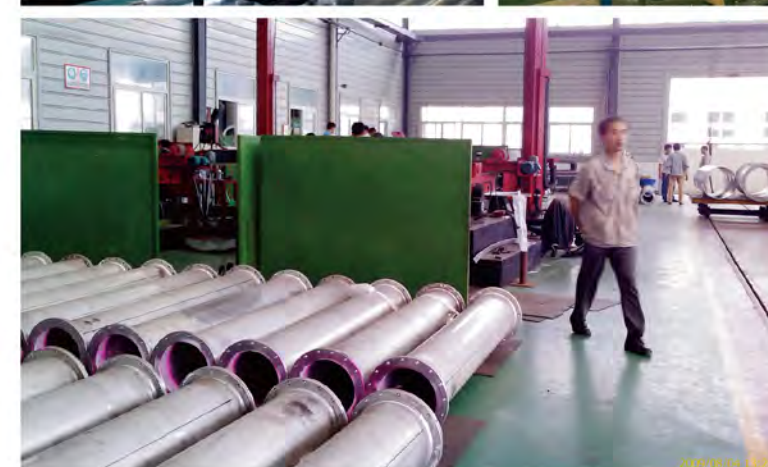
Workpiece material 5052, 5083 Al-Mg alloy and aluminum alloy

Workpiece wall thickness

Workpiece diameter

Structure type cylinder longitudinal seam, buff joint circumferential seam, pipe-flange inside, outside corner welding.

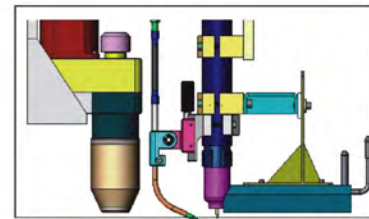
Welding seam requirement Penetration testing No crack PT X-ray detection of more than II level



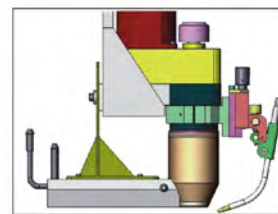


## 特材容器及复合板自动焊接系统

### Special Material And Composite Board Plasma Welding System



双枪P+T复合  
P+T



单枪等离子  
Single Plasma

## 工艺特点

### Welding procedure features

对于8mm以下不锈钢、10mm以下钛合金不开坡口单面焊双面成型壁厚超过以上范围，留5-6mm钝边75°“V”型坡口，等离子“小孔效应”打底，等离子弱弧或TIG填充、盖面焊接效率高、节省材料、焊缝质量高、热输入量小，对于特材易于保护、焊接变形小。

工件组对要求：错边及间隙都要小于壁厚的10%，且不大于0.8mm。

Thickness less 8mm stainless steel and 10mm titanium alloy without beveling; more than above thickness, using plasma root pass with V bevel 75° and 5-6mm tank, with plasma or TIG in filling and cap pass. It is a welding process with high quality, saving material, small heat input for protecting material.

Fit-up requirement: misalignment less than 10% wall thickness and less than 0.8mm.



## 压力容器介绍

### Pressure vessel introduction

#### 工件特点：

材料：镍基合金、钛合金、锆合金等

壁厚：3-12mm

筒径：Φ1000mm-Φ2500mm

工件长度：1500mm-6500mm

结构形式：多道筒体纵缝和环缝

焊接方法：等离子单枪焊或PAW+TIG双枪复合焊接

焊接要求：单面焊双面成型，X射线检查II级合格、

外表成型美观、焊缝保护达到颜色要求、焊缝重现性好

行业应用：通常被用于化工容器、食品机械、生物医疗机械、染整机械和运输储罐

#### Work piece features:

Material: stainless steel, nickel base alloy, titanium alloy, Zirconium alloy etc.

Thickness: 3-12mm (0.12"-0.5")

Diameter: Φ1000mm-Φ2500mm (39.3"-98.5")

Length: 1500mm-6500mm (59"-256")

Structural style: multi-circumferential seam and longitudinal seam

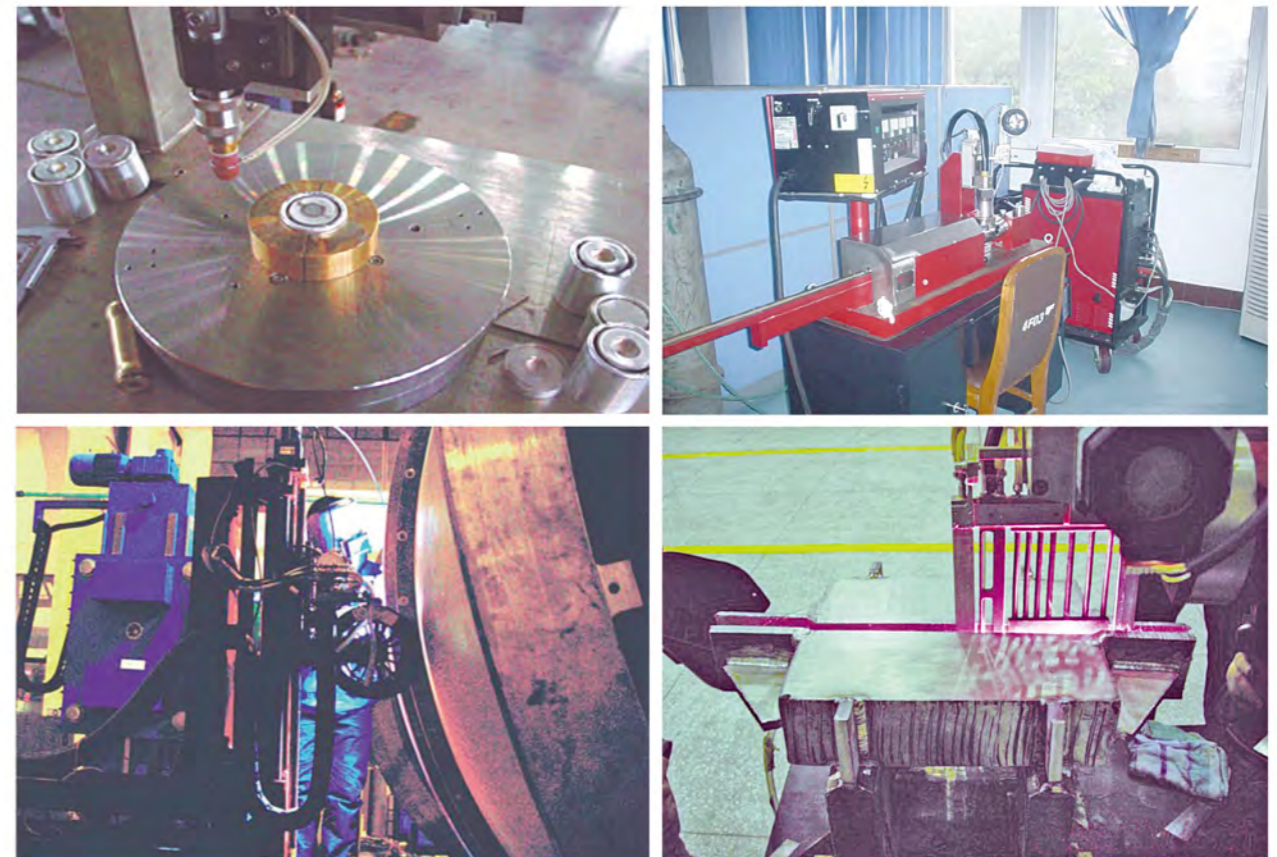
Type of welding: plasma single torch or plasma and TIG double torch

Welding seam requirement: single face welding and double face shaping, pass X-ray testing, surface shaping, protective seam and reproducibility.



## 特种专机 自动焊接系统

Military Industry Automatic Welding System



### 特点

Features

军工专机要求：精密纵、环缝专机，精密特殊类型专机，设备可靠性高，精度高（机械制造精度高、电气控制响应精度高），焊缝质量高，要求100%重现。

华恒技术优势：有十多年从事军工专机设计、应用的工程经验，具有交钥匙工程能力；有稳定的、长期从事自动化专机机械、电气预计研发队伍；有丰富的焊接工艺开发应用经验。

This system is useful for industries look for precise circumferential and longitudinal seaming systems that are highly reliable with detailed precision producing very high quality seams. Otto Arc System has more than 10 years experience designing and producing machines for the industrial military industries.





**其它类专机自动焊接系统**  
Others Automatic Welding System





## P+T双枪焊接工艺 Advanced P+T Double Torches Welding Process

### 工作原理

充分利用等离子电弧的能量，用小孔效应方法获得可靠稳定的背面焊缝成型，在200-300mm范围内紧跟的TIG自由电弧加丝，可获得良好的正面焊缝效果，即等离子在前，TIG加丝在后的双电弧工艺，可得到最佳的焊接效果。焊缝截面为铆钉状。

### 优点

- 比单枪等离子具有更好的焊缝成型和保护效果；
- 具有更高更可靠的焊接质量；
- 比单枪等离子焊接提高30-50%的效率；
- 能适应于不锈钢，钛合金，锆合金或其他稀有金属，适用范围广。

### Principle

To use plasma keyhole effect to get reliable and stable backside shaping, and TIG welding with wire feeding 200-300mm after plasma welding to get better front seam performance. The seam profile is screw shape.

### Advantages

More effective and better welding performance compare to single plasma torch welding  
High and reliable welding quality  
30%-50% efficient more than TIG/PAW welding  
Suitable for stainless steel, titanium alloy, zirconium alloy or other rare metal material welding

### 等离子焊工作原理

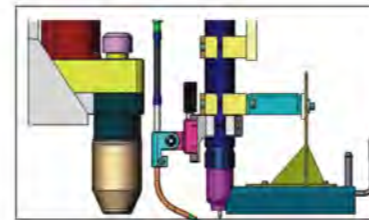
电极与工件之间的电弧，通过焊枪的特殊压缩结构，形成稳定的等离子压缩电弧，对工件进行熔化，以获得较大熔深的一种电弧焊工艺方法，通常分转移电弧和非转移电弧及混合电弧三种类型，常用为转移电弧工艺。

### Principle

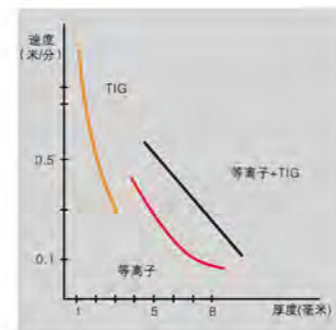
The arc between electrode and work piece is compressed by special torch structure and formed stable compressed plasma arc, to melt the work piece to get deep penetration. There are three types of arc, i.e. transferred arc, non-transferred arc, combined arc is common used.

### 焊接工艺介绍

等离子气体一般为纯氩气，具有较好的电离能力和电弧稳定效果。保护气根据材料的不同进行选配。不锈钢焊接采用95-97%Ar+3-5% $H_2$ ，钛锆等稀有金属采用高纯氩，碳钢采用纯氩或氩加氮混合气体。选择等离子工艺方法的原则根据工件厚度和材料决定。由于等离子弧焊具有众多优势，逐渐被用于食品、医疗器械、化工容器、制管、染整等其它行业



双枪P+T复合



### Welding process

Normally, plasma gas is pure argon gas, which has good ionization ability and arc stable effect. Protective gas depends on material.  
For stainless steel: 95%-97%Ar. +3%-5%  $H_2$   
For carbon steel: pure argon gas or argon gas with helium  
Plasma welding process choosing depends on works piece thickness and material  
There are many advantages to use plasma welding, therefore plasma welding technique is gradually used in food machinery, biomedical machinery, chemical container, piping industry, dyeing and finishing equipment and other industries.

### 焊接工艺特点

- 穿透能力强，8mm以下板厚无须开坡口，大大减小了焊前准备时间；
- 电弧能量集中，焊接热影响区小，焊接变形小；
- 焊接速度快，等离子比手工氩弧焊减小4-5倍时间；
- 卓越的焊缝质量重现性；
- 弧柱刚性大，采用小孔效应，可以实现稳定的单面焊双面成型；
- 电极缩在喷嘴内，不易污染和烧损，电极使用寿命长，焊缝缺陷少；
- 焊接质量好，可焊材料多；
- 等离子弧具有良好的可控性和调节性能。

### Welding process features

Strength in penetration, 8mm below without beveling to minimize welding preparation time.  
Energy concentration arc to get small heat affect zone, and small distortion  
High welding speed, plasma welding saves 4-5 times compare to manual TIG welding  
Excellent welding quality performance repeatability  
Rigid arc and keyhole effect to ensure stable and one side welding double side shaping solution  
Electrode is inside of the nozzle which is not easy to be polluted and burned therefore it is good for long lifetime using  
Good welding quality. There are many welding materials  
Good welding quality performance and filling materials saving plasma arc has good controllability and adjustability

## 等离子横焊 立焊工艺 Plasma Horizontal/vertical Welding Technique

等离子横焊、立焊是指在常规的等离子弧焊基础上通过改变焊枪的姿态和焊接位置而衍生出的焊接工艺。横焊是沿平行于水平面方向进行焊接的，而立焊是沿垂直于水平面方向进行焊接的，包括立向下和立向上两种焊接方式。相比于平焊，焊接姿态、位置发生变化的同时，熔池所受的电弧力和表面张力方向都随之改变，但熔池的重力方向却保持不变，从而增加了焊接工艺难度。

### 特点

- 能实现3-8mm不锈钢单面焊双面成型；
- 相对于平焊，焊接变形更小，焊接速度更快；
- 主要针对于薄壁或大直径罐体的焊接。

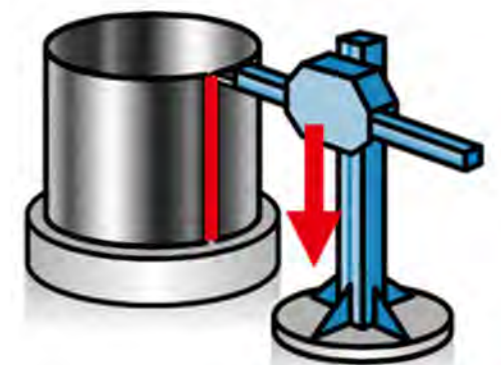
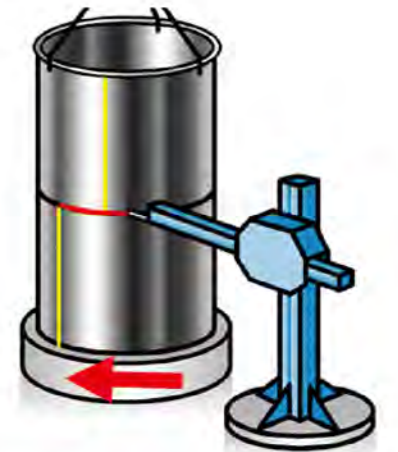
The plasma horizontal welding and vertical welding are derived from the conventional plasma arc welding process by changing the attitude and position of the welding torch. The horizontal welding is carried out parallel to the horizontal direction, while vertical welding is carried out perpendicular to the horizontal direction including and vertical downward welding and upward welding. Compared to the flat position, the direction of the arc force and surface tension change with the torch attitude, while the direction of gravity is maintained constantly, leading to increase the welding difficulty.

### Characteristic

- 3-8mm stainless steel single-sided welding double-sided formation
- Smaller distortion and higher speed compared to the normal position
- Mainly applied for thin-wall or the large diameter tanks

适用范围：大筒体、大直径罐体的不锈钢焊接  
适用场地：工厂预制、现场焊接

Application range: large diameter cylinders and stainless steel containers  
Application location: plant pre-fabrication or filed site

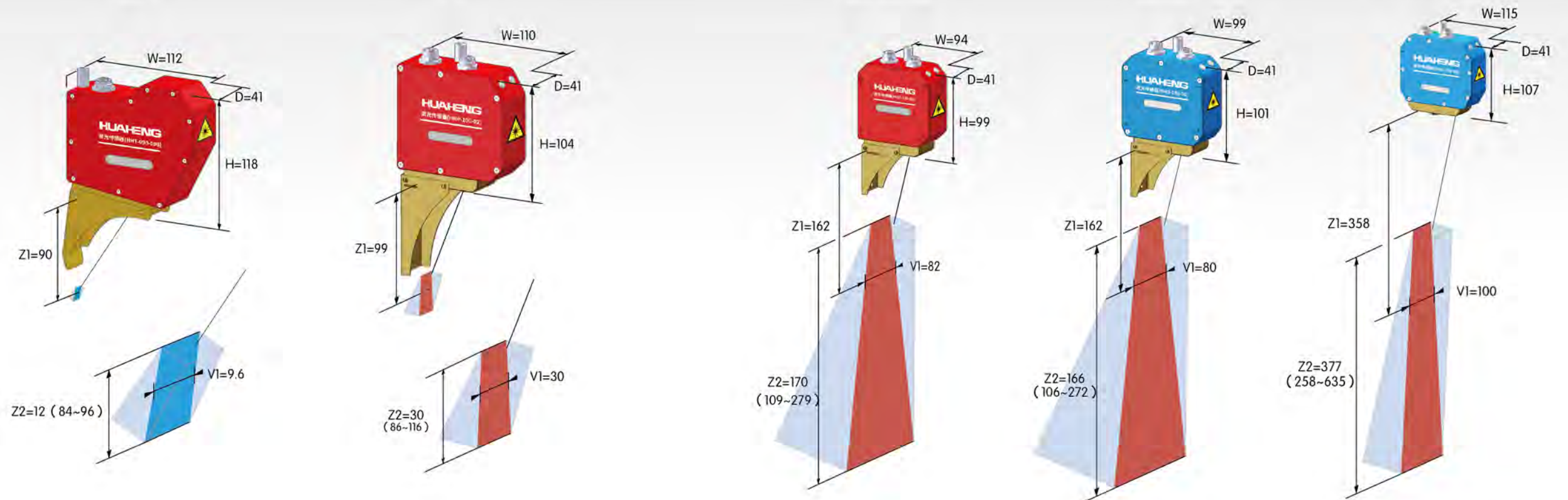


# 激光传感器

Laser sensor

系统名称 System name	激光跟踪系统	激光跟踪寻位系统	激光跟踪寻位系统	激光跟踪寻位系统	激光寻位系统
传感器型号 Sensor model	HHT-090-008	HHP-100-02	HHP-150-05	HHD-150-06	HHD-350-08
激光光源等级 Laser level	III B	III B	III B	III B	III B
Z1最佳视距 (mm) Optimum viewing height	90	90	162	162	358
Z2景深 (mm) Depth of field	12	30	170	166	377
视距范围 (mm) Working distance	84 ~ 96	86 ~ 116	109 ~ 279	106 ~ 272	258 ~ 635
V1视野 (mm) Field of view	9.6 @ 90	30 @ 99	82 @ 162	80 @ 162	100 @ 358
可检测最小焊缝间隙 (mm) Minimum gap	0.08	0.2	0.5	0.6	0.8
尺寸W/H/D (mm) Dimensions	112 X 118 X 41	110 X 104 X 41	94 X 99 X 41	99 X 101 X 41	115 X 107 X 41
帧率 Frame rate	75 @ FullView, Up to 450fps	60 @ FullView, Up to 230fps	80 @ FullView, Up to 230fps	60 @ FullView, Up to 120fps	45 @ FullView, Up to 120fps
重量 (Kg) Weight	0.72	0.73	0.65	0.66	0.66
工作温度 (°C) Operating temperature	5 ~ 40	5 ~ 40	5 ~ 40	5 ~ 40	5 ~ 40
防护等级 Protection level	IP65 (可定制IP67) customizable IP67	IP65 (可定制IP67) customizable IP67	IP65 (可定制IP67) customizable IP67	IP65 (可定制IP67) customizable IP67	IP65 (可定制IP67) customizable IP67
可支持安装位置 Supportable installation locations	背装 back	背装 back	正装 / 背装 / 侧装 front / back / side	背装 / 侧装 back / side	背装 / 侧装 back / side

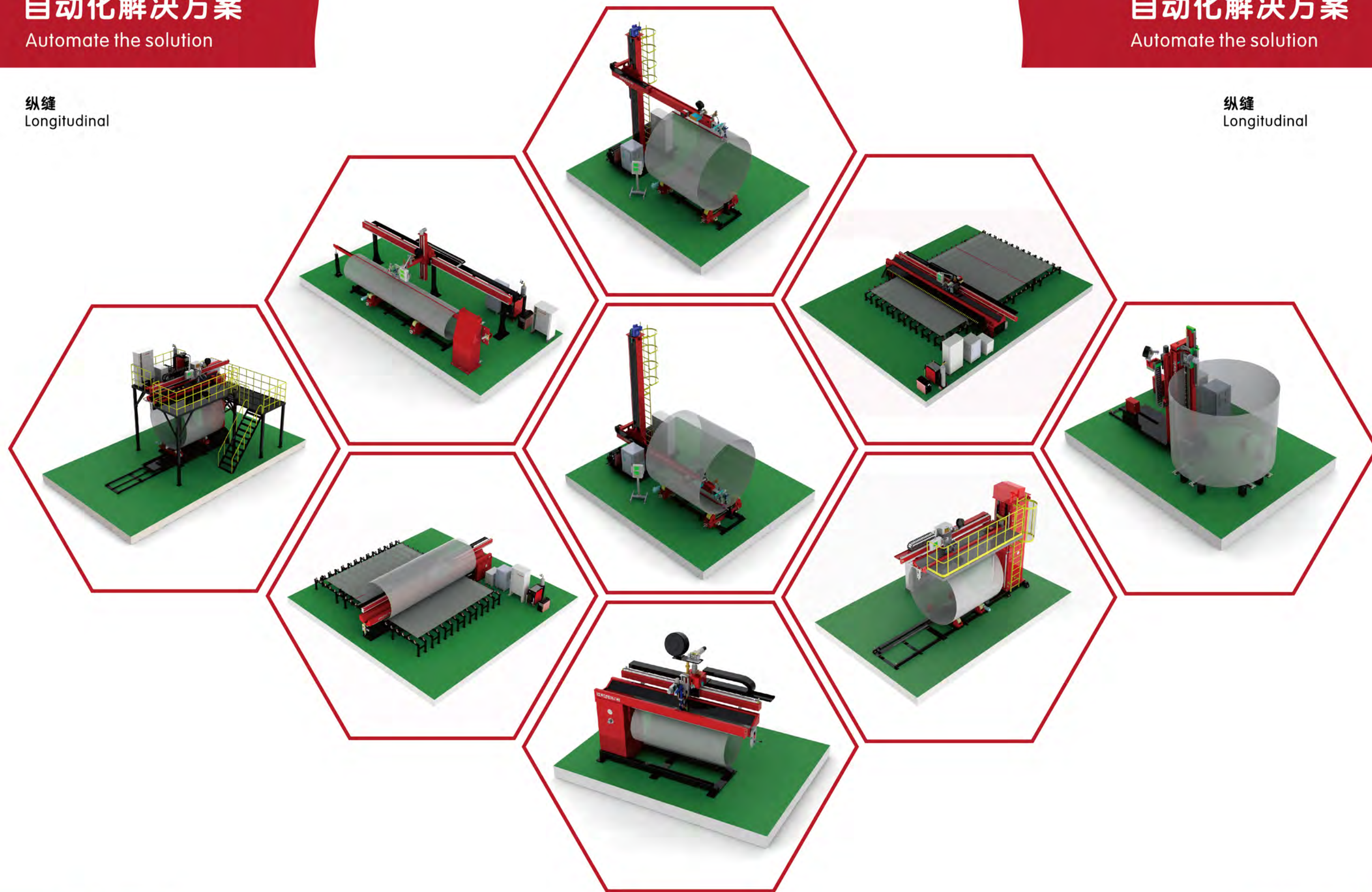
参数标注  
Parameter annotation



# 自动化解决方案

Automate the solution

纵缝  
Longitudinal



# 自动化解决方案

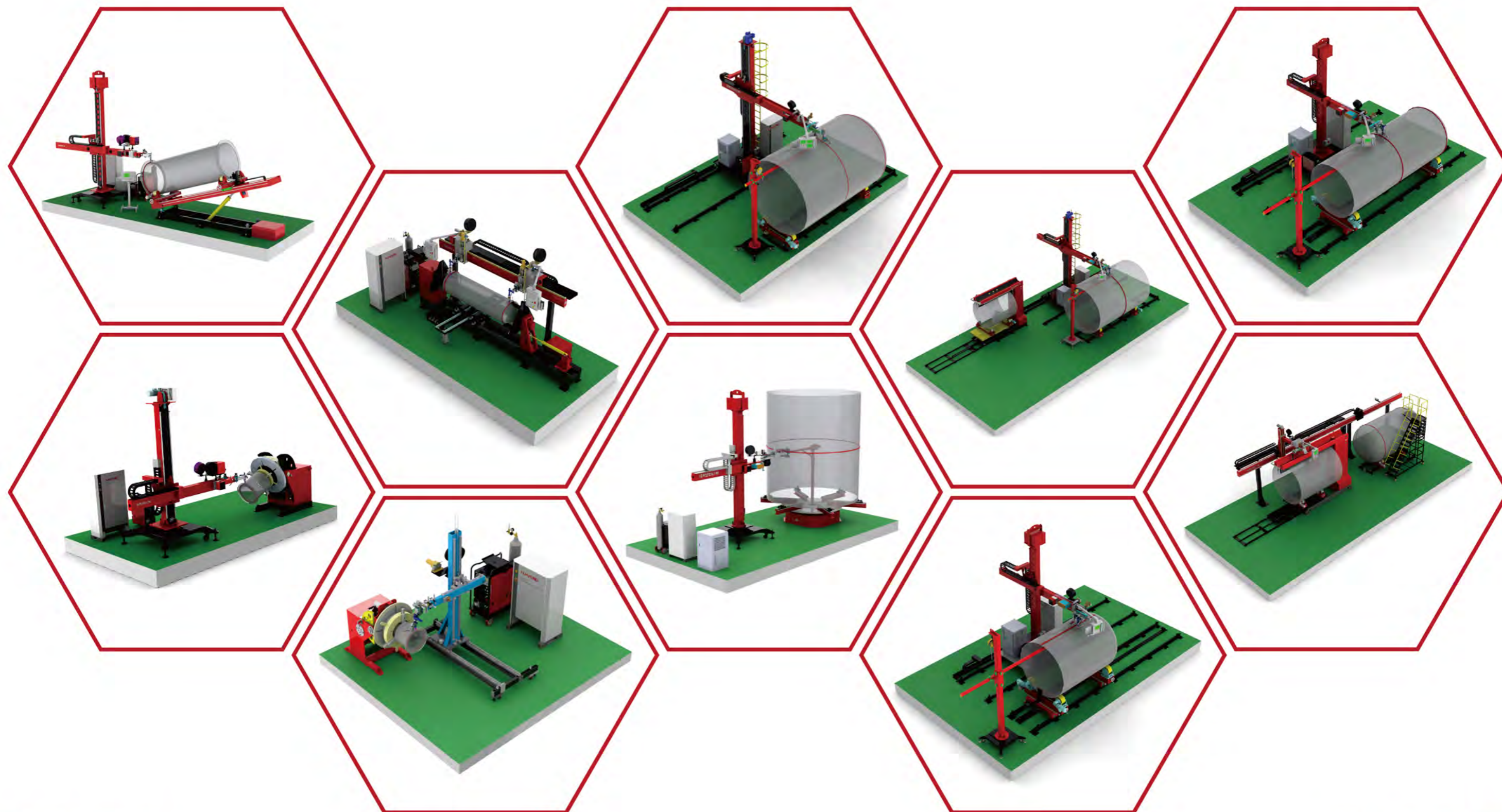
Automate the solution

纵缝  
Longitudinal

# 自动化解决方案

Automate the solution

环缝  
Circumferential



# 自动化解决方案

Automate the solution

综合  
Other solution