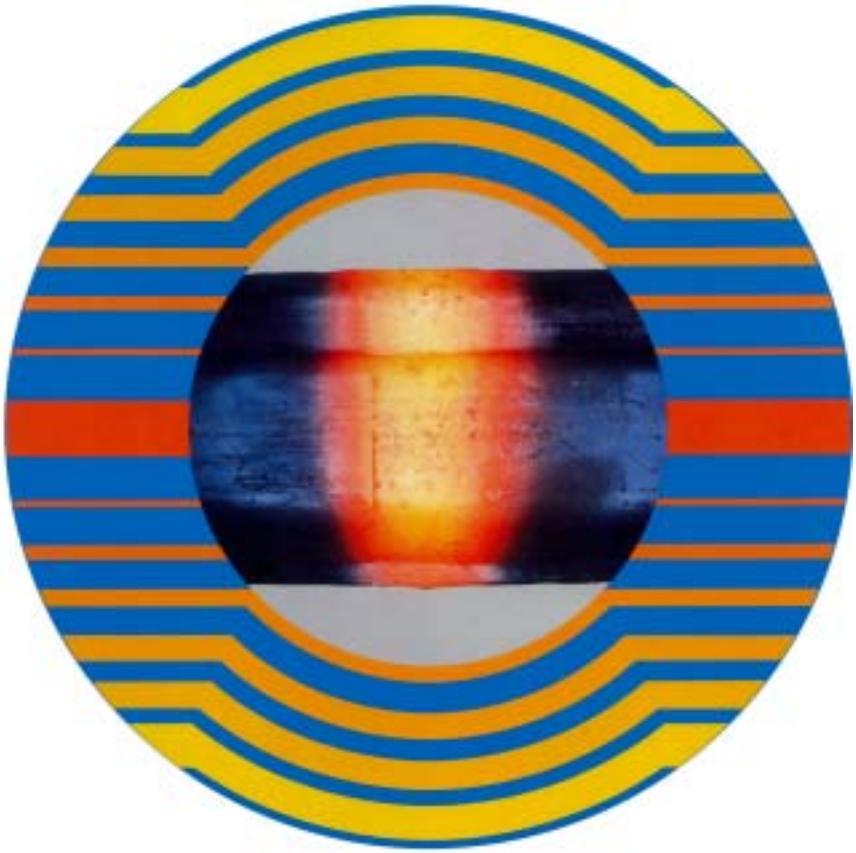
RAIL GAS PRESSURE WELDING APPARATUS



HAKUSAN MFG.CO.,LTD.

OUTLINE OF
RAIL GAS PRESSURE WELDING APPARATUS

Rail gas pressure welding was started in 1953 in Japan. Since then, rails have been made longer to prevent running noises, to improve riding comfort and to reduce rail track maintenance cost due to higher train speed. In 1974, a small type, lightweight rail gas pressure welding apparatus was developed.

This apparatus joins rails under pressure by heating butted rail ends with an oxy-acetylene flame.

This maximum temperature of rail weld interface is 2200 ° F to 2400 ° F (1200℃ to 1300℃). Consequently, both base metals are joined without any fusion and the strength of the weld joint is almost same as that of base metals.

Gas pressure welding is mostly mechanically accomplished.

Therefore, joining strength is even and highly reliable.

The same strength can be obtained by either gas pressure welding or flash butt welding.

In this welding method, on-track welding as well as shop or field depot welding are available.

A trimmer device is incorporated in the apparatus to remove burrs right after gas pressure welding, and this way, soundness of the joint can be checked.

This apparatus can be used also to weld head hardened rails (including part of alloy steel rails).

In this case, a post-weld heat treatment is necessary for obtaining weld joints as good as base metals.

Features

This apparatus is geared to obtain uniform weld quality. Because burrs are cut off through extrusion while during high temperature right after gas pressure welding, when a defect such as weld flaw occurs in the weld joint, it is opened during extrusion for trimming and this is effective for quality control.

Weld Strength and Hardness

Because heating temperature is controlled below the steel melting point and no filler metal is used, weld strength is as high as that of the base metal. The weld joint of the head hardened rail is softened due to welding heat. However, a post - weld heat treatment device can be used to restore the hardness of the softened part as high as that of the base metal.

Please refer to page 8 for details.

Workability

This apparatus is designed for compactness, lightweight and mobility to make on-track application possible, not to speak of shops or field depot welding. Pressure welding efficiency with this apparatus is remarkably high.

Please refer to page 9 for details.

Economy

Main consumables are oxygen, acetylene, fuel for the generator and grinding stones. Cost per weld is far more economical than that of other welding methods even when amortization for machines and labor cost are considered.

Please refer to page 11 for the calculating formula.

Welding and Post-Weld Heat Treatment

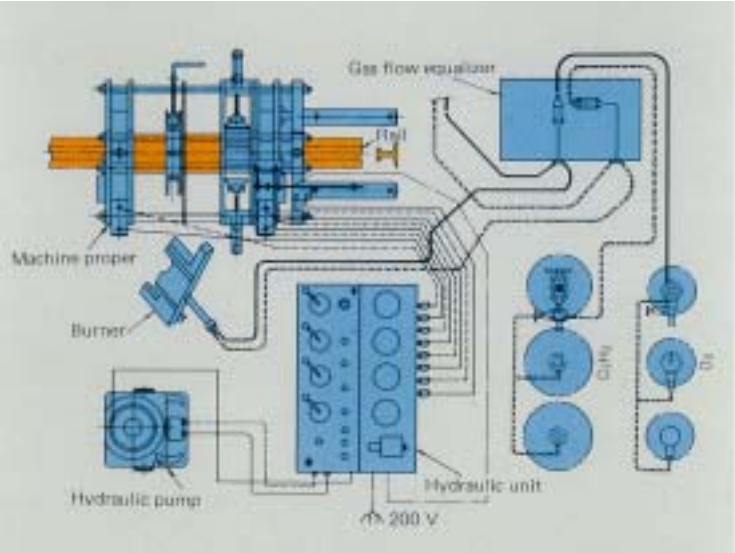
Welding

The ends of the rails to be jointed are butted against each other and pressure (about 190kN for JIS 60kg rail) is applied in the axial direction while the butted part is heated by an oxy-acetylene flame all around using a special burner. On completion of gas pressure welding, the trimmer device incorporated in this apparatus trims off burrs completely.

Gas pressure welding time:

6 to 7 minutes (for 132 lbs or 136 lbs rail AREA)

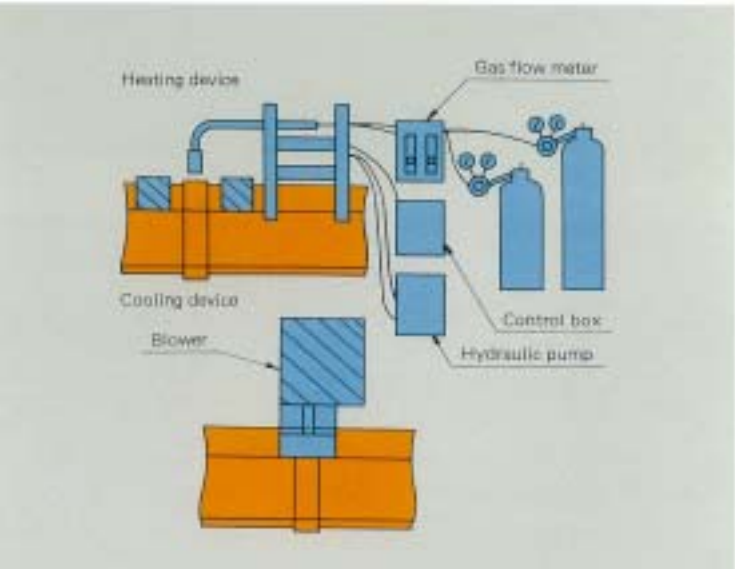
Upsetting length: 25mm



Post-Weld Heat Treatment

When the surface temperature of the head hardened rail falls to 1110 °F(600 ℃)after welding, the welded portion is heated for about 130 seconds with an oxy-acetylene flame using a special burner. Set a cooling device on the welded railhead to be heat-treated immediately after the re-heating and air-cool it for about 260 seconds with a blower.

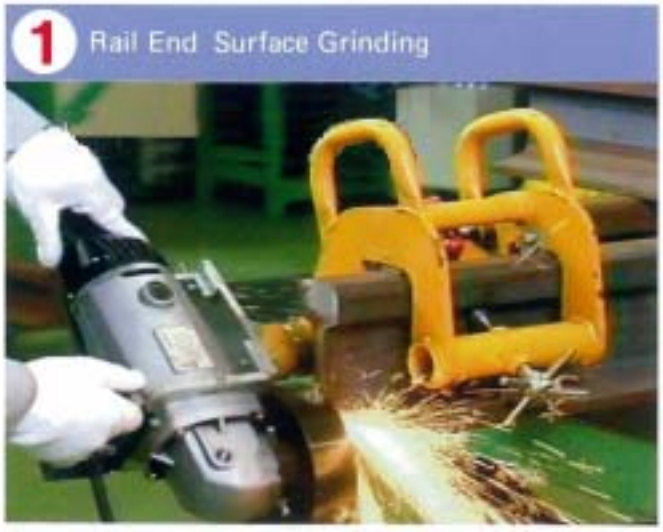
Hardness distribution in the section of the post-weld heat-treated rail is made same as that of the base metal.



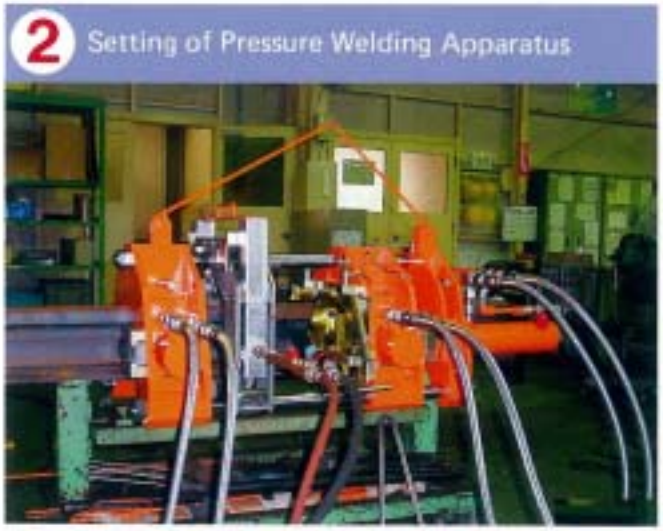
Item	Dimensions Length×Width × Height (mm)	Weight (kg)	Electric capacity
Heating Device	1000×300×500	25	-
Control Box	400×300×500	24	200V
Cooling Device	400×350×350	18	200V 330W
Hydraulic Unit	400×400×500	45	200V 400W

Welding Method

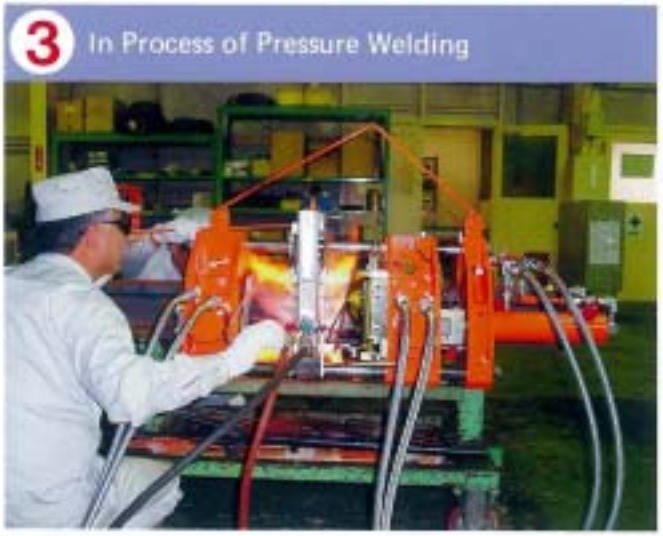
Rail Gas Pressure Welding



Grinding of the rail end surface is necessary for the rail gas pressure welding.
After it squarely finishes it up with a special grinder, the cleaning agent washes the worked surface.

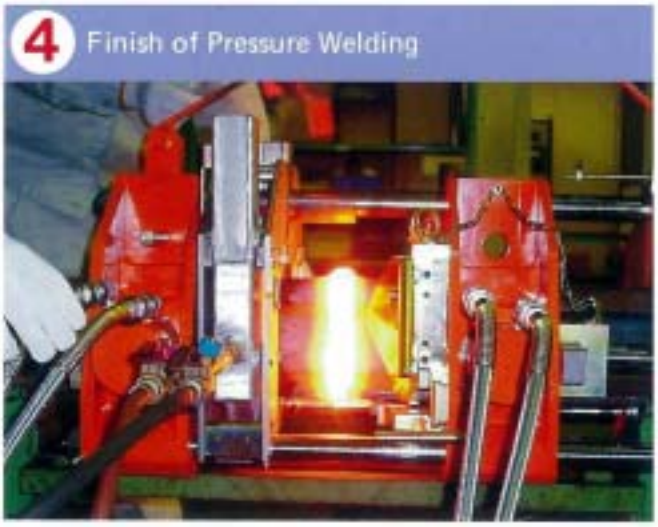


The welding machine is set on the rail, and the alignment checked of the rail is can take place.
Next, the welding condition is to be checked.



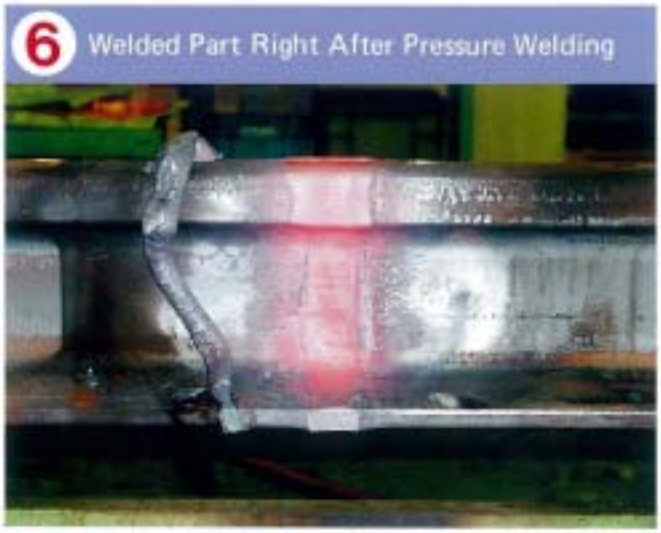
The welding machine pressurizes and heats the butting part of all surroundings with a special burner by oxy-acetylene flames and both rails are joined.

Rail Gas Pressure Welding



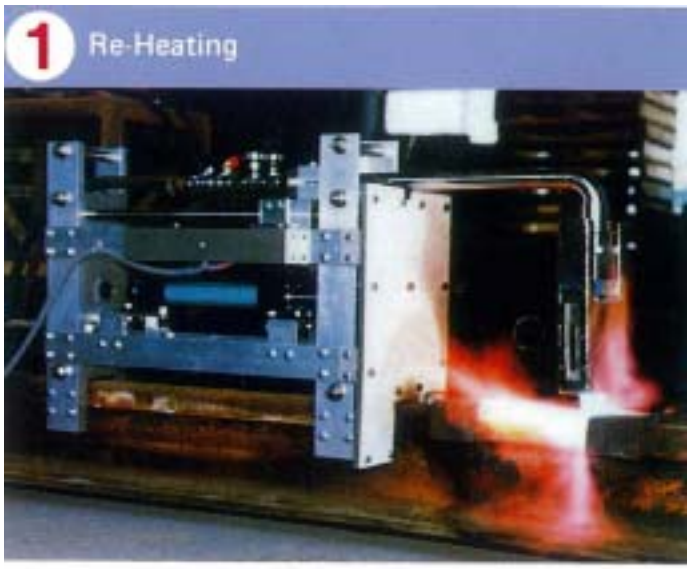
The pressurizing clamping from the right frame is reset after the welding, and the trimmer built into the machine is set.

The trimmer removes the bulge.
When the burrs of weld are hot trimmed immediately after welding, the area below the trimming edge is plastically deformed.

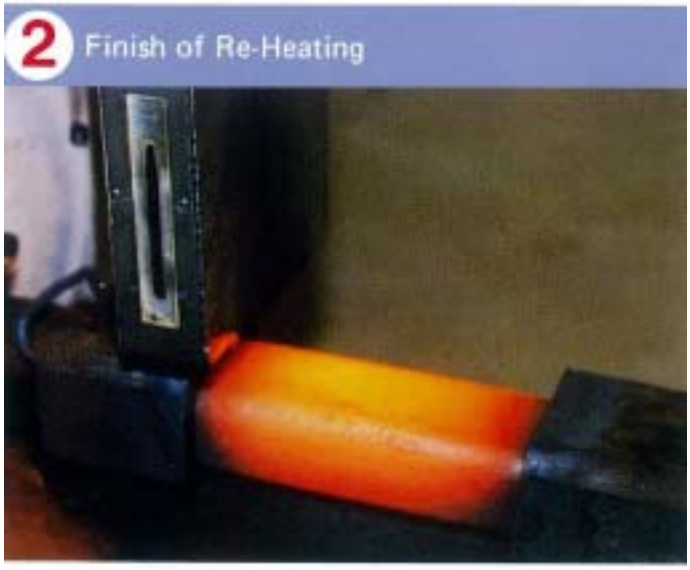


After trimming, the welder has to check the crack at the joint point. After grinding, penetrant test and magnetic particle test are examined

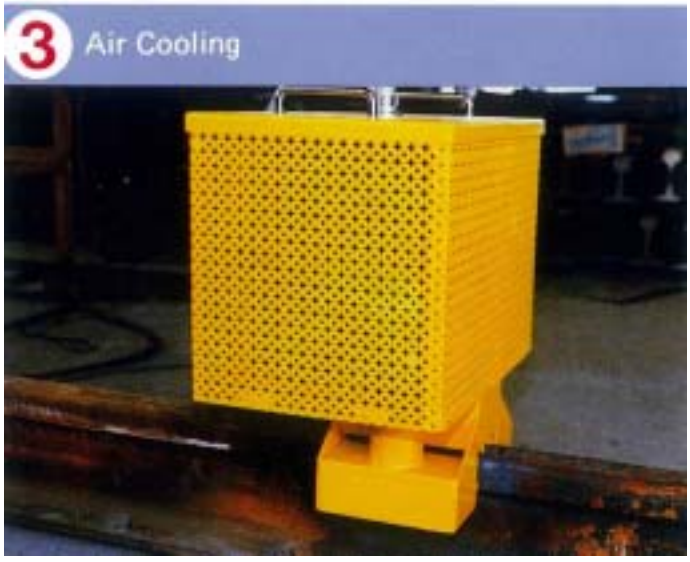
Post-Weld Heat Treatment



After the temperature of the rail reaches 600℃ or less, the head of the rail is heated with a special burner.



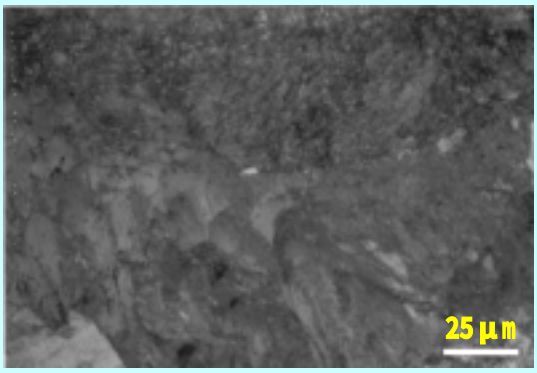
The temperature of the rail head can reach 1000℃ if it is heated for 90 seconds.



Immediately after heating, it is cooled by a special blower down to 300℃.

Performance

Macrostructure and Microstructure

Item	Macrostructure	Microstructure
Standard Rail JIS60kg		
Head Hardened Rail(HH340) JIS50kgN		

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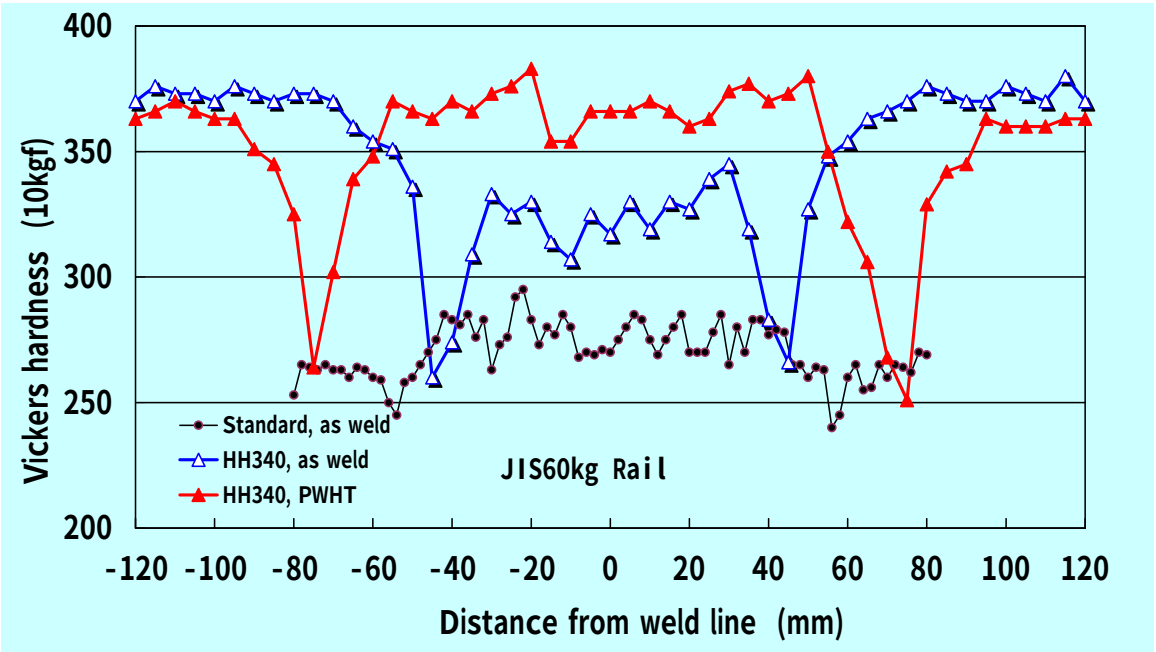
Vickers Hardness Distribution of Rail Tread Surface



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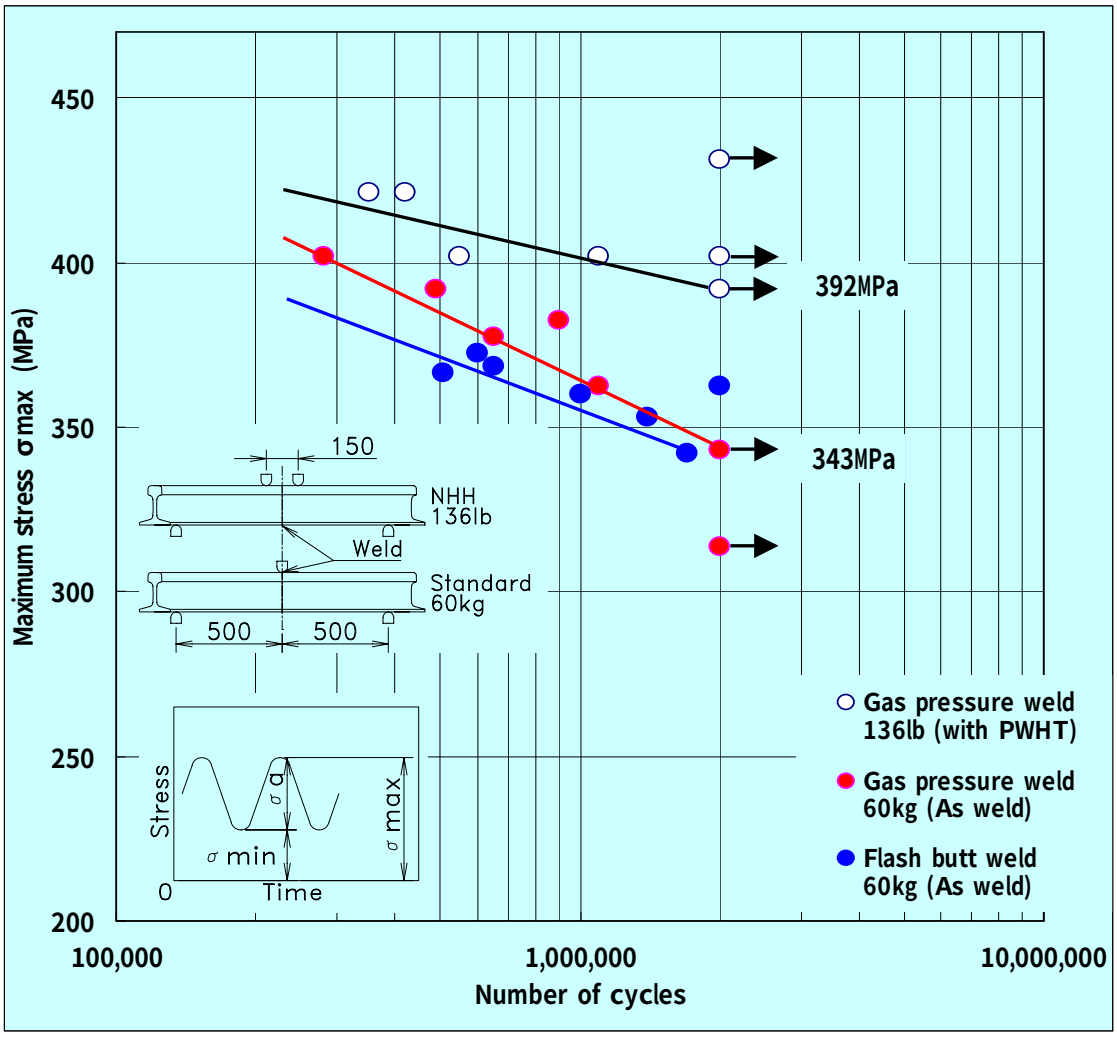
Strength

- Result of Bending Test of Actual Rail (Head up Bending Test)

Rail	Load (MN)	Deflection (mm)
Standard 60kg Rail	1.74	70
Head Hardened 136 lbs Rail	2.34	67

Fracture of Standard 60kg Rail | Fracture of Hardened 136 lbs Rail

- Result of Bending Fatigue Test of Actual Rail



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Comparison of Weld Strength by Various Welding Methods (Reference)

Standard JIS 60kg Rail

Item \ Welding Method			Gas pressure welding	Flash butt welding	Enclosed arc welding	Alumino-thermic welding
Fatigue Strength	(N/mm^2)		320	320	280	220
Static bending test	Load(MN)	HU	1.62~1.92	1.32~1.79	1.59~1.73	1.24~1.52
		HD	1.52~1.90	1.33~1.68	1.17~1.46	1.20~1.37
	Deflection (mm)	HU	42~93	32~98	40~61	13~31
		HD	36~89	30~80	18~34	13~21
Acceptable Bending Strength of JR Load(MN)-Deflection(mm)		HU	1.37 - 25	1.37 - 25	1.37 - 25	1.07 - 10
		HD	1.22 - 20	1.22 - 20	1.12 - 15	1.07 - 13

Note: HU = Head up, HD = Head down

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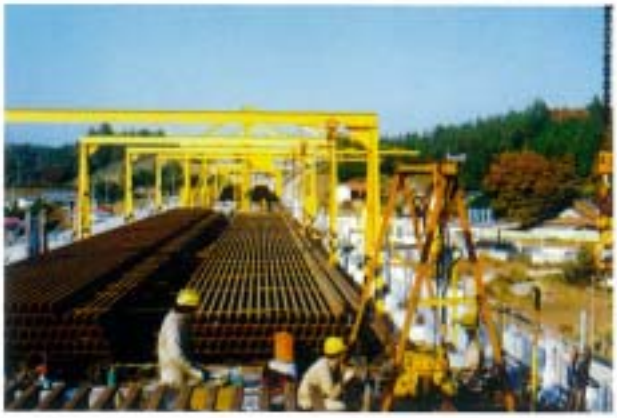
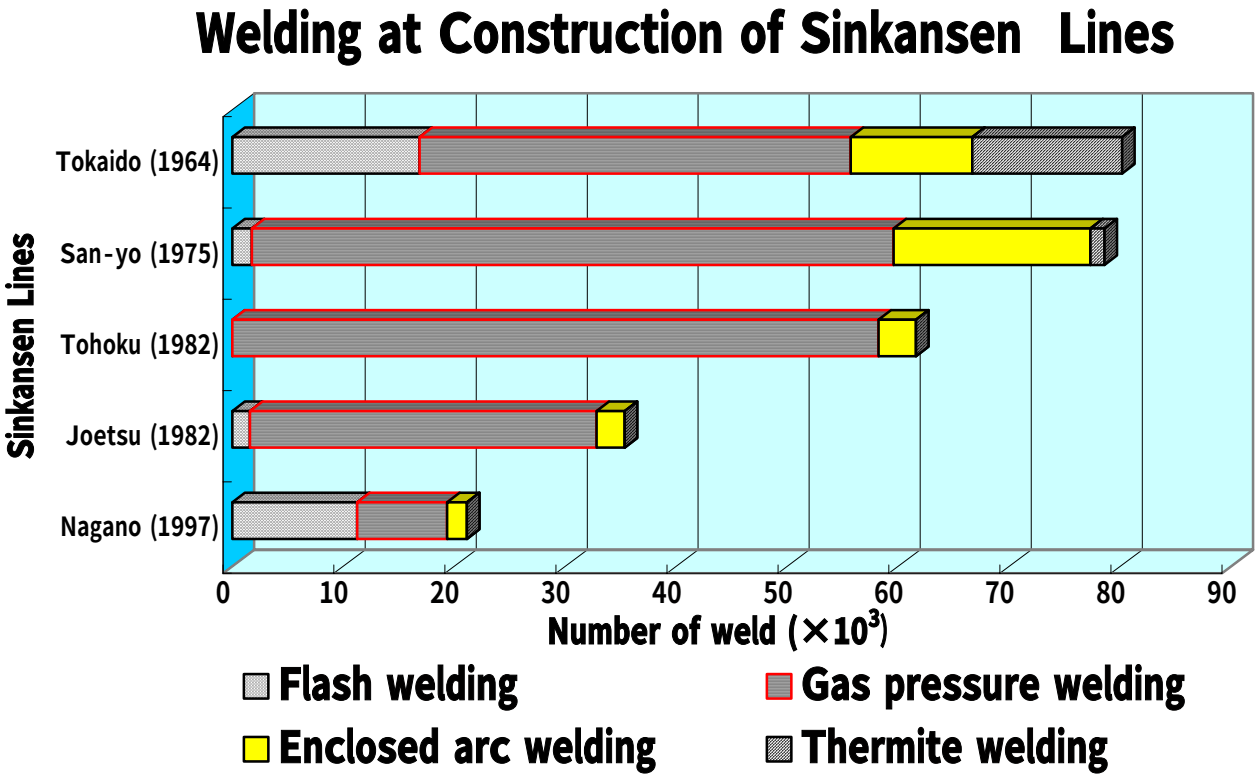
Practical Use of Gas Pressure Welding Apparatus

On Track Welding Method



Field Depot Construction Method

Number (Percentage) of Works Executed by Various Welding Methods in Construction about JR



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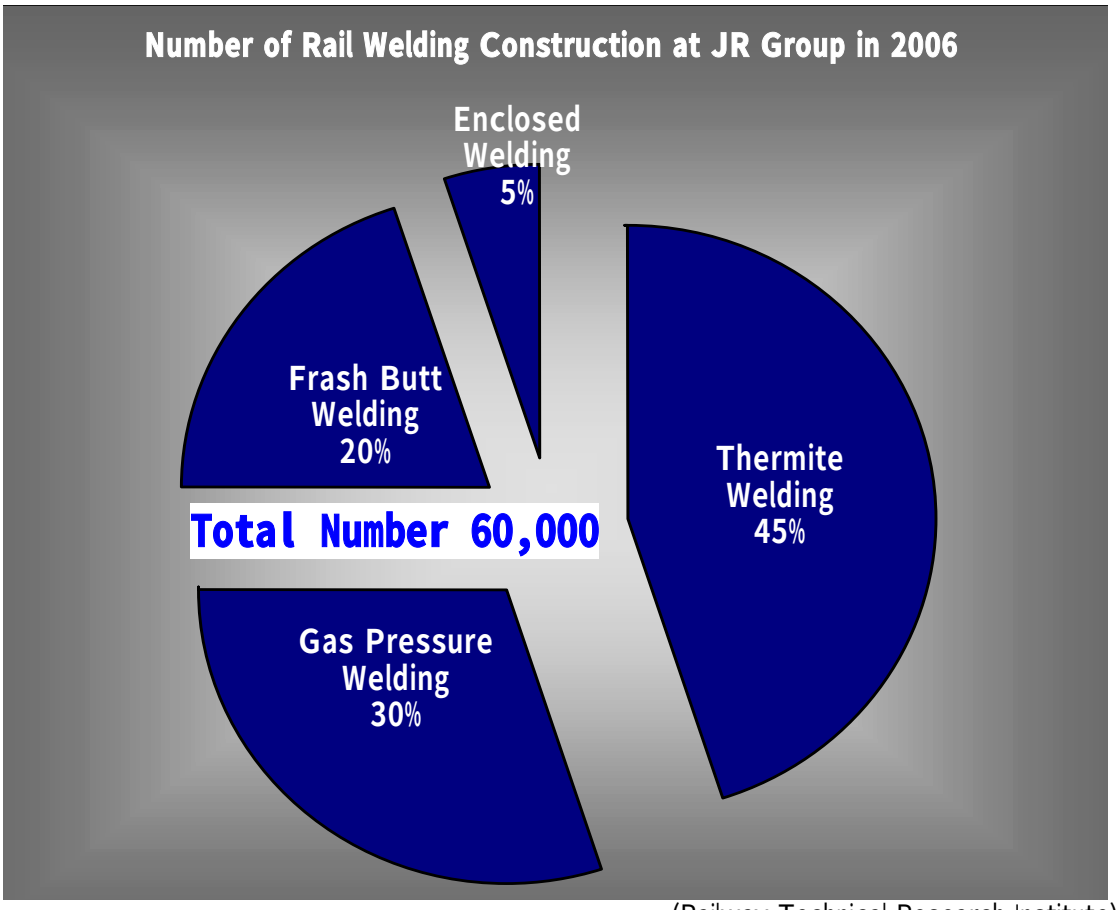

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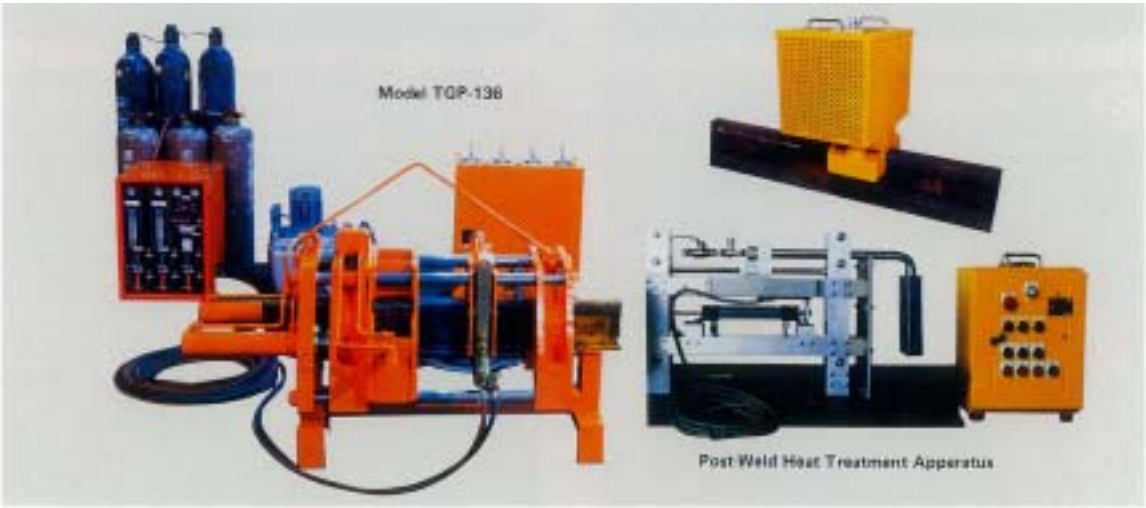
Cost Per Weld

	Item	On Track Welding Method	Field Depot Construction Method
1	Welding cycle time (60kg Rail)	Preparation : 8minutes Grinding of the rail end surface : 5minutes Welding time : 7minutes Others : 10minutes Total time : 30minutes	Preparation : 3minutes Grinding of the rail end surface : 5minutes Welding time : 7minutes Others : 5minutes Total time : 20minutes
		*Weld cycle time will be changes by the degree finishing.	
2	Cost of man power	Cost per weld $= 4\text{persons} \times @/\text{hour} \times \frac{\text{Welding cycle time}}{60\text{min}}$ ・・・・・・・・・・ A	
3	Cost of equipment	Equipment cost per weld = $\frac{\text{Cost of gas pressure welding apparatus}}{\text{Years of depreciation} \times \text{Number of welds(per year)}}$ ・・・・・ B	
4	Cost of consumables per weld	Cost of gas per weld= $\frac{\text{Connected number of gas} \times \text{Unit price of gas}}{\text{Number that can be welded}}$ Ex.) Oxygen $\frac{4\text{pc}\times@}{25\text{welds}}$ = ① Acetylene $\frac{5\text{pc}\times@}{25\text{welds}}$ = ② ① + ② ・・・・・・・・・ C The number that can be welded will be changes by the amount of the filling and the filling method of the gas. The example has indicated the case in Japan. (Oxygen : 7m³ (15MPa), Acetylene : 7kg)	
		Cost of grinding stones of rail end surface per weld $= \frac{\text{Unit price of stone}}{\text{Number that can be ground}} \times 2\text{rails}$ Ex.) $= \frac{\text{Unit price of stone}}{10\text{ grinding}} \times 2\text{rails}$ ・・・・・・・・・・ D The number that can be ground will be changes by the rail shape before grinding and grinding method.	
	Total cost per weld	Total cost per weld = A+B+C+D	

The cost of grinding and the inspection after it welds is not included in this table.

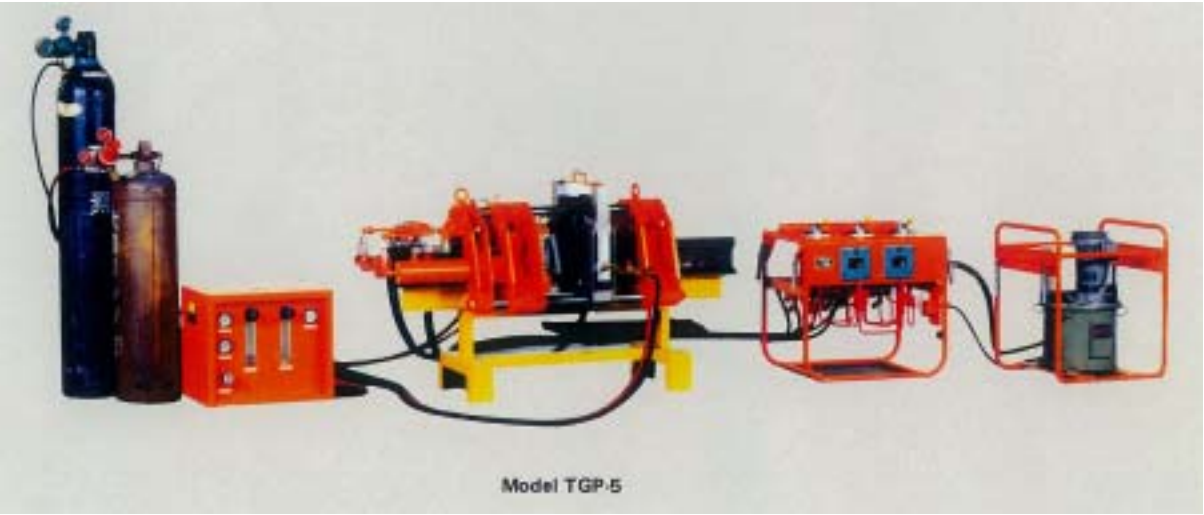
Specifications

Item		Specifications	
Model		TGP-119	TGP-136
Applicable rail (A special attachment is necessary in each rail.)		JIS 60kg, 50kgN AREA 119lbs	JIS 60kg, AREA 136lbs, 119lbs
Clamping pressure		Max 300kN(70MPa) Stroke 70mm	Max 400kN(70MPa) Stroke 70mm
Upsetting pressure		Max 350kN(70MPa) Stroke 330mm	Max 460kN(70MPa) Stroke 330mm
Trimmer setting pressure		Max 50kN(70MPa) Stroke 100mm	Max 50kN(70MPa) Stroke 100mm
Outside Dimensions	Main body	1480mm×970mm×445mm	1510mm×1000mm×550mm
	Hydraulic unit	760mm×500mm×810mm	760mm×500mm×810mm
	Hydraulic pump	350mm×456mm×615mm	350mm×456mm×615mm
Approx. Weight	Main body	500kg	750kg
	Hydraulic unit	180kg	180kg
	Hydraulic pump	105kg	105kg
Hydraulic pump	Motor	2.2kW, 200/220V, 50/60Hz, 3phase The voltage can be changed.	2.2kW, 200/220V, 50/60Hz, 3phase The voltage can be changed.
	Max. pressure	High Pressure 70MPa Low Pressure 9MPa	High Pressure 70MPa Low Pressure 9MPa
	Discharge	High Pressure 1.5L/min Low Pressure 8.0L/min	High Pressure 1.5L/min Low Pressure 8.0L/min



DESIGN/PARTS may be changed without notice

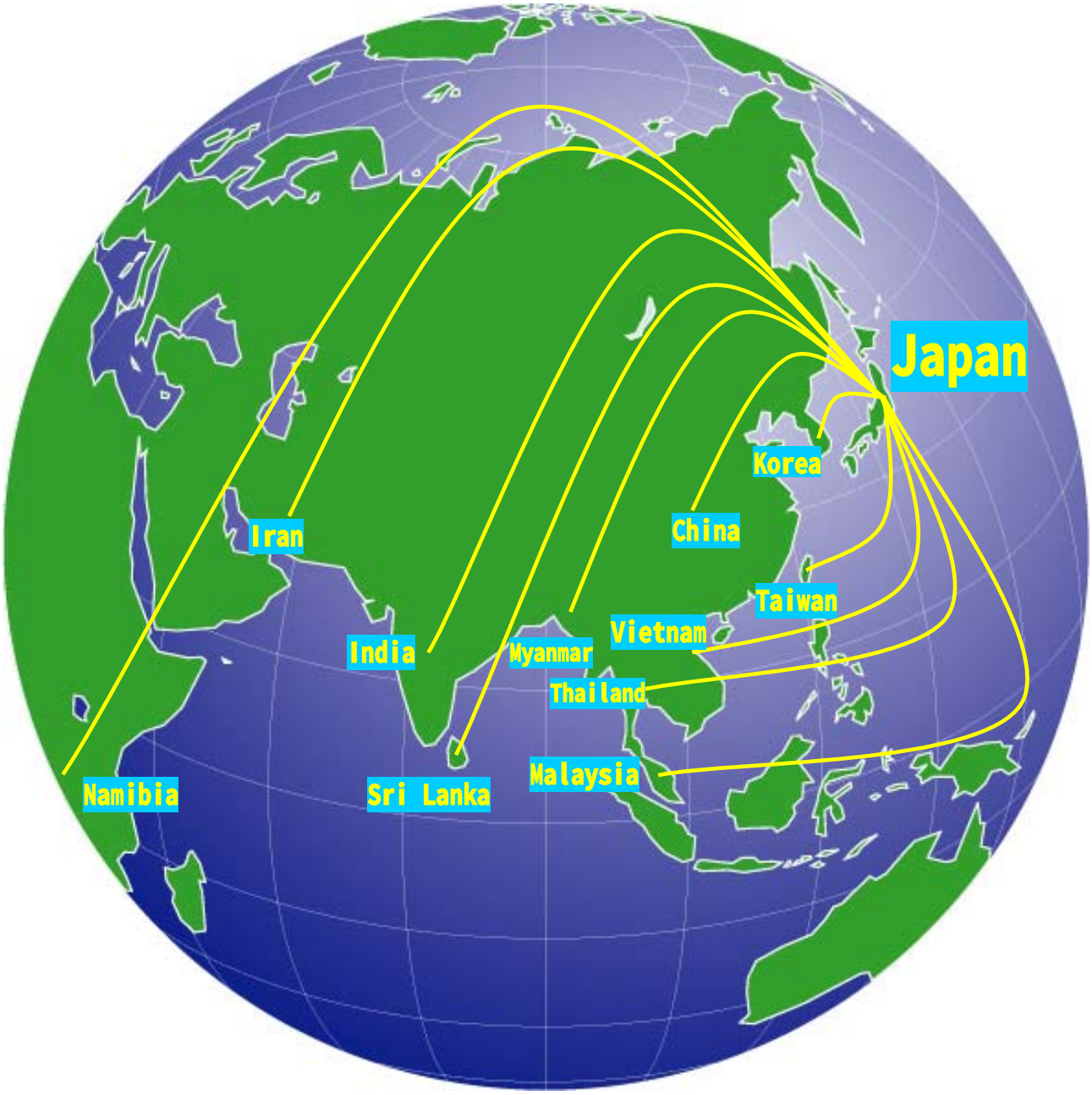
Item		Specifications	
Model		TGP-5	TGP-7
Applicable rail (A special attachment is necessary in each rail.)		JIS 60kg, 50kgN BS 80lbA、90lbA,100lbA UIC 54,60 GB 43 IRS 52	JIS 60kg, 50kgN BS 80lbA、90lbA,100lbA UIC 54,60 GB 43 IRS 52
Clamping pressure		Max 230kN(70MPa) Stroke 70mm	Max 230kN(70MPa) Stroke 70mm
Upsetting pressure		Max 330kN(70MPa) Stroke 210mm	Max 330kN(70MPa) Stroke 250mm
Outside Dimensions	Main body	1,260mm×590mm×425mm	1,340mm×550mm×450mm
	Hydraulic unit	725mm×500mm×700mm	860mm×550mm×700mm
	Hydraulic pump	550mm×500mm×650mm	710mm×500mm×800mm
Approx. Weight	Main body	300kg	350kg
	Hydraulic unit	90kg	90kg
	Hydraulic pump	115kg	115kg
Hydraulic pump	Motor	1.5kW, 200/220V, 50/60Hz, 3phase The voltage can be changed.	1.5kW, 200/220V, 50/60Hz, 3phase The voltage can be changed.
	Max. pressure	High Pressure 70MPa Low Pressure 8MPa	High Pressure 70MPa Low Pressure 8MPa
	Discharge	High Pressure 0.9L/min Low Pressure 6.5L/min	High Pressure 0.9L/min Low Pressure 6.5L/min



DESIGN/PARTS may be changed without notice

Memo

Sales performance of apparatus



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