



Production of Rail Fasteners

An integral part of
railway infrastructure

Presented by:

SAFE Rail Fastening Systems @ 2023



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About Us-SAFE Rail Fastening System (Zhejiang) Co., Ltd.



To provide the entire solutions in rail fasteners industry-
Efficient, Reliable, Economical and Environmental friendly

Mission

Products range includes fastenings for ballasted tracks and slab tracks for all roads profiles from heavy-haul to high-speed as well as conventional rails.

Automated workshop

Automatic production line with robots and real-time computer monitoring , minimize idle time, minimize labor and managing costs

Traceability(IMS)

Precise quality control along the production line (e.g. temperature); data accessible and in-time analysis with solution take place

Stable quality

Cutting-edge research on robots selection about the defective products to make sure the highest efficiency and quality standards

Environmental friendly

Selection and design of environmental friendly production process, to be responsible for the environment protection



How to establish a production line in 6 months?-China Case



Timeline to establish the production line

small group with ten team members, leadered by experienced factory manager (served in the company manufactured the rail fasteners for the first highspeed rail line in China)





Workshop Tour



Automated Tension Clamp Production Line

From Cutting, Heating, Molding, Quenching, Tempering, Surface Treatment, Antirust Treatment, Packaging, to Warehousing.





Lab Tour



 Fully equipped lab with professional technicians

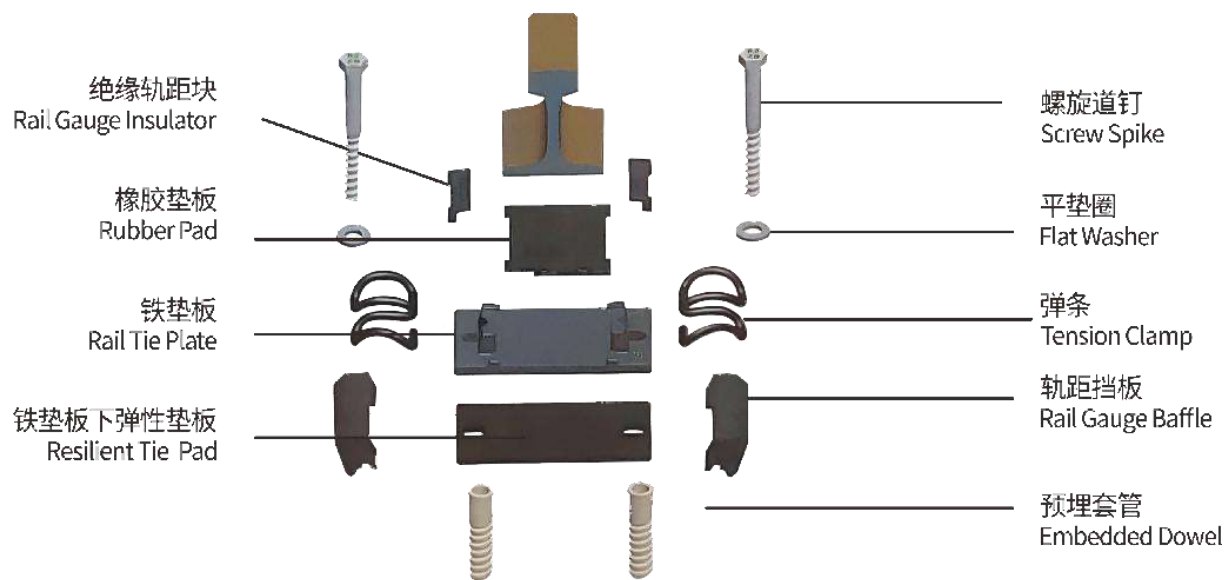
Vital testing items: Hardness Metallographic structure Decarbonization layer Residual deformation Fatigue performance Antirust performance and etc. Raw Mat. & WIP & FG lab testing will make sure all the indicators meet the requirements, so that immediate actions could be taken accordingly, which is the key to achieve better quality control. So that we could reduce the defective rate in order to save production costs.





WJ-8 型扣件系统

WJ-8 Fastening System



WJ-8 Fastening System

Most widely
used in high-
speed rails in
China



System Index- WJ-8 Fastening System



Rail: 60kg/m

Slab track with shoulder blocks
Compliance with highest speed up to 350km/h



Rail Gauge: 1435mm (In China)

Suitable for most rail gauge



Fatigue performance

To keep high durability of the product,
minimize maintenance cost

Antirust performance

To survive under different weather
conditions such as warm and humid, extreme
temperature and etc.



Static stiffness: 50kN/mm or 35 kN/mm

To provide comfortable and smooth
travel experience



Clamping force: Clamp W1>9kN; Clamp X2>6kN

To ensure the stability of rail
superstructure

System Index-To ensure the stability of rail superstructure



Clamping force

Clamp W1>9kN;
Clamp X2>6kN



Anti pulling-out force

no less than 60kN



Rail gauge horizontal adjustment

range: -10mm~+10mm;
adjustment level: 1mm



Rail gauge vertical adjustment

range: -4~+26mm;
adjustment level: 1mm



Lab testing items and requirements-E.g. Tension clamp



No.	Testing Items	Requirement
1.	Shape and Size	The shape and dimensions of the clamp should meet the design requirements. The contact length of the straight section of the clamping limbs (with a gap smaller than 0.3mm) should not be less than 6mm. The bending angle of the clamping limbs should not exceed 1.0mm, and both limbs should not have reverse bending.
2	Appearance and Label	The clamp should not have burrs and scratches that affect assembly, and it should have a permanent factory label.
3	Hardness	42HRC 47HRC
4	Metallographic structure	The microstructure of the clamp should consist of uniformly tempered martensite and tempered sorbite, with a small amount of discontinuous ferrite allowed in the core.
5	Decarburization layer	The total decarburized layer depth of clamps should not exceed 0.13 mm
6	Residual deformation	After the clamp is tested for residual deformation, the residual deformation depth should not exceed 1.0 mm.
7	Fatigue performance	The clamp should not be broken after 5 million times fatigue tests, and the residual deformation should not be greater than 1.0mm.
8	Antirust performance	The surface of the clamp should be treated with anti-rust treatment. The protection level of the clamp bars after anti-rust treatment should not be lower than level 5, after 150 hours neutral salt spray (NSS) test.



PART

01

Tension Clamp (Clamp)

Four robots in W-Type Clamps Production Line





Current status of traditional CLAMPS production

Traditional manual production



**Harsh
working environment**

workpiece temperature 800-
1000 (1472-1832° F),
ambient temperature
40 (104° F)



**High
labor intensity**

both hands work at the same
time, and the workpiece is
transported from one process to
the next in about 3 seconds
without stopping for a long time



**Frequent
work-related injuries**

such as burns and crush
injuries occur



**Unstable
quality**

pass rate is less than 95%;
high no of defective
products



**Increasing
labor costs**

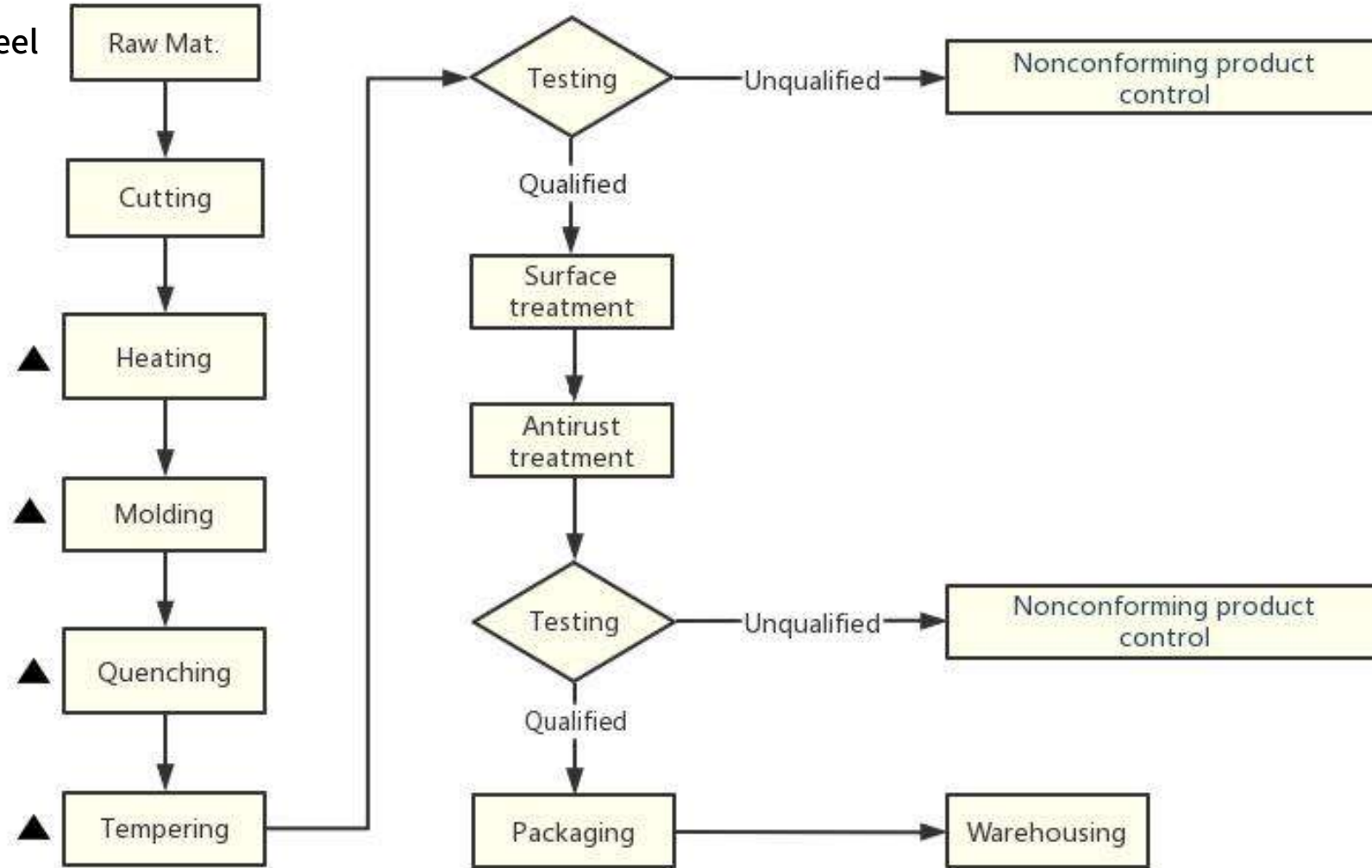
making management
more difficult



Production processes



60Si2Mn spring steel



▲ NB : critical processes



Tension clamp production line



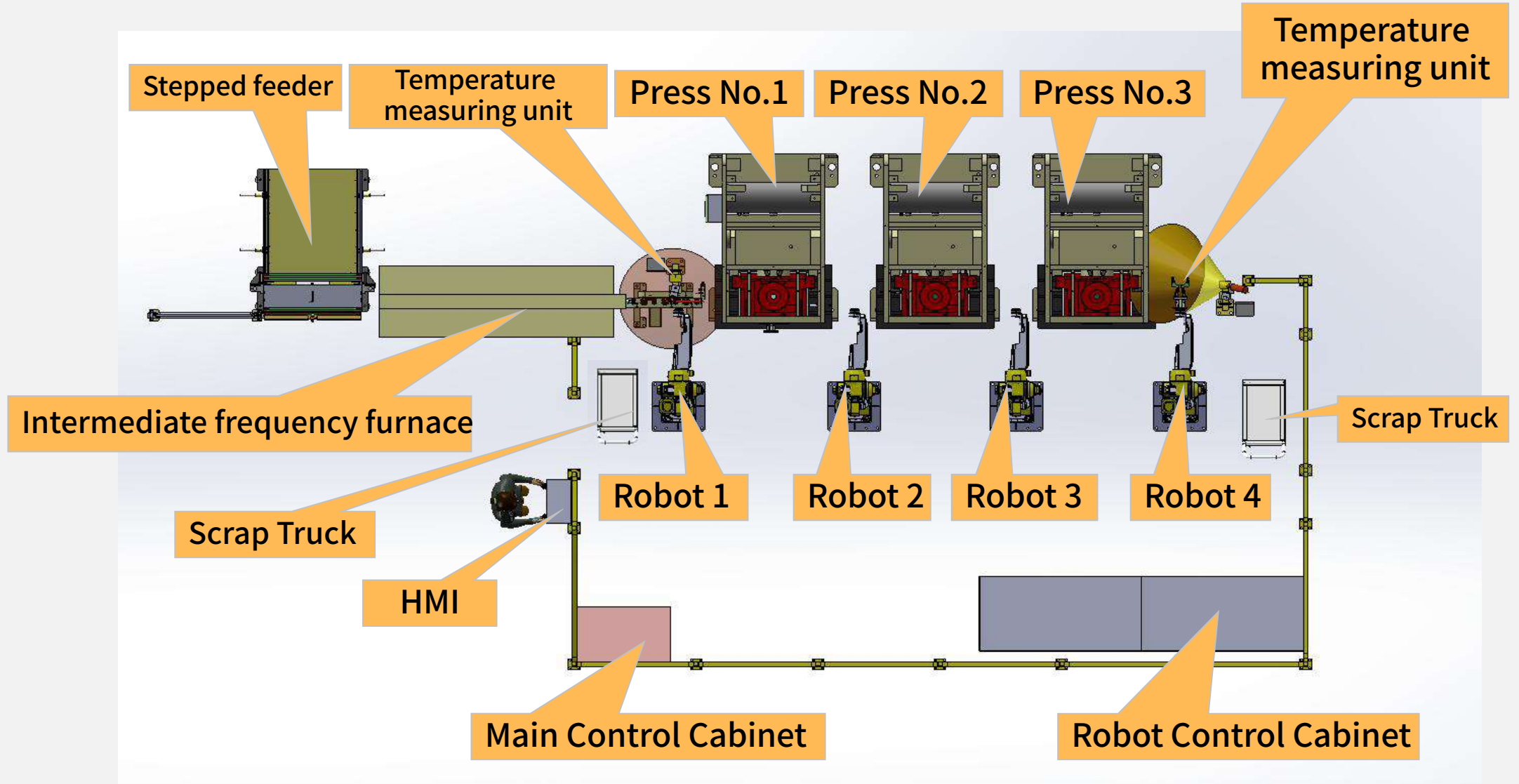
Cutting Process

- ✓ This machine can complete the three processes of loading, cutting and feeding at one time.
- ✓ The shift output (8 hours) is nearly 30,000 pieces, and the maximum cutting diameter is $\phi 22$.
- ✓ The machine has *high degree of automation*, accurate length, less wasted material, good quality, less noisy, low energy consumption.
- ✓ *The production efficiency* is more than 4 times higher than traditional manual punching.



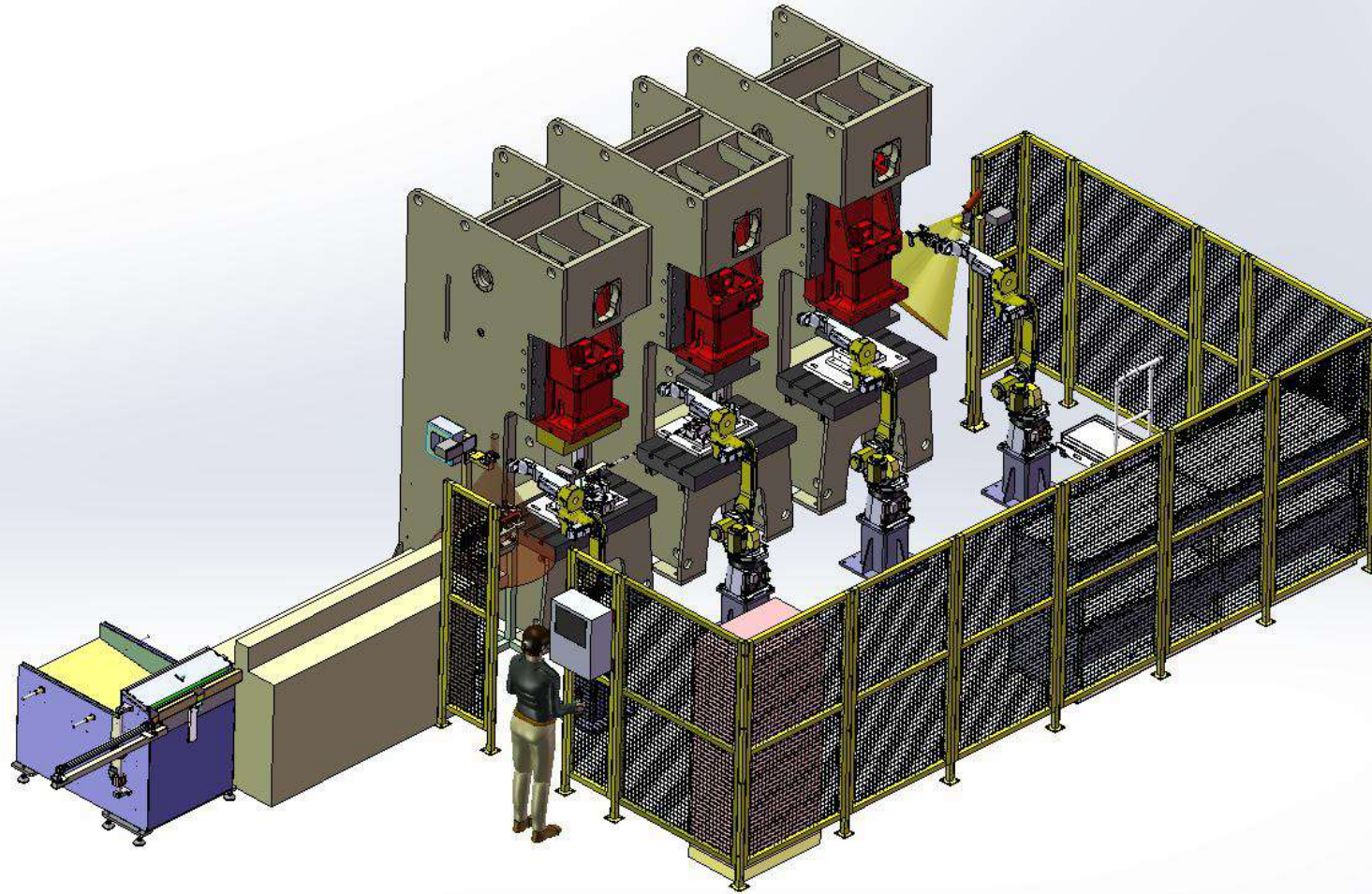


Layout of Production Line-Key parts





Layout of Production Line-Key parts





Tension clamp production line



Stepped feeder

- 1.) Compatible with bars of 500-750mm length (WJ-8: 560mm)
- 2.) Compatible with bars with diameters of 13-18mm (WJ-8: 14mm)
- 3.) The device beat is 4s/pcs
- 4.) The storage capacity of the silo is about 400-500
- 5.) The discharging center of the equipment is 1000mm \pm 50mm
- 6.) Moveable equipment to facilitate the replacement of quartz tubes in the intermediate frequency furnace



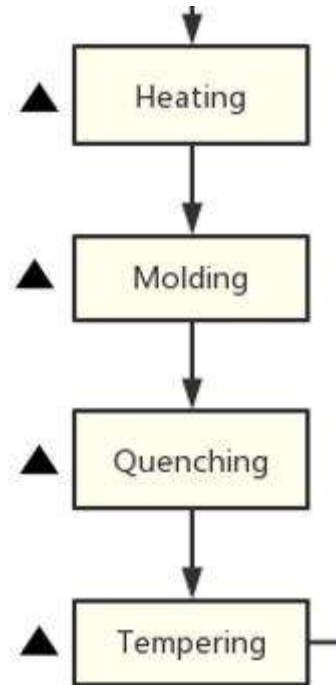


Tension clamp production line



Heating Process

- ✓ Within the production, starting from heating, molding, quenching to tempering, those are critical processes.
- ✓ The clamp quality control after the heating process, the requirement is hardness (RC60-63), decarburization layer depth (< 0.12), the microstructure of the clamp should consist of uniformly tempered martensite.





Tension clamp production line

Step description

The round bar is discharged through the front end of the intermediate frequency furnace and enters the power sprocket to transport the material to the predetermined place, and the feeding robot graps the bar material and puts it into a sequence molding process.





Tension clamp production line



Molding Process-Four Robots-Pioneering technology





Tension clamp production line

Molding Process-Four Robots-Pioneering technology

Feeding Unit



Through the feeding mechanism, reaching the designated position triggers the in-position sensor signal, and the feeding robot graps the material into the lower die of the first-order mold and waits for punching; if the material temperature is not qualified, then it will be put into scrap truck.

First-sequence punching unit



After punching is completed, the first-sequence robot's gripper moves the workpiece from the No. 1 press to the No. 2 press, waiting for punching;

Second-stage punching unit



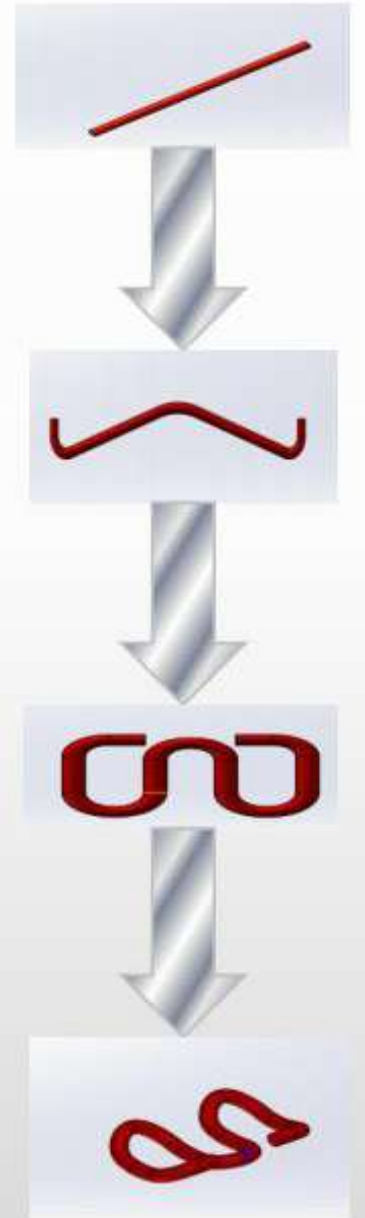
After punching is completed, the gripper of the second-stage robot transports the workpiece from the No. 2 press to the No. 3 press, waiting for punching;

Unloading Unit



After the punching is completed, the unloading robot gripper will grab the workpiece to the tail end temperature measurement area for temperature measurement. If it is qualified, it will be put into the quenching tank; if it is not qualified, it will be put into scrap truck.

W-Type Clamps





Tension clamp production line



 Molding Process-Debugging Video

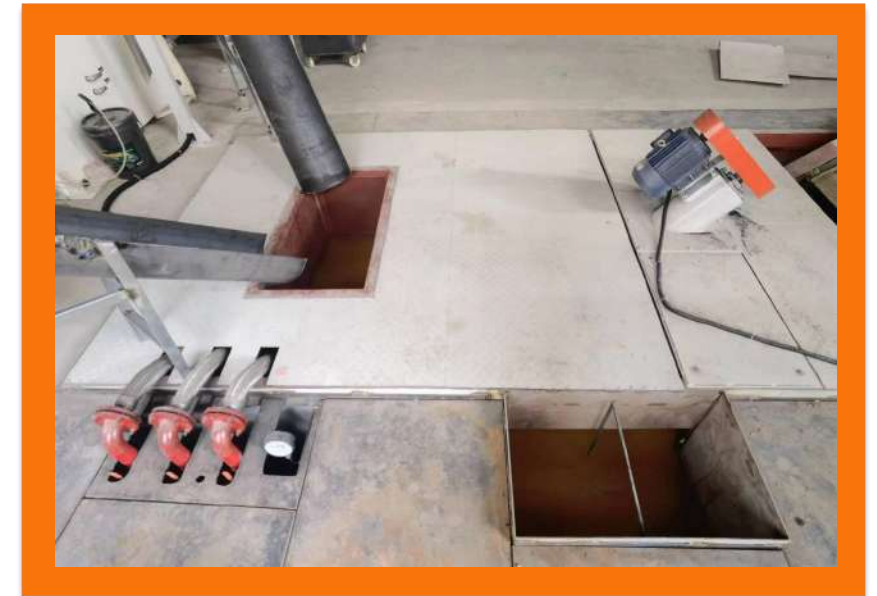




Tension clamp production line

Quenching Process

- ✓ We must strictly control the material heating temperature, waste heat quenching temperature, select quenching medium and quenching medium temperature.
- ✓ The robots carries out temperature measurement and sorting at the beginning and end of the third thermoforming, and we also use bright quenching oil to control the oil temperature, so as to ensure that the products in this process meet the overall standards.





Tension clamp production line



Tempering Process

- ✓ Tempering equipment adopts advanced continuous controllable atmosphere mesh belt furnace, which has a high degree of automatic control;
- ✓ All tempering treatment process parameters are continuously monitored by computer, and the process is stable;
- ✓ The protective atmosphere in the furnace is methanol cracking gas, and the atmosphere is controlled stably to prevent the decarburization of products during quenching. Its carbon potential can be automatically controlled by the carbon potential control system to ensure that the product is within the controlled range.
- ✓ During the process control, computer, touch screen and PLC are combined, and an automatic control system with full computer monitoring operation is equipped, which can monitor the temperature, time and carbon potential of the product process in the furnace for 24 hours, and its monitoring data is automatically archived to ensure the historical traceability of the product status.





Tension clamp production line



Surface treatment Process

- ✓ The fatigue performance and elasticity of clamps are the key to ensure the durability and stability of fastener system.
- ✓ The use of straight-through roller spraying machine can greatly improve the quality of shot blasting products.
- ✓ Therefore, we choose the determined size of steel shot, the blasting pressure, blasting density and blasting time, and use steel shot to spray on the surface of clamps directly, so that its surface can achieve the effect of cooling, hardening and strengthening.
- ✓ Therefore, the fatigue life of clamp will be increased by about 15%-20%.





Tension clamp production line



Antirust treatment Process

- ✓ Special rust prevention requires powder electrostatic spraying. Powder spraying is to spray powder coating on the working surface with powder spraying equipment (electrostatic spraying machine).
- ✓ Under the action of electrostatic, the powder will be uniformly adsorbed on the surface of the workpiece to form a powdery coating; After low temperature curing, the powder coating is superior to spray painting in adhesion, corrosion resistance and aging resistance, and the cost is also lower than that of spray painting with the same effect.
- ✓ China has a vast territory, covering the hot, humid and cold areas. In order to meet the requirements that the clamp can adapt to various weather conditions and harsh conditions, we carry out anti-rust treatment on the surface of the clamp on the premise of ensuring its performance.
- ✓ The anticorrosion method we adopt is polyurethane electrostatic spraying and low temperature (< 200) curing process.
- ✓ After 150 hours salt spray testing, the surface of the product produced by this process does not rust, which completely meets the design requirements.
- ✓ Hanging surface strengthening and hanging spraying of workpieces are one-stop operation, which completely avoids the transfer of semi-finished products in the middle.





Information Management System



Tension clamp production line Info Mgt. System

主界面 生产管理 质量管理 设备管理 信息维护 报警管理 通讯监管

总体概况 在线通信状态 5/5 报警 Alert No. 产量 Today's Quantity

Robot Line 1

In operation/In fault/Manual

- Robot 1 condition
- Robot 2 condition
- Robot 3 condition
- Robot 4 condition
- Press 1 condition
- Press 2 condition
- Press 3 condition
- Thermometer ()-1
- Thermometer ()-2

Robot Line 2

In operation/In fault/Manual

- Robot 1 condition
- Robot 2 condition
- Robot 3 condition
- Robot 4 condition
- Press 1 condition
- Press 2 condition
- Press 3 condition
- Thermometer ()-1

Line 1

产品型号: Model
生产批次号: Batch
计划数量: Planned Quantity
当前数量: Current Quantity
合格率: Pass rate
订单预计完成时间: Estimated hours

Line 2

产品型号: Model
生产批次号: Batch
计划数量: Planned Quantity
当前数量: Current Quantity
合格率: Pass rate
订单预计完成时间: Estimated hours

Tempering Info

(单位: °C) 温度

- Quenchant Temperature ()
- Tempering furnace zone temperature ()

Tempering Info

(单位: kw) 功率

- Tempering furnace zone power (kw)

Robots Line 1

设备节拍: Beat
上料机状态: Feeder condition
中频炉状态: Medium frequency furnace condition
机器人状态: Robot condition

Thermometer ()
Press condition
Robot condition
Scrap No
Working condition

Press condition
Robot condition
Working condition

Thermometer ()
Press condition
Robot condition
Scrap No
Working condition

Quenching cleaning Equip. (min.)
Stirring motor condition
Conveyor motor condition
Conveyor motor speed

Heating Equip. min.
Motor condition
Motor speed

Anti-rust Equip.
Motor condition
Heating and drying motor condition

Robots Line 1

设备节拍: Beat
上料机状态: Feeder condition
中频炉状态: Medium frequency furnace condition
机器人状态: Robot condition

Thermometer ()
Press condition
Robot condition
Scrap No
Working condition

Press condition
Robot condition
Working condition

Thermometer ()
Press condition
Robot condition
Scrap No
Working condition



PART
02

Resilient Tie Pad RTP

Automatic RTP production line with pouring molding machine





Resilient Tie Pad Production Line

- ✓ The production line of resilient tie pad adopts the automatic production line of pouring molding machine controlled by digital CNC in the whole process
- ✓ Which is automatically completed from pouring, mold opening and closing to demoulding and taking out parts





Resilient Tie Pad Production Line

- ✓ The metering and transmission system of raw materials adopts German Bama high-precision gear metering pump and E + H brand mass flowmeter.
- ✓ Weight accuracy, proportioning accuracy can be controlled within 0.3% , which can effectively ensure the stability of product quality.





Resilient Tie Pad Production Line

- ✓ The automatic pouring platform consists of three-axis servo motion control system, head, nose, screw rod motion structure and automatic lubrication system.
- ✓ The servo motor drives the head to move back and forth, up and down, left and right through the screw rod through the planetary reducer, and automatically controls the whole process in the work, which can meet the pouring requirements.
- ✓ The nose structure uses unique patented technology to take away the heat generated by the high-speed rotation of the spindle through the internal circulation of cooling water; The problem of different temperature rise under long-term continuous working conditions of the nose is solved.





Resilient Tie Pad Production Line



- ✓ The mold heating adopts the liquid medium heating mode of pump circulation, which is divided into three sections independently, and a single set of mold has a separate valve switch.
- ✓ Compared with the previous heating method of drying tunnel, the mold temperature control is more accurate.
- ✓ The pouring turntable contains 66 pairs of molds.
- ✓ It takes 12 minutes for the turntable to rotate once.
- ✓ The 24-hour uninterrupted production capacity can reach 7920 pieces.





Resilient Tie Pad Production Line



The two-axis vacuum adsorption grabbing mechanical arm can automatically grab the finished products in the mold after opening the mold and transport them to the position of the rear conveyor belt, which increases the automation degree and reduces the labor intensity of personnel.





PART

03

Looking Ahead

What to expect in future



 **Thanks**



More info:
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