

High Pressure Water Jet Structure Design

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Abstract: Welding is an indispensable processing technology for modern production, but residual stress is unavoidable after welding, which has a great influence on the structural integrity. How to reduce the residual stress has been a hot topic of research. High-pressure water jet is a new method of surface strengthening. Compared with traditional shot blasting, it has many advantages such as good reinforcement effect, low cost, no pollution, easy automation, and easy reinforcement of narrow and deep groove parts. In this paper, based on the principle of surface enhancement of water jet, a simple water jet excitation device is designed to realize the application of water jet in eliminating residual stress. The paper first briefly introduces the related knowledge principles of water jet, and then describes the design process of two-direction transmission, including rack and pinion drive design and ball screw drive design. Afterwards, the high pressure system is designed.

Keywords: Water jet, welding, Residual Stress, High pressure system.

1. INTRODUCTION

Ancient China has discovered that droplets slowly penetrate the rock by virtue of the mass hitting force imparted by the free-fall movement. With the development of science and technology, people give the droplets a much greater impact than the free-fall body movement. Perseverance can only be observed in the moment when the dripping stone is observed. This is the water jet[1]. Water jet technology is also called water jet technology. It uses water as a medium to make it get a huge amount of energy through a high-pressure generating device, and then uses a specific flow movement method to spray high-intensity energy from a small nozzle at a high concentration.

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shot blasting, it has many advantages such as good reinforcement effect, low cost, no pollution, easy automation, and easy reinforcement of narrow and deep groove parts [2]. Therefore, it is of great significance to design a high-pressure water jet machine and apply it to eliminate residual stress.

2. GEAR RACK DRIVE

The design of high-pressure water jet machines needs to proceed from each organizational structure, accurately design each component, and finally organically combine them to meet design requirements. It should follow the principle of low cost, low quality, and easy handling. The movement of the X-axis is straight-line movement, the movement speed is not high, the work table needs to drive the workpiece to move back and forth 5 to 10 times, so that the water jet fully acts on the workpiece, so that the residual stress is eliminated more thoroughly. The rack and pinion drive can convert rotational motion into linear motion, and its bearing capacity is large, the transmission accuracy is high, up to 0.1 mm, and the length of docking can be changed freely, and the range of transmission speed is selected to be large. The precision required for processing and installation is low, and its effect on the performance after wear is small. Therefore, this program chooses rack and pinion drive, connects the coupling, the connecting shaft and the rack and pinion through the deceleration motor, the rack and the workbench are welded, the workpiece is placed on the workbench, a series of movements are transmitted, and finally the round-trip motion of the workpiece is realized. . The scheme diagram is shown in Fig. 1:

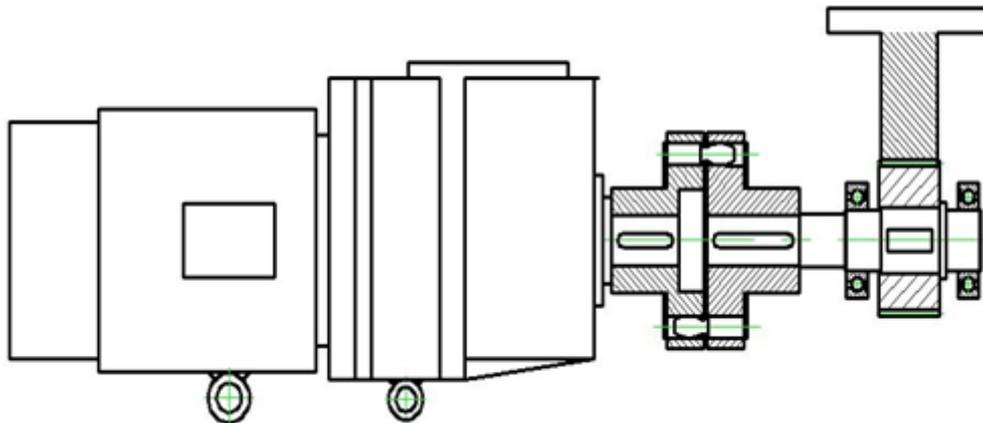


Fig. 1 Gear rack scheme

3. BALL SCREW DRIVE

When the high-pressure water jet machine is working, the nozzle is required to be directly above the weld seam. The distance between the nozzle outlet and the weld seam is 5 to 10 mm. The jet of water ejected by the nozzle is perpendicular to the workpiece surface, and the nozzle movement speed is not required to be high. In order to meet the moving precision, the ball

screw drive is selected [3]. The nozzle is connected to the worktable in the vertical direction (Z axis). The workbench is connected with the ball screw. The motor drives the ball screw through the coupling, which will eventually drive the nozzle up and down in the vertical direction. The scheme diagram is shown in Fig. 2:

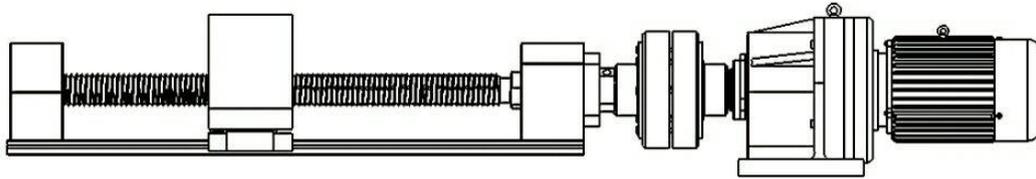


Fig. 2 Ball screw scheme

4. HIGH-PRESSURE SYSTEM DESIGN

At present, there are mainly three types of high-pressure water production methods in water jet equipment [4-5]:

The first is to pressurize the water directly with a high-pressure pump, which eliminates the need for a hydraulic oil system. The structure is simple and the construction cost is low, but its pressure is not high and it is mostly used in applications below 300 MPa.

The second is to use a combination of a plunger pump and a reciprocating booster to achieve the purpose of pressurizing the low pressure water according to the principle of force balance between the two ends of the piston. Its structure is relatively simple and the pressure is high, but due to the presence of the phase difference of high pressure water, it has unavoidable pressure fluctuations.

The third type is a phase booster in which two or more reciprocating boosters are connected in parallel. Since the phase difference of the output high-pressure water is reduced, the pressure fluctuation value is relatively reduced, but its structure is more complicated and the control and maintenance are more difficult.

The maximum pressure of the designed high-pressure system is 250 MPa. The use of a high-pressure pump can meet the requirements, and the structure is simple, the construction cost is low, and it is reasonable. The scheme diagram is shown in Fig. 3:

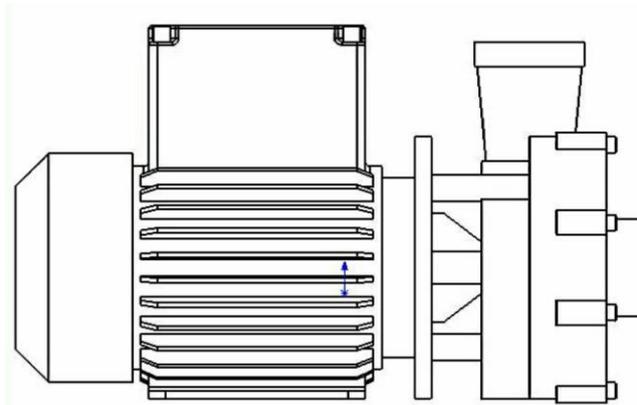


Fig. 3 High Pressure Pump

5. WORK PROCESS OF HIGH PRESSURE WATER JET MACHINE

In order to better eliminate the residual stress of the welding workpiece, the high-pressure water jet machine should operate according to certain requirements. The specific working steps are as follows:

After the welded workpiece is cooled, it is fixed on the working platform (X axis horizontal direction);

Move the nozzle directly above the weld seam. The distance between the nozzle outlet and the weld seam is 5 to 10mm. The jet of water ejected by the nozzle is perpendicular to the surface of the workpiece.

To start the high pressure water jet system, adjust the water jet beam axis heart pressure is 220 ~ 250MPa;

Starting from the starting point of the weld, moving the workpiece along the direction of the weld to the end of the weld (the starting and ending points are relative to the nozzle).The workpiece moving speed is 100mm/s, keeping the nozzle outlet and weld spacing unchanged; Maintain the distance between the nozzle and the workpiece in step (4) and the workpiece movement rate. Move the workpiece reciprocally 5 to 10 times in the direction of the weld and close the hydraulic system.

The working schematic is shown in Fig. 4 [2]:

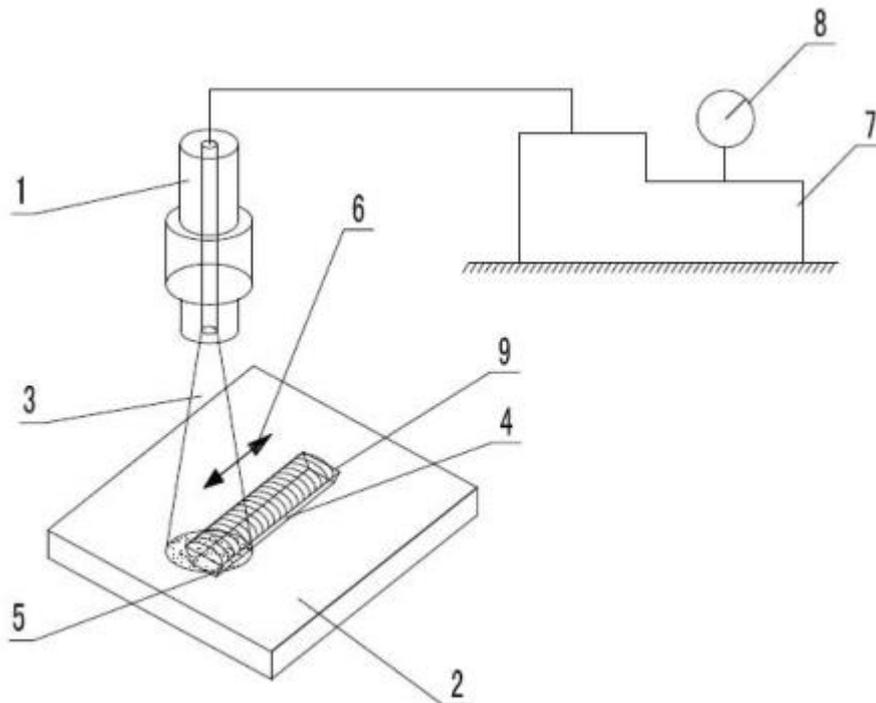


Fig. 4 Schematic diagram of high-pressure water jet machine

6. CONCLUSION

This design is an application-type design. Based on the principle of surface enhancement of water jets, the basic composition of the machine: the power section and the transmission

section are designed in two parts. The equipment that can meet the basic working requirements is designed. Among them, The power section includes the design of the high pressure system; the transmission part includes the movement in two directions, the movement in the Z-axis direction and the movement in the X-axis direction, which are respectively the rack and pinion drive and the ball screw drive design. The equipment is based on the surface hardening principle of high-pressure water jet, which can effectively eliminate the residual stress of the welded part and improve the performance of the structure.

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