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Design and Research of Pneumatic Fixture Based on Automotive Sheet Metal Parts

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Abstract：Based on the need for rapid welding of intelligent automotive sheet metal parts, a pneumatic clamp was developed for this process. The design of the fixture measuring mechanism, fixture base plate, clamping device and positioning mechanism was elaborated in detail. The simulation of the vulnerable unit in the fixture system proved that the pneumatic fixture has high safety and reliability.

1. Introduction

Pneumatic fixture is a special process device which is assembled and fixed in the process of machining. Its performance directly affects the quality of products. The rationality of the fixture design is to ensure that the workpiece quality, improve labor productivity, reduce labor intensity, the basic way to reduce the manufacturing cost [1, 2].Therefore, the continuous development of pneumatic clamp is a great power, to push forward manufacturing current fixture research is widespread attention from domestic and international manufacturing industry [3].Pneumatic clamping in processing technology in a key position, therefore to design a reasonable and advanced fixture has a realistic significance to the development of manufacturing industry.

2. The structure of fixture design

2.1. The positioning device structure design

The automotive sheet metal pieces need to connect with other components in the process of welding, so in the process of positioning clamping, it should be located in clamping operation respectively.

The processing sheet metal parts is the stamping forming of sheet parts, appearance is more special, so the clamping and location shall be fully considering the size and the prestressing force can hold.

The positioning plate is made of Q235 steel plate, thickness of 12 ~ 19 mm. Because of not only ensures the precision positioning block spacing, but also to ensure that the electrode holder into the convenience. According to the above practical application and the six-point positioning principle, the clamping and fixing points are designed as shown in figure 3.

2.2. The concrete structure design

2.2.1 Design of measuring mechanism

Datum level and reference slot. The reference level of the measuring mechanism is the working surface of the fixture floor, and the reference slot is designed on the fixture floor with two vertical cross grooves.

The position of the slot may be determined by actual need, but the design principle should be such that the coordinate points are located on a hundred bits, as shown in figure 1.

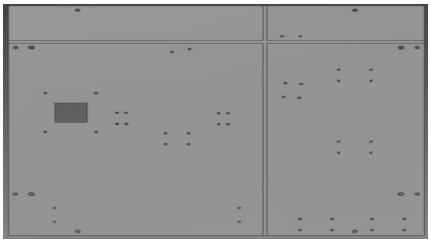

Fig. 1 Measuring mechanism

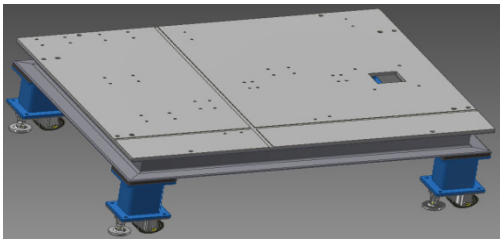

Fig. 2 Fixture floor

2.2.2 Fixture floor

The bottom plate of clamping device is the basic component of clamping device. Its precision directly affects the accuracy of positioning mechanism.

The length of sheet metal clamped by this fixture is 0.767m, and relevant materials are consulted [4]. The clamping fixture bottom plate is of the size of: the length of the bottom plate is between 1-2m. Use steel plates of 20-22mm thickness. Section steel USES no. 16 channel steel.

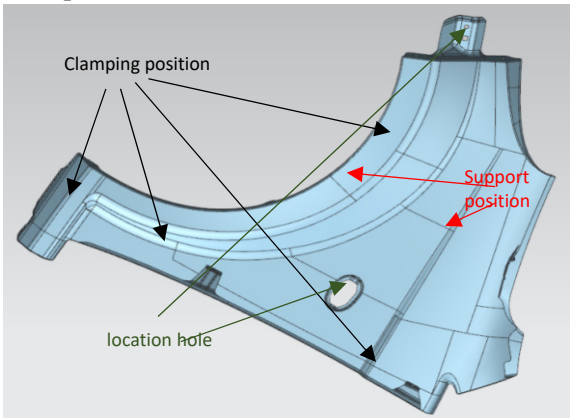

Fig.3 Sheet metal clamping master diagram

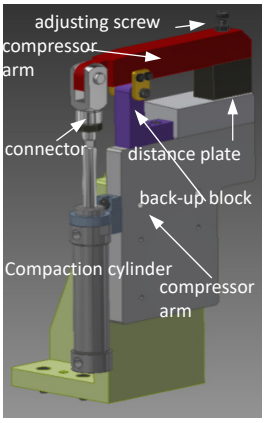

Fig.4 Clamping device

Fig.5 Schematic diagram of leg

2.2.3 clamping device

The design of the fast clamping device is shown in fig 4. The realization of the fast clamping device is that the compressed cylinder actuates the fixed function of the sheet metal through the connecting head driven by the compression rod. For sheet metal parts formed by sheet metal stamping the clamping force action point acts at the supporting point to avoid the phenomenon that the clamping force makes the workpiece bend or deviate from the positioning datum. According to the documents and the actual situation of sheet metal, for the stamping parts between 1.5-2.5mm, the clamping clearance is not larger than that of 1.5mm. The clamping force of each clamping point is 500-3000N [5].

2.2.4 Design of the leg of pneumatic clamp

The large size of the sheet metal makes the fixture need to carry heavy load. In order to facilitate the jig to move freely in the assembly line of the workshop, to meet the needs of production and to improve the working efficiency, the pneumatic fixture pillar is designed as a hybrid structure of roller and foot brace. As shown in fig 4.

2.2.5 Positioning mechanism design

Positioning pin is an important means of locating workpiece. In this design, positioning pin and workpiece hole are matched, the diameter of positioning pin is slightly smaller than workpiece hole 0.2-0.5mm, the shape is similar to that of workpiece hole, and the workpiece can be extended 5-10mm, and the material is made of 4steel with balanced performance. Front high frequency quenching, hardness HRC 42-45, surface blackening treatment [5], positioning mechanism as shown in fig 6.

2.3. Simulation

2.3.1 Simulation analysis

In order to verify the rationality of the design of the pneumatic clamping device, the ANSYS stress simulation analysis is carried out for the compression rod with the largest force and the most frequent movement in the process of use.

The compression rod material is selected as alloy steel. The thermo-physical parameters are shown in Table 1 at room temperature. Because the compaction bar is relatively regular in shape, the three-dimensional hexahedron mesh element is used to divide the material. The cell size is 10mm and the applied load is 100N. It can be seen from the stress distribution diagram 7 that the stress distribution is relatively uniform, in which the stress concentration is about 3.5 Mpaat at the link between the cylinder and the support block, which is far lower than the yield limit of the alloy steel at 460 MPA, and the maximum deformation is about 0.013 mm, which can meet the actual processing requirements.

Table 1 Thermo-physical parameters of alloy steel

Elasticity modulus	density	yield strength	heat conductivity	specific heat
210GPa	7700 kg·m^3	450MPa	50W/(m·K)	460J/(kg·K)

3. Fixture assembly and use

3.1. Fixture composition

The pneumatic clamping device consists of five parts: clamping bottom plate, positioning device, clamping mechanism, measuring system and auxiliary system, as shown in figure 8 below.

The workpiece machined surface location hole and fixture positioning device with a two pin positioning, achieve rapid positioning function by measuring the auxiliary system, by adjusting the controller action button to realize pressure cylinder operation, realize the fixed clamping part. When finished, close the cylinder control switch and remove the workpiece.

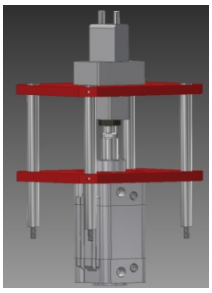

Fig.6 Positioning mechanism

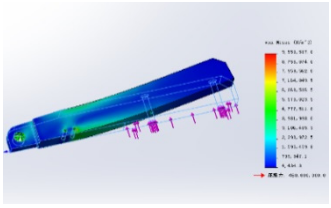

Fig.7 Compression rod simulation diagram

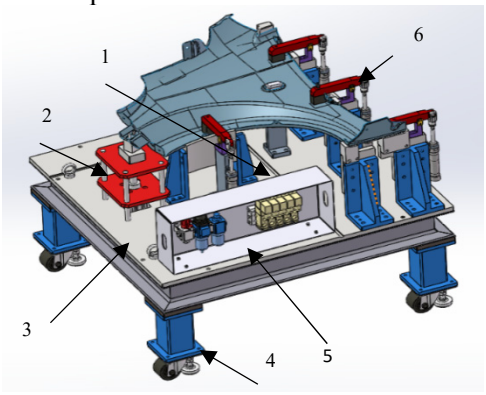

Fig . 8 Assembly drawing of pneumatic clamping device

Measurement assistance system 2-Locating device 3-Fixture bottom plate 4-leg 5-Control system 6-Gripper mechanism

4. Summary

In view of the practical application, the pneumatic fixture designed in this paper has the characteristics of accurate positioning and simple clamping movement, which can fully guarantee the product quality, effectively improve the production efficiency and reduce the labor intensity of the users. Realize the demand of intelligent production. The reliability of the fixture is ensured by the simulation of the vulnerable compression rod. It provides some reference significance for the design of modern NC machine tool fixture.

Acknowledgment

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Reference

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