Fixture design of connecting rod parts

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Abstract

Metal cutting machine tools play an important role in the field of mechanical design and manufacture, and the fixtures used on machine tools are also indispensable in the mechanical design and manufacturing process. In the process of mechanical design and manufacture, the fixture can guarantee the processing quality of its products, improve the production efficiency of the products, reduce the production cost of the company's products, and realize the safe automation of the production of the products by the factory. Clear the processing requirements of the machined workpiece, using a positioning scheme that combines the short pin and the plane. After determining the shape of the workpiece, the clamping scheme for the workpiece is selected, and the common clamping action scheme using the studs, nuts and clamps is finally decided. A quick-change drill sleeve is used for the choice of the guide, and the drill sleeve can be taken out at a certain angle. Of course, each part type of the drill chuck fixture is designed to include a drill sleeve screw, a quick change drill sleeve, and a bushing. There is also the choice of bolts and nuts used in the drill chuck, the design of the platen scheme, and the choice of the specific solution for the clamp.

Keywords

Connecting rod drilling machine fixture, short pin and plane, bolt and clamp, clamp specific.

1. Introduction

Metal cutting machine tools play an important role in the field of mechanical design and manufacture, and the fixtures used on machine tools are also indispensable in the mechanical design and manufacturing process[1]. In the process of mechanical design and manufacture, the fixture can guarantee the processing quality of its products, improve the production efficiency of the products, reduce the production cost of the company's products, and realize the safe automation of the production of the products by the factory[1]. The accuracy of the workpiece after machining is guaranteed to meet the requirements. The various external factors and the technical level of the operator when the workpiece is processed will not affect the machining accuracy of the workpiece, and the accuracy of different parts of the same batch can be processed[2].Try to keep at the same level; shorten labor time and increase labor productivity of workers, which can greatly reduce unnecessary time. Fixtures can also adopt multi-station working position and a large number of clamping parts, greatly improving the labor productivity of their parts[5]. The use of the fixture can augment the processing range of the machine tool. When the batch processing of the parts is not too much, the type and specifications of the workpiece are relatively large, and the machine type is not satisfactory, the design machine tool fixture can be used[3]. Increase the technological scope of the machine tool, for example, install the die on the lathe of the lathe, so that the box with the hole system can be processed; the production conditions of the laborers can be improved, the production and processing products of the enterprise can be reduced, and the parts can be mass-produced and processed. After the fixture is used, the clamping and disassembly of the parts is more convenient and quicker, and the pneumatics are used. Tight, force-expanding mechanism, etc., can make production conditions of the operator has been greatly improved, resulting in a large degree of product rejection rate of decline in business.

A jig used in a drilling machine for drilling, expanding, reaming, and threading a workpiece is referred to as a drill jig, and is generally referred to as a jig[2].In the use of the drilling process, the positional accuracy of the hole or the hole system can be improved, which is advantageous in ensuring the accuracy of the size and shape of the hole[4].

2. Fixture design of connecting rod parts

2.1 Overall structural design of the fixture of the connecting rod parts

Analysis of the Fig. 1 link part drawing requires machining of two axially threaded holes with a diameter of 14. Assume that the axial direction is the Z-axis direction. To machine two threaded holes, we only need to limit 5 degrees of freedom through the analysis of the part structure, including X-axis, Y-direction movement and rotation around the X-axis, Y-axis, and Z-axis. Of course, after another analysis, it can be seen that when the six degrees of freedom are limited, that is, the limitation of the movement in the Z direction does not affect the processing of the part, we can adopt a fully positioned positioning scheme.

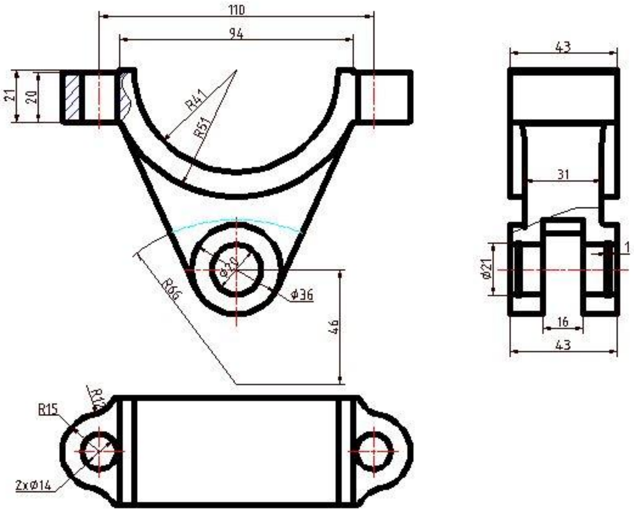

Fig. 1 Part drawing

Therefore, it is considered that the large plane positioning scheme limits the three degrees of freedom, and a short cylindrical pin limits the two degrees of freedom. Of course, it is also necessary to add a short pin under the contour of the part to combine to limit the rotation in one direction. When the translation in three directions and the rotation around the three axes are tightened, the processing requirements of the part are fully guaranteed. Its positioning scheme is shown in Fig. 2.

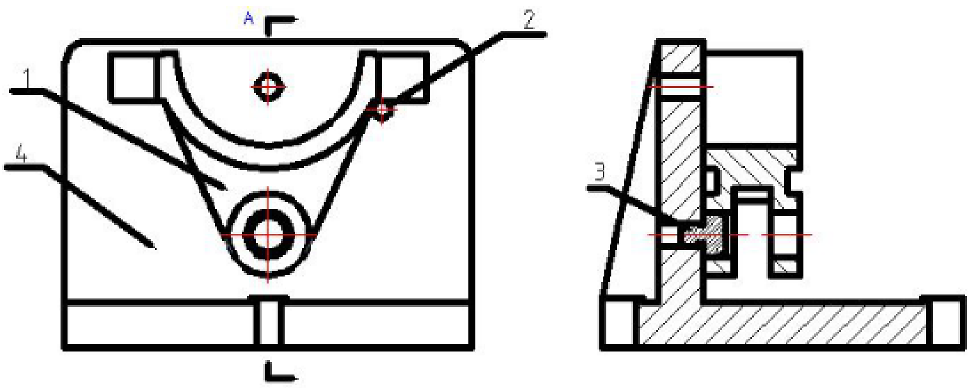

Fig. 2Positioning scheme design

1-workpiece 2-short cylindrical pin 3-short locating pin 4-clamp specific plane

2.2 Design fixture clamping scheme

The workpiece to be machined is relatively small in volume and its quality is not too great. Therefore, a standard type of drill will be used, and its overall stress and connection conditions are ideal. Moreover, the clamping force required by the workpiece is not very large, so the clamping scheme we designed can be completed by the staff's direct manpower. In the clamping process, the auxiliary force transmission workpiece, we choose to use the bolt and nut cooperation.

We also considered making the process as convenient as possible. We designed the use of open washers, as shown in Fig.3. This is the clamping scheme we designed for bolts and nuts. At this point, after clamping, it is sufficient to ensure that the workpiece does not have a positional offset during the machining process.

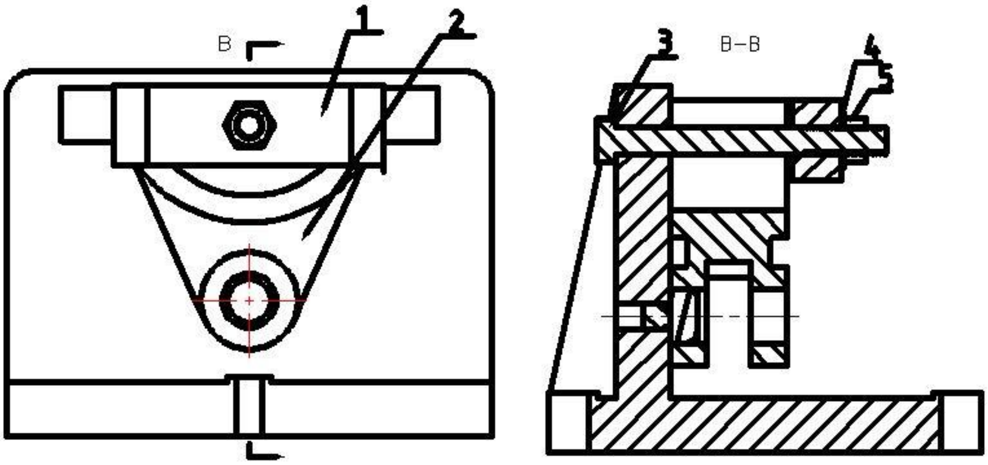

Fig.3 Clamping scheme

1-Auxiliary clamp 2-workpiece 3-M10 bolt 4-open washer 5-M10 nut

2.3 Designing the guiding scheme of the fixture

In the process of processing the parts, the relative position requirements of the threaded holes are ensured, and the position of the tools during machining is not inaccurate. This often requires us to design the drill jigs with guides for the fixtures throughout the design. In the structure, the guiding device is very important, which determines the merits of a fixture function. Usually, the use of the drill sleeve can be changed, and the rotation of the drill sleeve is also limited by screws. When the drill sleeve is removed, the screw should be removed first to remove the drill sleeve; the quick change drill sleeve is replaced by the replaceable drill sleeve. Faster, we don't need to screw out the screws completely, and turn the drill sleeve to a smaller angle to replace the drill sleeve.

We use the quick-change drill sleeve for the drilling fixture for the connecting rod parts of this time, as shown in Figure 4. Our process requires threaded hole processing. We first drilled the drill with a diameter of 14 on the drill bed, and then used the tap to perform the manual tapping step. The drill sleeve used is different, so we have to use Replace the faster drill sleeve, that is, the quick change drill sleeve.

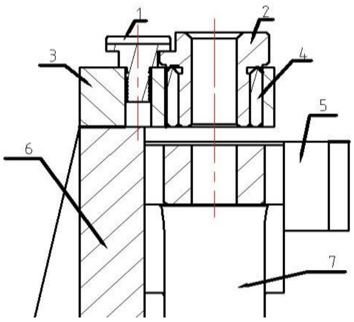

Fig.4 Oriented design

screw 2-fast-change drill sleeve 3-drill template 4-bushing 5-pressure plate 6-clip specific 7-workpiece

3. Parameter calculation

3.1 Calculation of drilling cutting force

We use Q235 steel to machine parts and use high-speed steel as the material of the drill bit.

Table1knows the torque:

$$M = 0.34d^2f^{0.8}K_p \quad (1)$$

Drilling force:

$$F_f = 667df^{0.7}K_p \quad (2)$$

The meaning of each coefficient is:

K is the correction factor, Available from Table 2 $K_p=(\sigma_b/736)^{0.75}$

d is the diameter of the drill,

f is the feed per revolution,

Set all Drill machine $f = 0.05mm/r$

So $K_p=(\sigma_b/736)^{0.75} = 1$

$M = 4.383N \cdot m$

$F_f = 974.882N$

Table 1 Estimation of drilling cutting force

Numble	Mechanical properties	Workpiece material	Tool material	Processing methods	Calculation formula
1	Drilling torque M	Structural steel	High speed steel	Drill	$M = 0.34d^2f^{0.8}K_p$
2				counterbore	$M = 0.88da_\sigma^{0.8}f^{0.8}K_p$
3		Heat resistant steel	High speed steel	Drill	$M = 0.40d^2f^{0.7}K_p$
4		grey cast iron	High speed steel	Drill	$M = 0.21d^2f^{0.8}K_p$
5				counterbore	$M = 0.83d^2a_\sigma^{0.75}f^{0.8}K_p$
6			Cemented carbide	Drill	$M = 0.12d^{2.2}f^{0.8}K_p$
7	Drilling force F	Structural steel	High speed steel	Dril	$F_f = 667df^{0.7}K_p$
8				counterbore	$F_f = 371a_p^{13}f^{0.7}K_p$
9		Heat resistant steel	High speed steel	Dril	$F_f = 1402df^{0.7}K_p$
10		grey cast iron	High speed steel	Dril	$F_f = 419df^{0..8}K_p$
11			Cemented carbide	Dril	$F_f = 412d^{1.2}f^{0.75}K_p$

Table 2 Correction factor values

Numble	Workpiece material	grey cast iron	Malleable cast iron	copper
1	K_p	$(HB/150)^{0.6}$	$(HB/150)^{0.6}$	1.7~2.1

3.2 Design tightening mechanism clamps and check bolts

For the design of the compact, we need to follow the dimensions and machining requirements of the workpiece, as well as the internal and external structure of the entire drill chuck. The finished design is shown in Figure 5.

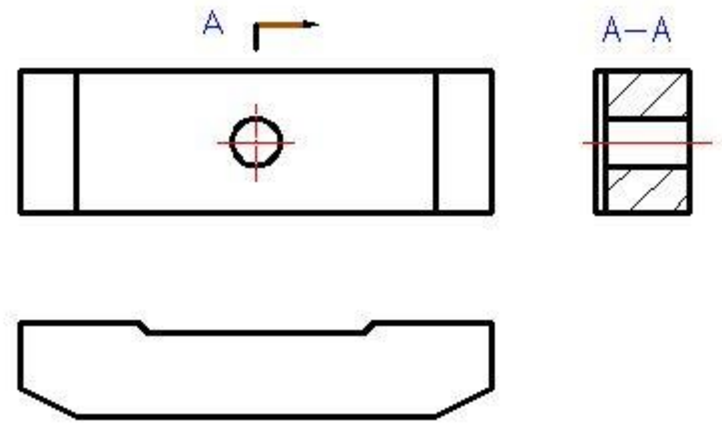

Fig.5 Oriented design

Our design uses a manual clamping device, so it does not need to be calculated very accurately. Table 3 nut shows that the maximum axial force generated by the M10 nut we used is 3570N during the clamping process. Strength check formula:

$$d \geq 2C\sqrt{\frac{F_w}{\pi\sigma_b}} \quad (3)$$

d-External thread nominal diameter

F_w-Axial force

C-coefficient

σ_b-45 # steel, $\sigma_b = 600N/mm^2$

Bring the above parameters, Calculated: $d \geq 4.7$

so the M10 bolt can reach the strength requirement.

According to the material of the workpiece to be processed, Q235 steel, $\sigma_b = 736GPa$,the material uses high-speed steel cutter, the drill with a diameter of 11.9mm, Drilling machine feed rate: $f = 0.05mm/r$, Found by the mechanical design manual:

Feed force:

$$F_f = C_{F_f} d^{Z_{F_f}} f^{F_f} K_{F_f} \quad (4)$$

Torque:

$$M_c = C_{M_c} d^{Z_{M_c}} f^{M_c} K_{M_c} \quad (5)$$

And according to the material of the workpiece and the tool, we can know:

$C_{F_f} = 600 \ \ Z_{F_f} = 1.0 \ \ F_f = 0.7$

$C_{M_c} = 0.305 \ \ Z_{M_c} = 2.0 \ \ M_c = 0.8$

So: $F_f = 309.5N \ \ M_c = 0.49N \cdot m$

By the designed compact size, $F_w = \frac{KM}{2fr}$

For formula:

M-Drilling torque   From the above: $M = 0.49N \cdot m$

f-Coefficient of friction, $f = 0.15$

K-fety factor, $K = 2$

r- rquivalent friction radius, $r = [(D^3 - D_2{}^2)/(D^2 - D_2{}^2)]/3$

D- Workpiece diameter ,D=74mm

D_1-Perforated plate diameter，$D = 25mm$

So, $F_w = 122N$, Can find the clamping force of the M10 size nut 3570N

$F_w = 122N < 3570N$

Therefore, the M10 bolt can fully meet the requirements.

Table 3 Clamping force of hex nut with wrench

Numble	Nominal diameter of thread d	Thread diameter d_2	Handle length L	Force on the handle F_Q	Generated clamping force F_w
1	10	9.026	120	45	3570
2	12	10.863	140	70	5420
3	16	14.701	190	100	8000
4	20	18.376	240	100	8060
5	24	22.052	310	150	13030

4. Conclusion

The main innovation is the design of the structure to ensure the efficiency and processing accuracy of the processing. The design is easy for the operator to process and maintains efficient operation. Secondly, the rapid drilling sleeve was designed and used. After the hole was processed, the original drill sleeve could be quickly removed and replaced with the drill sleeve used in the other process. The labor intensity required is greatly reduced, and the labor efficiency of production is greatly increased. In general, the design of the drill-clamp fixture for the connecting rod parts is quite successful, effectively solving the problems in production and meeting the requirements for its use.

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