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Fixture Design for Automobile Oil Receiving Tray Reaming and Milling

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Abstract

Common solutions of fixture design for nonstandard part machining is clearly expatiated as to the automobile oil receiving tray drilling and milling are operated: set forth the fixture solution according to the form of the part and data of the machining equipment, explicit the structure composition of fixture, and calculate the fixture process data, which is basically needed for perfect clamping.

Keywords: *Automobile Oil Receiving Tray; Fixture Design; Fixture Solution; Structure Composition; Process Data*

1. Introduction

Automobile oil receiving tray is with irregular shape and high machining precision, as to the Figure 1, the work piece is pressure casting formed and is with good quality as the semi-finished product. The to be machined elements are the border milling with flatness error is not exceeding 0.25mm, middle island surface milling with roughness error is not exceeding 0.8μm ,hole broaching with roughness error is not exceeding 0.8μm. All machining is operated on the Numerical Control Center, and all the machining items finished with only once fixing[1-2].

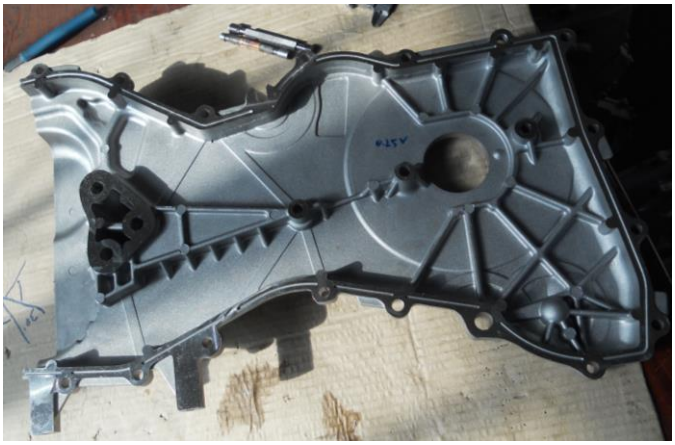

Figure 1. Work Piece for Machining

2. Scheme Design

Fixing is resorted to one surface and two locating pins. As shown in Figure 2, the two locating pins are at No.4 and No.10, and the freedom of moving along the X axel and Y axel is restricted and rotation freedom around the z axel is also restricted. Bearing posts of No.1, No.5 and No.8 confirm another plane which restricted the rotation freedom around X axel and Y axel, and the moving freedom along Z axel is also restricted, too. The above

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fixing scheme meets the requirements of totally fixing. Auxiliary bearing post at the places of No.2, No.3, No.6, No.7, No.9 and No. 11 avoid the part deforming in the process of machining, all auxiliary bearing posts have no conflict with the six point fixing principle, but peered the fixing force and the machining force [3].

Compositions of the fixture are locating post, auxiliary bearing posts, locating pins, fixing components, connecting components and the fixture body [4].

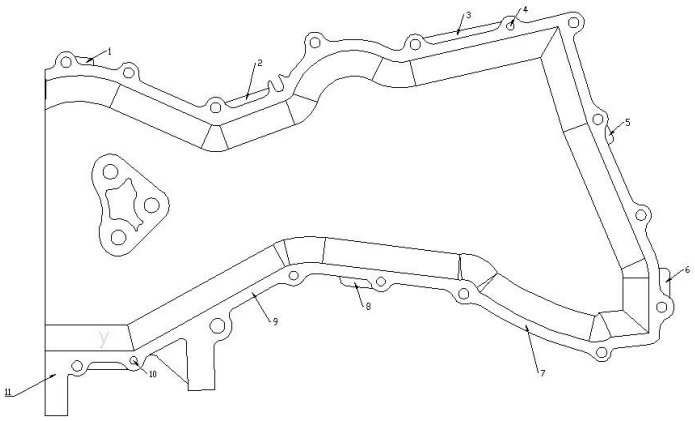

Figure 2. Fixing Locations

Three-dimensional modeling of the fixture is as shown in Figure 3.

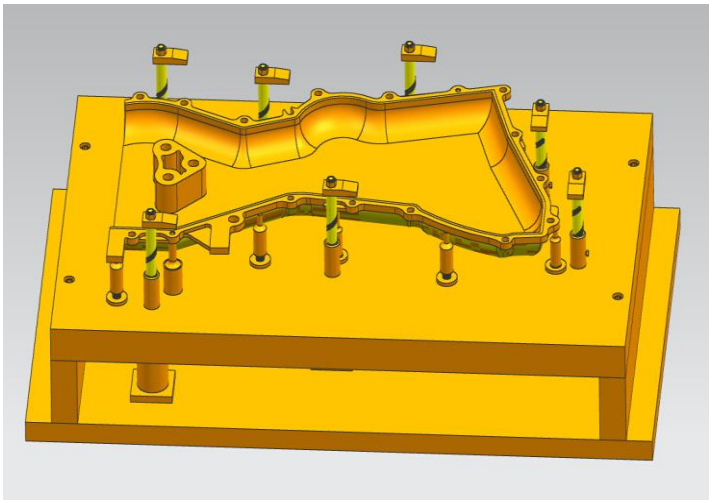

Figure 3. Three-Dimensional Modeling of the Fixture

Technical requirements for fixture design: rated working pressure of the cylinder is 0.25NPa, and cylinder piston rod axel is perpendicular to the surface of the fixture body so that the cylinder has good working i.eproperties [5].

Cylinders near the locating pins and post should be operated and has the work piece clamped firstly, thus the work piece is located precisely, other four cylinders are to be mobilized as the auxiliary bearing posts are adjusted. Total fixing force is counterpart the machining torque, and the work piece must be fixed firmly in the process of machining. Air compressor works in a stable state so that ensure the going through clamping force is in a stable state in the machining process which is good to minimize work piece vibration and misplacement; but pay attention to the clamping force so that it does not exceed certain quantity in case of work piece deformation or damage[6].

3. Fixture Body Design

3.1. Fixture Body

Fixture refers to the primary skeleton of the fixture; it includes the mounting plate of the locating elements and clamping elements except the connecting to the die holder. Fixture body must be with good strength and stiffness so that to make the stable dimension and the matching surface, the fixture body is also with adequate machining precision[7].

The designed fixture is to use on the XH7145A numerical controlled machining center, the working platform of the machine is with T groove for fixture assembling, some of the technical data is as shown in Schedule 1.Which is necessary for the special fixture design.

Schedule 1. Primary Technical Data of the XH7145A Numerical Controlled Machining Center

item	unit	technical index
stroke of X axel	mm	700
stroke of Y axel	mm	450
stroke of Z axel	mm	500
Distance between main shaft and operating platform	mm	145-645
Distance between main shaft and upright lead rail	mm	460
fast moving（X/Y）	mm/min	12000
fast moving（Z）	mm/min	1000
feeding rate	mm/min	1-5000
dimension of operation platform	mm	700X450
Bearing rate of operation platform	kg	600
T grove of operation platform(quantity、groove broad、interval)		3/18/125
Max speed of main shaft	r/min	8000
motor rate of main shaft	kw	5.5/7.5

The assemble drawing of the fixture body which is with pedestal is as shown in Figure 4. Technical requirements: fixture body is adopted 45 steel with annealing and ageing treatment so that to reduce the internal residual stress. The locating posts, pins and auxiliary bearing posts must be machined according technical requirements of the parts. Upper and lower surfaces of the fixture body must be kept parallelism with the plainness no more than 0.1mm. Dimensions of the fixture is 550mm×350mm×50mm.

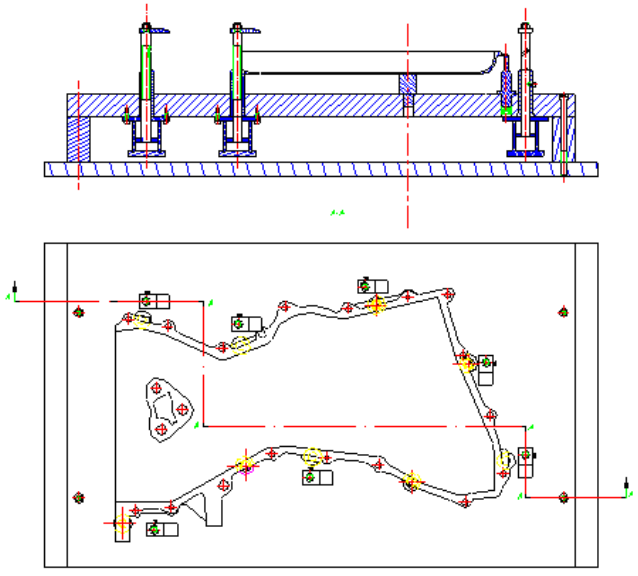

Figure 4. Assemble Drawing of Fixture Body

3.2 Locating Parts

Locating parts of the fixture includes 3 locating post which confirm the bench mark plane; two locating pins restrained other freedom. All locating parts must be with enough stiffness, enough strength and enough abrasion resistance. Locating parts adopt 40Cr material, with annealing and ageing treatment. For locating parts mounting, axis of the parts must be perpendicular to the fixture plane with tight fit. Check the 3 locating post to confirm they are in the same plane, which is very important for precise locating.

Auxiliary bearing posts are made of 45 steel, screw assembling. Rotate the Auxiliary bearing posts until the upper plane surface of the post contact with the machining work piece after its fixing. Auxiliary bearing posts enhance work piece mounted stiffness but with no locating misplacement affect.

4. Technical Data for Fixture Body Design

4.1 Cutting Force Calculation

Cutting force of reaming

Cutting force of reaming is

$$F = 9.81 \times 61.2 d_0 f^{0.7} k_F \tag{1}$$

Thus

$$F = 9.81 \times 61.2 \times 2 \times 1.3^{0.7} \times 1.2$$
$$= 620N$$

Cutting force of milling

Cutting force of milling is

$$F = C_p a_p^{1.1} f_z^{0.8} d^{-1.1} B^{0.95} z K_p \tag{2}$$

Thus

$$F = 167 \times 2^{1.1} \times 0.3^{0.8} \times 50^{-1.1} \times 50^{0.95} \times 6 \times (\frac{343}{736})^{0.8}$$
$$= 236N$$

In Equation (2)

F——cutting force, N

C_p——coefficient considering of work piece material and tool type in process of rapid steel milling

a_p——milling depth, mm

d——diameter of milling tool, mm

f_z——amount of feeding for each tooth of milling, mm

B——milling width, mm

Z——number of milling tool

K_p ——coefficient of correction considering of work piece material in process of rapid steel milling

4.2 Clamping Force Calculation

Clamping force is

$$W_K = \frac{KF}{\mu_1 + \mu_2} \tag{3}$$

Thus

$$W_K = \frac{2.5 \times 620}{0.7 + 0.5} = 1292N$$

In Equation (3)

K is 2.5 as the calculated value of K is 2.5.

μ_1 ——friction factor between clamping part and work piece, μ_1 =0.7

μ_2 ——friction factor between work piece and bearing surface, μ_2 =0.5。

Only one machining style is implicated, and the reaming force is larger than the milling force, thus the reaming force is as the bench mark for clamping design.

4.3 Cylinder Selection for Clamping

Effective force as cylinder retraction is

$$F_2 = \mu_2 p \frac{\pi}{4}(D^2 - d^2) \tag{4}$$

Thus

$$F_2 = 0.55 \times 0.25 \times \frac{\pi}{4}(50^2 - 20^2)$$
$$= 225N$$

In Equation (4)

F_2 ——effective force as cylinder retraction, N

μ_2 ——thrust coefficient as cylinder retraction

P——working pressure, MPa

D——piston diameter, mm

D——piston rod diameter, mm

The design fixture adopted 7 cylinders, total output force if 225×7=1575N, which super the clamping force WK with properly margin. That makes the selection of the cylinder with the piston diameter of 50mm, piston rod diameter of 20mm.

5. Conclusion

The special fixture for the irregular work piece machining is convenient for both mounting and adjusting, and the reaming and milling are both carried out with one fixing

for the work piece machining, the simple and flexible fixture is secured the machining qualities of the work piece.

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