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The design & calculation for hydraulic cylinder of workpiece hydraulic clamping system of a special CNC machine for guide disc

Ke Yang[a], Shangjun Guan, Cunlong Wang

College of Mechanical Engineering, BeiHua University, Jilin 132021, China

Abstract

This paper describes and introduces the design of hydraulic cylinder, which has ensured the safety and reliability of workpiece hydraulic clamping system of a special CNC Machine Tool for Guide Disc.

Keywords-hydraulic cylinder;guide disc;CNC machine tool; clamping mechanism

1. Introduction

The guide disc machine tool, which is mainly used in the guide disc producing in the product line of the hot rolling seamless steel tube, is a sort of special-purpose machine tool for metal cutting. The function of the guide disc is to roll the capillary tube with long mandrel after perforation into the tube with thin wall, which is shown as Fig. 1. Since in the technique of tube rolling, the guide disc is easily to be abraded and difficult to adjust, besides, after constantly tube rolling for 40 to 60 tons on one group of guide discs, the abrasion on the outside of the guide disc is severe and it requires to reproduce to the original arc. Therefore, the guide disc machine tool is specialized and compulsory in this process.

In the last decade, Chinese original design of the normal numerical control machine tool, which emphasizes on the traditional manual clamping style for the workpiece, the manual impulse of the spindle feed stepless, and the structure of the split style, can not match the technical requirements for the efficiency, accuracy, and automation when producing guide disc. In this circumstance, a Special

* Corresponding author. Tel.: 86-18643205988.
E-mail address: keyang2009@163.com

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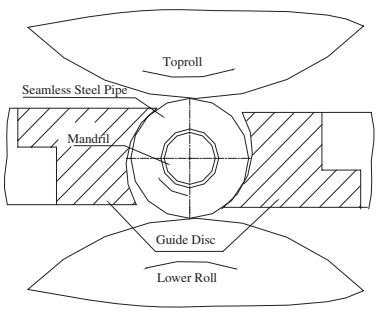
Numerical Control Guide Disc Machine Tool is developed, and which achieves the goals of automatically clamping workpiece, telescopic hydraulic control spindle, and holistic structure design. The precision of the repositioning reaches at 0.008mm and the surface roughness reaches at Ra1.6μm. In the mean time, in order to improve the reliability and stability, the Active Isolation Technology is adopted.

Owing to the manual clamping style of the guide disc machine tool, the operators has to work on the worktable which seems to be about one metre tall to clamp the workpieces and with no doubt that it will be definitely more troublesome and dangerous.

The part of solid line is the hydraulic clamping mechanism of the clamping system specially designed by us to make the guide disc workpiece clamp automatically (Fig.2), which implies that as long as the button is pressed by the operators, the workpiece will be clamped of its own quickly. Moreover, it also proves to be stable, safe, reducing the labor intensity of the operators.



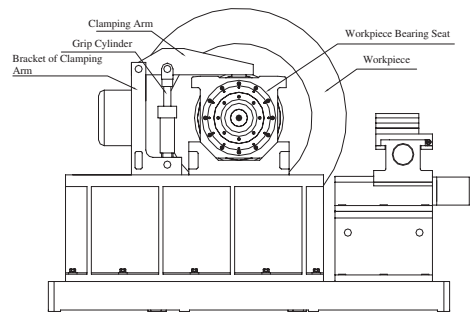


Fig. 1. The sketch map of the rolling of the seamless pipe; Fig.2.Hydraulic clamping mechanism

2. Design parameters of the hydraulic cylinder

2.1 Basic Design Parameters

Working pressure on plunger: F_W=32346N; Working hours: 4.5s;
Maximum speed:

$$\upsilon_{\max} = 60\ mm/s$$

2.2 Forces Analysis of Oil Cylinder Plunger

The applied forces on plunger are shown in "(1)" when the plunger is working.

$$F_P = F_W + F_R + F_I + F_f + F_S \tag{1}$$

F_P —
F_W —
F_R — o 0 when the oil is in oil box.
F_I —
F_f — mponents except oil cylinder.
F_S — der and the seamless plunder bar.

2.3 The Flow Calculation of Hydro Cylinder

The flow is shown in "(2)":

$$q_{\max} = \upsilon_{\max} A / \eta_m \tag{2}$$

Where "A" is the applied force area when oil return is under way.

$$A=(D^2-d^2)\pi/4$$

$$A=(100^2-50^2)\times 3.14/4=5887.5\text{mm}^2 \tag{3}$$

In which:

D —Inner diameter of the cylinder, further information accessible from calculation part of the cylinder.

d —Diameter of plunder bar, further relevant information from calculation part of the plunder bar.

$\upsilon_{\max}$ —Maximum speed, $\upsilon_{\max}$ = 60mm/s.

η_{m} —Mechanical efficiency of oil cylinder, which is defined by the products themselves. However, as to the primary calculation, $\eta_{\text{m}} \approx 0.85-0.99$ and on average, it is 0.95.

Now we substitute into "(2)" and obtain the flow.

3. Design & calculation for hydraulic cylinder

3.1 Design Calculation to the Inner Diameter of the Cylinder

. The design calculation to the inner diameter of the cylinder is shown in .

$$D = \sqrt{4F_P / \pi P \eta_m} \tag{4}$$

In which "P" is the working pressure of the oil cylinder.

3.2 Design calculation of the wall thickness

According to the inner diameter of cylinder "D", outer diameter "D_g" can be obtained through the standard of JB1068-67 and further more, wall thickness can be calculated by "(5)".

$$\delta = (D_g - D)/2 \tag{5}$$

3.3 Design Calculation to the Effective Working Length of the Hydro Cylinder

The effective working length of the hydro cylinder depends on the maximum working journey. Hydraulic clamping mechanism of the guide disc on the oil cylinder is illustrated in Fig.3, whose effective working length relies on the workpiece height, the opening-closing oil height, the module height and a length of free height.

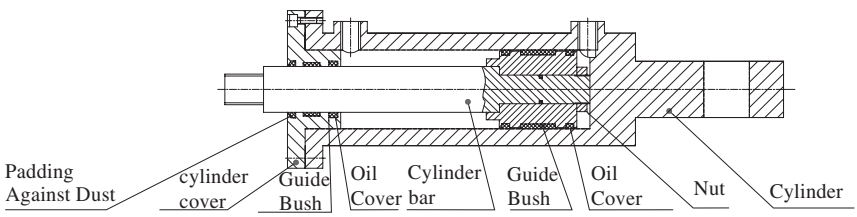


Fig.3. Structure diagram of guide disc's hydraulic clamping mechanism on oil cylinde

3.4 Check on the Intensity of Plunder Bar

Intensity of the plunder bar can be checked and calculated by "(6)".

$$d \geq \sqrt{\frac{4F_P}{\pi[\sigma]}} \tag{6}$$

In which:

d —

$[\sigma]$ – Allowable stress of plunder bar.

4. Conclusion

By means of theoretical calculation, a new kind of feasible and effective oil cylinder is designed in this paper, because of which automatic clamping of the workpiece can be guaranteed. The machine has not only obtained the national utility models patent but also has been put into production. Besides, it is applied to the seamless steel tube enterprise and has created substantial economic benefits to the producing enterprise.

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