

DOI: 10.13434/j.cnki.1007-4546.2014.0409

Structure Design of the Mobile Cutting Machine Tool Based on Pro/Engineer

CAI Chang-liang¹, TANG Shu-feng^{1,2}, QIU Hong-ran¹

¹School of Mechanical Engineering, Inner Mongolia University of Technology, Hohhot, 010051, P. R. China;

²Inner Mongolia Electric Power Research Institute, Hohhot, 010020, P. R. China

Abstract: In order to solve the existing problems of current metal cutting equipment, combined with the development situation of metal cutting industry in China, on this basis, a design can realize multi-shaped metal cutting machine tool. Introduces the working principle of the machine tool, the structure and parameters of the main component, and the establishment of the model by using the 3D modeling software Pro/Engineer (Pro/E); through listing the advantages of the mobile machine, shown that the metal machine tool has the structural characteristics of mobile, semi automated, can improve the cutting precision, increase cutting efficiency, and the utility market has certain value. It has guiding significance for the further study and the potential applications of the mobile cutting machine tool.

Key words: metal cutting industry; mobile cutting machine tool; working principle; Pro/E

1 Introduction

Manufacturing technology has been one of the important pillars of the world economy, economic development is largely benefit from advanced manufacturing technology, and basic manufacturing plays an important role in the whole manufacturing technology. Metal cutting is a preparation process of manufacturing on the basis of manufacturing, the quality of the cutting process will directly affect the follow-up work^[1].

At present, the traditional metal cutting equipment of

the domestic commonly used grinding wheel cutting machine, grinding wheel cutting machine is the use of high-speed rotation of the wheel to cut processing equipment which have widely applied in steel, iron, non-metallic materials and some non-ferrous metals, machinery, metallurgy, automobile manufacturing, construction, mining and other industries^[1-2]. Based on the structure of NC machine tool, made some improvement and designed a movable metal cutting machine tool in the traditional cutting equipment, the metal cutting machine tool has mainly the improvement and innovation in 5 aspects:

1) Design of the horizontal screw moving mechanism;

- 2) Design of the material cutting fixture;
- 3) Design of the dust protection cover;
- 4) Design of the chip collection box;
- 5) Design of the removable feet device.

2 The design of overall structure

In order to ensure the realization of the preset properties, the design principles of the cutting machine tool is^[3-4]: The main structure must be compact and reasonable, the working parts with high independence and affordable. Metal cutting equipment uses a removable desktop structure, the cutting table equipped with cutting collection device, can adopt different modes according to the different styles of the material^[4], the drawing and the completion of the assembly of the whole model are finished in Pro/E, the assembly model is shown in Figure 1.

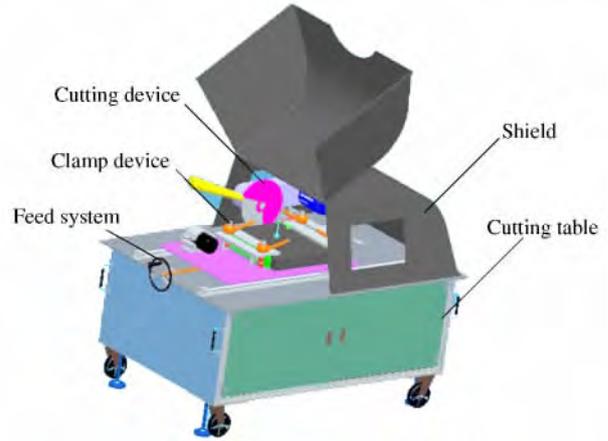


Figure 1 The assembly model

3 The design of main components

Combined with the different shapes of the cutting materials, and ultimately determine the structure of the main components of the cutting machine; during cutting, select different fixtures according to the shape of the material, the structure of main components is shown in Figure 2.

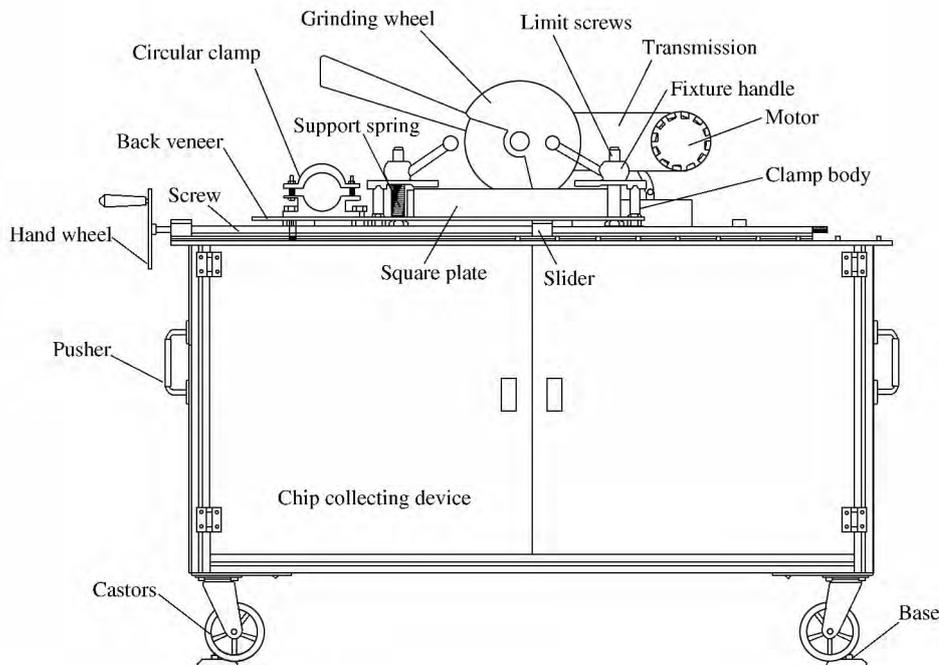


Figure 2 The structure of main components

3.1 The design of cutting device

3.1.1 The choice of grinding wheel

Many different types of grinding wheel cutting machine, with its cutting form can be divided into linear cutter, hanging cutting machine, work-piece rotary cutting machine, cross feed type machine, swing cutting machine and others [1-2]. The form of cut-off of the cutting machine belongs to the work-piece feed type of straight line, this cutting method is widely used and technology enriched, the work-piece feed formula is shown in Figure 3.

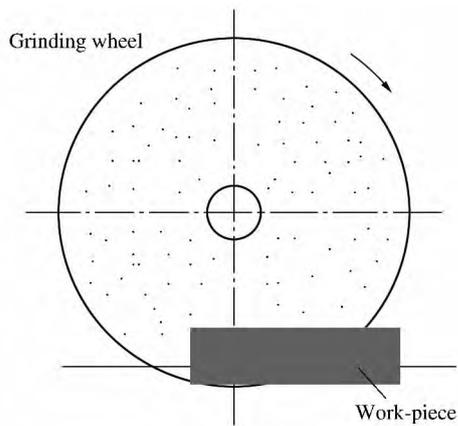


Figure 3 Work-piece feed formula

Depending on the size requirements of the work-piece, resin grinding wheel cutting discs diameter is 400 mm. The grinding wheel sheet of high hardness, good self-sharpening performance, speeds up to 3 500 r/min or more, reference to the multiple brands cutting disc of market, the choice of Shanghai Bluebird brand resin cutting discs which can cut the diameter of the round steel up to 900 mm.

3.1.2 Motor selection

Based on the grinding force and the force analysis of belts and cutting wheel, the wheel speed and other requirements, references commonly used motor

configuration of cutting equipment wheel, selects three-phase asynchronous motors of Y series, technology parameters of the motor is shown in Table 1 [5-6].

Table 1 Technology parameters of the motor

Type	Power/kW	Rated speed/(r • min ⁻¹)	Quality/mg
Y100L-2	3	2 870	25

3.2 The design of clamping device

Machine tool clamping device has always been an important part of the process equipment design, also known as the machine tool fixture. Machine tool fixture should be able to ensure the requirements of precision highly, improve production efficiency, reduce labor intensity and excretion convenience. The combined form of the cutting machine tool fixture using circular metal fixture and square plates, which makes the cut division of labor more clearly, improve the cutting efficiency greatly, the structure of clamping device is shown in Figure 4.

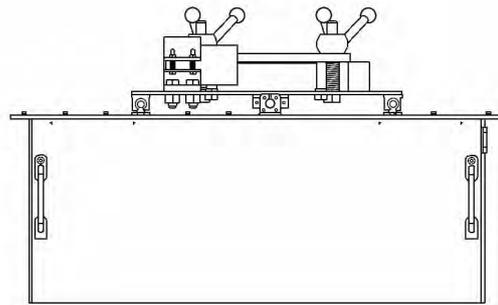


Figure 4 The structure of clamping device

3.3 The design of feed System

Taking into account the form of cutting machine is the way of work-pieces feed, the feed rate of work-pieces needs to be artificially controlled in the cutting

process^[7], therefore, the body uses the matched movement of ball screw and linear guide rail slider axis to achieve the purposes of work-pieces feeding in the design process, the feed system is shown in Figure 5.

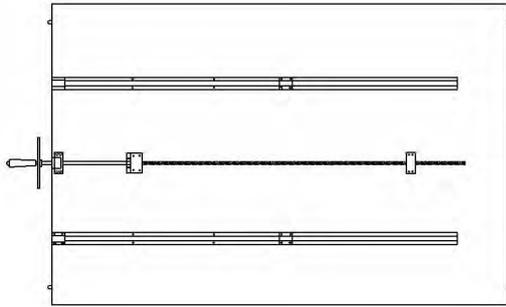


Figure 5 The feed system

The total length of ball screw (l_u) is related to the margin of mechanical (l_a) and the length of nut (l_n):

$$L_u = 2L_a + L_n \approx 1.3L_x = 1800 \text{ mm} \quad (1)$$

$$L_n = (1 - 2) p_h \quad (2)$$

Where, p_h is the transmission ration of reducer; l_x is the maximum travel of machinery.

The type selection of screw is SFU20 × 1800 by calculation, the main shaft ball screw rod provides with a nut and a nut seat, the screw at both ends with two support bases which are fixedly connected with the backboard central, the backboard on both sides is installed a optical axis slide guide, the optical axis guide rail seat is fixed on the machine frame. During the cutting operation, the hand-wheel screw rotating motion makes the backplane motion in a straight line on the slider, to achieve the purpose of the feed of work-piece.

3.4 The design of cutting table

The size of cutting table is 1 800 mm × 1 200 mm ×

600 mm. The cutting platform rack is mainly a combination of 45 × 45 aluminum profile. Aluminum has the advantages of light weight, good plasticity, welding does not require installation and disassembly convenient^[8-9], the aluminum can well meet the design requirements of machine tool, the structure of cutting table body is shown in Figure 6.

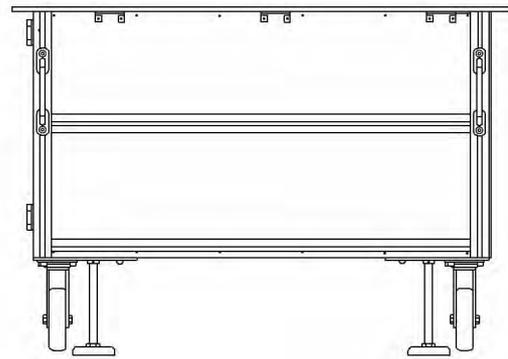


Figure 6 The structure of cutting table body

4 Conclusions

The mobile cutting machine tool has been transformed with the reformation and the innovation of the structure of traditional metal cutting machine, the structural design process of cutting machine tools is described, the transformation of the machine tool has the following advantages:

- 1) The design of horizontal screw feed mechanism, combined with the use of the hand-wheel, the feed rate can be artificially controlled better, thereby reducing the cutting speed of grinding wheel and avoiding overheating and unnecessary damage;
- 2) The unique design of cutting fixture, expanded the range of diameter and thickness of processing work-piece greatly, and can reduce the fixing time of work-piece, then improve the cutting efficiency;

- 3) Added dust protection cover , to solve the traditional artificial manipulation of cutting machine when cutting operations that generate splashing cutting scratch and scald caused by scratches and burns;
- 4) The design of cutting collection device , is a good use of the free space of machine tool , on the other hand can be concentrated and regular collection and disposal on the chips , avoiding unnecessary trouble of cutting chip cleaning every time after the operation;
- 5) With the use of the feet and casters , the machine moving more convenient , labor intensity is reduced , this provides a possible way for cutting machine more automation.

References

- [1] Guo L J , Chao W Y , Bin L , *et al.* Kinematics analysis of a robotic rock grinder [J]. Chinese Science Bulletin , 2007 , 52 (23) : 3229-3304 (in Chinese)
- [2] Bei Z , Can F Y. Grinding of brittle materials with brazed diamond grinding wheel [J]. The International Journal of Advanced Manufacturing Technology , 2013 , 67 (9/12) : 2845-2852 (in Chinese)
- [3] Devrient M , Knoll B , Geiger R. Laser transmission welding of thermoplastics with dual clamping devices [J]. Physics Procedia , 2013 , 41: 70-80
- [4] Jie T W , Guo G W , Wei Z D , *et al.* A general approach for error modeling of machine tools [J]. International Journal of Machine Tools and Manufacture , 2014 , 79: 17-23 (in Chinese)
- [5] Campolo D. Motor selection via impedance-matching for driving nonlinearly damped , resonant loads [J]. Mechatronics , 2010 , 20 (5) : 566-573
- [6] Hoshi E , Shima K , Tanji J. Neuronal activity in the primate prefrontal cortex in the process of motor selection based on two behavioral rules [J]. Journal of Neurophysiology , 2000 , 83(4) : 2355-2373
- [7] Jun Z H , Hua L Q , Qing Z. Shuo , Theory and method of mechanism system design [J]. Frontiers of Mechanical Engineering in China , 2010 , 5(4) : 399-411 (in Chinese)
- [8] Svekrov V M. Increasing the wear resistance of abrasive wheels [J]. Metallurgist , 1971 , 15 (5) : 323-324
- [9] Irie S , Greg K , Ren Z , *et al.* Dynamic property of aluminum foam [J]. The International Journal of Multi-physics , 2010 , 4(2) : 103-111

Brief Biographies

CAI Chang-liang is now a master in the College of Mechanical Engineering , Inner Mongolia University of Technology. His research interests include control and structure design of the robot. 1025012430@qq.com

TANG Shu-feng is now a senior engineer in the Inner Mongolia Electric Power Research Institute. His research interests include control and structure design of the smart grid robot.

QIU Hong-ran is now a master in the College of Mechanical Engineering , Inner Mongolia University of Technology. His research interests include analysis and research of the cardiovascular stent.