

Further Research on the Integration of Headstock Electromechanical Turning and Milling

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Abstract

In this paper, this paper firstly tests the impact of belt drive on the headstock and machine tool under load environment which will bring loss, high friction and reduce machining efficiency. From there, this paper finds the reasons for these effects, analyzes the physical application context of them, changes the possibility of the problem occurring from the substance, and specifies the effects of eliminating heat dissipation, reducing noise, etc. while solving the belt drive problem, thus realizing further research on the integration of the headstock electromechanical turning and milling.

Keywords

Headstock Belt Drive; Integration; Further Research.

1. Background & Technology

CNC machine tools are essential in the industry of machining, which meets the immediate needs of the production of machinery and its systems. The headstock installed to the CNC machine contains the box of the machine, in which there is a transmission device, the drive that acts as power on the market is broadly divided into two types, one is the traditional belt drive, a modern electronic gearbox drive. The headstock equipped with belt drive is more complex in structure, the belt drive requires two to two or more gears, and the size of the gears needs to meet a certain angular and linear velocity, more gears, which inevitably increased the volume of the headstock, resulting in a waste of space resources. With limited factory floor space, it is necessary to increase the number of CNC machines to expand the scale of machinery production and improve the efficiency of the finished product, while the number of CNC machines depends on the limits of the factory floor space capacity. Moreover, the material of the belt is mostly rubber and silicone, which is a consumable product and needs to be replaced regularly. The belt works by sliding friction, which also consumes a lot of energy and adds to the burden of production costs. These are the negative effects of CNC machine headstock belts that hinder the production of high precision, efficient parts machining [1].

2. Program Objectives for Conducting Research on Novel Technologies and Problem Solving

Research content: CNC machine headstock belt is part of the power system components, if the belt can be replaced by other ways to ensure that it does not reduce the speed of the headstock work as well as the accuracy of processing, while retaining all the advantages of the belt drive, so that the loss of the belt can be reduced. Without the belt, the motor and the headstock are integrated, forming a one-piece machine tool headstock, which takes up much less space when installed in the machine tool, and can be installed with various specifications of turning, milling, grinding machines, etc., which is easy to install, and at the same time can replace the headstock of most of the machining class

machine tools on the market. The goal to be achieved by further research on it: Achieving an accurate transmission relationship with other power devices, thus replacing belts, greatly reducing the centrifugal force and amplitude of the spindle when rotating at high speed, improving machining accuracy, and steadily improving the overall performance of the headstock. Moreover, the size of this power unit is nearly one-third smaller than the traditional complex belt headstock, thus solving the negative impact generated by the belt and meeting the immediate needs of mechanical production and processing. And in order to be able to achieve this goal need to solve the problem is to choose a suitable electronic gear box, to ensure that the electronic gear box of high precision transmission, so as to realize instead of mechanical transmission belt to achieve accurate transmission relationship, in the same maintenance cost with the belt can maintain the machinery longer service life. There is also a need to solve the problem of heat dissipation after the formation of the headstock and the motor as a whole, we use a spiral structure of the heat dissipation cylinder, in order to enhance heat dissipation, and then supplemented by water cooling heat dissipation, and thus design a box structure with a volume of one-third smaller.

3. Feasibility Analysis of Novel Technologies

The feasibility of integrating the headstock turning and milling is explained in terms of solving the problems to be solved separately by forming the integrated type and the advantages brought by shedding the belt drive.

The performance of the headstock and motor components, heat dissipation characteristics, friction characteristics and vibration coefficients have an important impact on the high precision characteristics of mechanical parts processing, shedding the belt of the CNC machine headstock, reducing the friction, and there is not much vibration amplitude, but also need to consider the factors affecting heat dissipation. For example, the original belt is in direct contact with the outside world, so the contact area is relatively large, low confinement, which cannot be said to be a disadvantage in terms of heat dissipation, the removal of the belt will reduce the contact space between the box and the outside world, which will certainly affect heat dissipation. It is important to analyze the factors affecting heat dissipation and use the data to draw conclusions. If the real data meet the criteria for machining mechanical parts, then the study of the integration of turning and milling in the headstock is feasible.

Design the structure of integrated headstock turning and milling, with design features: Motor housing, motor spindle removal, streamlining of motor bearings, disappearance of lathe spindle pulley and omission of belt. It adopts the spiral structure of heat dissipation cylinder, the unique structure of water-cooled inflow flow channel, so that the motor cooling and processing cooling synchronized to save water and electricity resources, its combined above-mentioned advantages, cost saving, retaining features, and tight and detailed structure. The spiral structure of the heat sink barrel and water-cooled infusion can compensate for the low heat dissipation performance caused by the reduced contact area in the box, because the spiral structure is to reduce the volume while increasing the contact area of the motor surface, through the physical application of the background to achieve the goals required by the new technology. The unique structure of the water-cooled inflow runner plays a major role in determining the cooling efficiency of the motor, and the R&D designers continue to optimize the line and shape of the runner to improve the cooling efficiency of the water-cooled inflow and enhance the performance of the cooling system. In addition, increasing the number of runners and using cooling water with different effects can significantly increase the cooling efficiency, but at the same time lead to greater pressure losses. Therefore, the efficiency of water-cooled infusion in the actual design process cannot be increased indefinitely, and a water-cooled infusion system that meets the needs of its own industry should be developed according to the reality [2].

We have designed the structure of integrated headstock turning and milling. Whether its performance can surpass the traditional headstock requires several experiments to exclude the chance of conclusion, so we have to find an easy and efficient way to measure the statistical experimental data. The specific

method of collecting experimental data: through controlled experiments, study the traditional CNC machine tool headstocks on the market and turn-mill integrated headstocks, record the parameters of the experiments, and compare the final experimental parameters to find out whether the data of the temperature characteristics of the turn-mill integrated headstocks can surpass those of the common headstocks with motors on the market. With regard to temperature, the main purpose is to monitor the heat dissipation of the headstock, combine the actual measurement with the theoretical calculation to come up with a comprehensive data, and compare the comprehensive data of the integrated headstock with the traditional headstock. Temperature parameters are usually measured using a temperature displacement monitoring system, supplemented by an infrared imaging system, which keeps other factors consistent by controlling variables, such as processing the same mechanical part over the same amount of time, which is the actual measurement perspective to analyze the heat dissipation of the CNC machine headstock. The spindle generates huge energy in high speed rotation and this energy is converted into heat leading to an increase in temperature making the spindle thermally deformed, also the temperature characteristics of the headstock can be compared with the degree of thermal deformation of the spindle of the machine tool headstock[3].

By comparing the comprehensive parameters of the two, it is finally concluded that the headstock turning and milling has better heat dissipation performance than the traditional CNC machine tool headstock. The solution of the heat dissipation problem increases the feasibility of the headstock turning and milling integration instead of the traditional machine tool headstock.

The integration of power motor and spindle simplifies the traditional power device, discarding the pulley, transmission gear and gearbox, using the electronic gearbox variable speed principle to achieve different speeds, the servo motor and the headstock need to pass multiple transmission between them, solving the problem of large centrifugal force of the spindle in the headstock and large noise during operation. The elimination of a series of transmission devices in the middle makes noise reduction, more environmentally friendly, indirectly improves the quality of people's lives, responds to the national initiative, and provides another sufficient condition for the feasibility of the integration of headstock turning and milling.

Elimination of the belt reduces the cost of tedious maintenance at a later stage. The traditional CNC machine tool headstock is relatively closed, and some cutting fluid and coolant will easily fall into the mechanical parts in the process of production and processing. When these liquids penetrate into the machine tool headstock, will react with the metal, slowly destroy the metal, if not cleaned from time to time, will make the metal rust, affecting the normal work of the machine tool headstock, so after the use of its maintenance costs are extremely high. After forming the integrated type, the headstock closure is greatly improved, eliminating the possibility of external cutting fluid and coolant infiltration, making the metal effectively protected from the root, making the time interval for regular maintenance of the machine longer, reducing additional manual operations, thus reducing the consumption of physical and human resources and lowering the maintenance cost, which is an important factor in the feasibility of the headstock turning and milling integration.

In summary, the feasibility analysis of the integration of headstock turning and milling fully illustrates that the integration is realistic from the different perspectives of negative impact solutions and positive advantages. With the rapid development of science and technology, the research and application of headstock turning and milling integration is a trend in the future development of science and technology, in line with the trend to solve the problem of pain points, improve the efficiency of machining mechanical parts and promote the development of the economy.

4. Generate New Content for its Practical Application

At present, China advocates the awareness of environmental protection and insists on sustainable development. In a large population, the need for rational use of natural resources is even greater, so shedding the belt, that is, a large number of raw materials consuming machines will be replaced by new products, so the integrated machine tool headstock was conceived, it will be the future trend of

technological development. In recent years, under various national policies and guidelines, China's CNC machine tools have also been developing with the continuous development of the global economy, and production has been increasing. But compared with other developed countries, China's CNC technology is still relatively backward. The foreign CNC machine tools, especially in many modern manufacturing machines, developed rapidly, which achieved the multi-functional and high productivity. Under the continuous strengthening of our science and technology and economy, the development of CNC machine tool technology will certainly reach new heights. As of April 2022, the COVID-19 still has a great impact on people's lives, seriously hindering the development of CNC machine tool industry, and foreign epidemic is even more severe. In this special period, China should be more in the field of CNC machine tools to achieve a corner overtaking, and constantly approach the level of CNC technology in developed countries. The industrial distribution pattern in China is characterized by a high level of comprehensive strength of CNC machine tools in regions such as Shandong and Beijing, due to the rapid economic development of these regions and the broad market, advantages that are conducive to the development of the industrial system [1].

In recent years, CNC machine tools in China have developed rapidly, but there are several shortcomings, the specific problems are as follows:

1) Low innovation capacity of CNC technology

By looking for major platforms on CNC machine tools related information, we understand that most of China's CNC enterprises in cooperation with foreign enterprises, can only be responsible for the relevant components of an assembly, and the core technology is derived from foreign enterprises. This phenomenon will easily lead to our country will rely on foreign technology to a large extent, deeply blocking the development of our domestic CNC enterprises. Although the well-known experts in China's domestic CNC machine tool industry in the search for the core technology of the road, in the continuous breakthrough of the status quo at the same time, efforts to improve the performance of domestic CNC machine tools, and continue to shorten the gap with other foreign. However, certain developed countries abroad have a more excellent experimental environment and master more core technologies than we do, so they have developed products with far higher processing efficiency than our country, and we face a serious situation [4].

2) Lack of technological innovation environment

It lacks innovation in CNC machine tools in China, and there are fewer patents for inventions. China's socialist market economy is developing rapidly, but in many places there are shortcomings, such as the relevant laws are not perfect, which leads to various CNC enterprises in China in competition with each other, enterprises in order to more quickly and easily to seek the benefits thereof, will simply ignore technological innovation, and then purchase foreign advanced technology, the most important core components need to be imported from foreign enterprises. This fast business model is difficult to make their own business long-term competitive relationship, but also not conducive to the steady development of China's CNC machine tools.

3) Low technical reliability of products

The performance of a CNC machine depends on the accuracy and speed of the machinery it produces. In the manufacture of products not only to rate more quality, the reliability of product technology determines the advanced and backward products. From this perspective, we can know that China's CNC machine tool technology lags behind the level of developed countries, the durability of CNC machine tool products is lower than the products of developed countries, and China's CNC machine tools are twice the frequency of failure in developed countries. In the technical reliability of products, it is more important that we strive to improve the development [5].

5. Practical Effect of the New Technology

The headstock and motor are integrated, the motor housing and motor spindle are removed, the motor bearings are streamlined, the lathe spindle pulley disappears, there is no belt drive, which greatly

reduces the centrifugal force and amplitude of the spindle when rotating at high speed and improves the machining accuracy. The machine itself has high precision and rigidity, and it can select favorable processing dosage, carry out multi-coordinate linkage, process complex shaped parts, machine the mirror surface of parts, and increase productivity. Reduced volume makes the headstock more convenient to install in CNC machine tools, saving space resources, and easy to replace, facilitating the maintenance of the headstock and reducing the total time for machining mechanical parts. Shedding belts reduces the consumption of rubber and silicone, etc., saving resources and the cost of the engineering chain. The use of electronic gearboxes instead of belts greatly reduces the friction of each transmission part, and the percentage of energy consumed by friction for machine work is reduced, which improves the overall mechanical efficiency [1].

6. Conclusion

Technology continues to innovate with the trend of the times, showing a steady growth trend, in order to comply with this trend, this paper analyzed and summarized a series of problems arising from the integrated CNC machine head box belt, and put forward the corresponding solutions to its negative impact. This method is to replace the traditional belt drive with a new power unit, which not only solves the negative impact of the belt, but also has a greater improvement in the overall performance of the machine tool headstock, and the environment of the processed parts is improved to meet the needs of mechanical production for the benefit of mankind.

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