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SPINDLE ASSEMBLY DESIGNS

The spindle assembly is one of the most critical components of any metalworking machine, always participating in the shaping movement and entering the drive of the main movement. It accounts for from 50 to 80% of errors in the overall balance of accuracy of the machine. The quality of the spindle assembly has the most significant impact on the accuracy, reliability, performance of the entire machine. Thus, the dynamic quality of the spindle assembly directly affects the quality of the products.

A spindle assembly consists of a spindle, its supports and a drive element, enclosed, as a rule, in a separate housing. In essence, the spindle assembly is a rotor system with its own design features, determined primarily by the scope.

The design of the spindle is determined by the following features:

a) the size of the spindle, the distance between the supports, the presence of holes for the passage of materials or other purposes;

b) drive parts (gears, pulleys) and their location on the spindle;

c) bearing design and type of bearings;

d) method of fixing devices for parts or tools that affect the design of the front end of the spindle.

The spindle dimensions, its length and diameter, the distance between the supports, the elastic and damping parameters of the supports determine the inertial and intrinsic stiffness and dissipative characteristics of the spindle assembly and form its own amplitude-frequency response of the spindle assembly.

The rolling bearings of the ballast unit have a high-speed (short-term up to 200-300 thousand rpm) acceptable for most tasks, and a high load capacity. An important role in their wide use is played by the speed of replacement and maintainability, which positively affects the reliability of the spindle assembly as a whole [1].

The works of V.S. Balasanyan, V.B. Balmont, V.V. Bushuev, A. Jones, T. Harris, Z.M. Levina, A.M. Figatner, V.E. Push, A.V. Push and many other scientists are devoted to the design and development of spindle rolling bearings.

Extensive use in modern control systems has found a pattern of application in one support of several identical bearings. Depending on the number of bearings in the support, there are two types of installation types: duplex, triplex and quad. Bearings can be assembled together in several ways depending on the desired characteristics.

Analysis of modern spindle assembly designs shows that about three quarters of spindle assemblies with rolling bearings have angular contact ball bearings of the “triplex” type in the front support and that the use of angular contact ball bearings in spindle assembly machines constantly increases.

For spindle rotation frequencies above 15000 rpm, spindle assemblies with an integrated motor or spindle motor are used (Figure 1.).

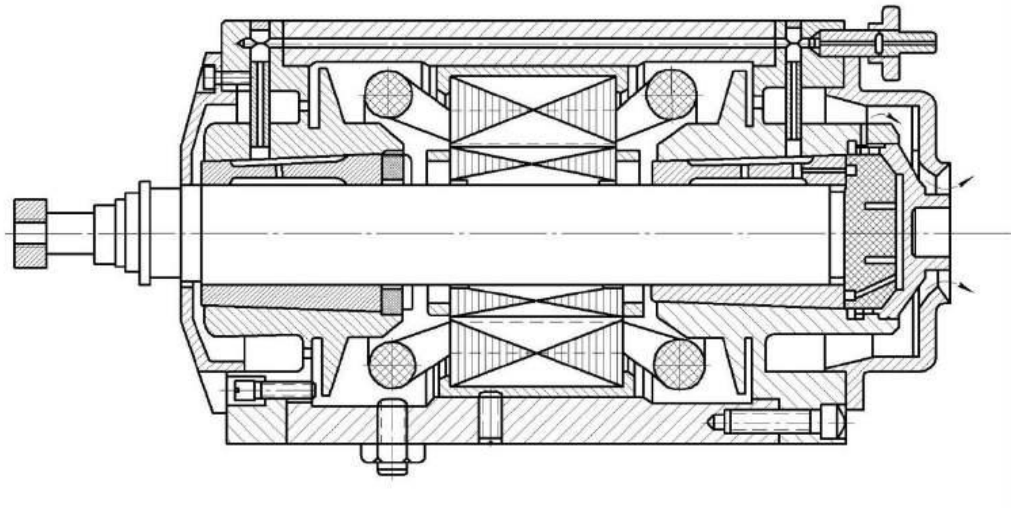

Figure 1. Spindle assembly with integrated motor

Often, the spindle assemblies of this design are also called electrical spindles. The motor is integrated into the housing of the spindle assembly and ensures the transmission of torque without restrictions due to belt or gear transmissions. The motor spindle consists of a spindle shaft mounted on bearings, a motor and a tool clamping system. Air-oil lubrication allows to achieve higher − by 20% and higher − rotation speeds. The power of the motor spindle is determined by the power of the motor. Asynchronous and synchronous electric motors are most often used as a motor.

Electric motors are powered by frequency converters, the current form of which allows to achieve high stability of the rotation frequency [2].

With the current trend in designing high-speed spindle assembly, when the spindle is taken as an absolutely rigid shaft on elastic supports, the dynamic quality of the spindle assembly will be completely determined by the elastic-damping characteristics of its bearings, which in 90-95% of cases for the spindle assembly of the machine park consist of rolling bearings. The elastic-damping characteristics of the spindle assembly largely depend on the choice of the optimal preload value of the bearing supports, and its practical implementation is one of the most difficult problems of designing and manufacturing spindle assemblies. Thus, the efforts of the preload determine the dynamic quality of the spindle assembly, and the task of developing methods for its assessment, especially without disassembling the spindle assembly, is relevant.

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