APPLICATION PERSPECTIVE OF GAS-DYNAMIC BEARING IN THE AEROSPACE INDUSTRY

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In the middle of the last century the development of new technology come up against a problem of the bearings creation, which can provide reliable operation of high-speed components in various devices and move at a speed to hundreds of thousands of revolutions per minute. Creating bearings with negligible friction was actual task in the field of control and measuring instruments and measurement techniques. In nuclear and chemical engineering - bearings, that can operate in conditions of radiation, high and low temperatures and in chemically active environments. In engineering, there was a need for the introduction of new technical solutions to improve the reliability efficiency, and significantly improve fabricability, weight and size settings. This is especially true for various of small power units, mounting group and sealing machines and equipment, the rapid development of which appear in Russia and abroad. Ubiquitous rolling bearings and plain bearings with liquid lubricant couldn't meet the arising demands. The search for new types of bearing have led to the conclusion, that the most promising bearing, in which a working agent, that fill the gap between the friction surfaces, is non-liquid lubricant and the gas (e.g. air).

As well as other countries, gas lubrication theory developed in the Soviet Union too. There were the two major research centers in this area: Experimental Research Institute of Machine Tools, in which the work was done under the direction of Sheynberg S.A., and the Department of Mathematics and Mechanics of the Leningrad Polytechnic Institute, in which developing a theory of gyroscopes in the gas bearing and gas-static mounting group for precise alignment of devices was carried out under the supervision of Loytsyanskiy L.G.

In the space industry bearings provide basic work units and mounting group, such as the control system, generator, turbocharger, clutch and pump. The bearings, which are in the control system, direct the engine nozzle, allowing orient spacecraft in the space for the astronauts in the right direction during the flight.

Magnitude of the required resource is not less than 10000 hours in the modern spacecraft. Improving resource is possible through the use of gas-

dynamic bearings in the mounting group of the gyroscope. The load-bearing capacity is created by the injection gas into the gap bearing due to the high speed of relative motion, during the shaft rotation in the cup or cup in the shaft, forming a pair of friction with the tapered shape of the gap in the sliding direction.

Aerodynamic sliding bearings are high-speed bearings, which provide surfacing mobile part of the drive at large angular velocity. Gas-dynamic bearings are self-contained, compressors or other sources of external pressure are not required for their work.

Classification of gas-dynamic bearings:

1. Design type: the converted type of bearing - a design with the shaft rotation in the cup; bearing unconverted type - design with a rotating cup in the shaft.
2. Geometric shape surfaces of journal and bearing: conical (fig.1, a), cylindrical (fig.1, b), spherical (fig.1, c) and hemispherical (fig.1, d).

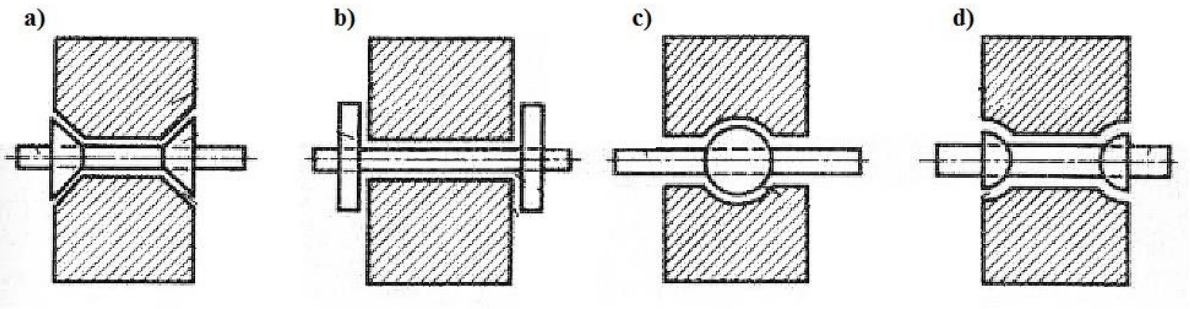

Fig.1. Basic types of gas-dynamic bearings

Design feature of the aerodynamic bearings is absence of reversal. The rotation is possible only in the direction in which particles of the air entrained by grooves, are injected into the grooves of the gap bearing. More information about gas bearings designs can be found in [1].

The most important advantage of plain bearings with gas lubrication is the contact lack in a working regime between the mutually moving parts. Practically, this enables unlimited resource of continuous work such (especially when they are used in a part of the control systems in weightlessness conditions), and the low level of self-vibration (thus, low noise in the output signal) [2]. The accuracy of the stability of the rotor mass center is provided by the compressibility of the lubricant layer and reaches a fraction of a micron.

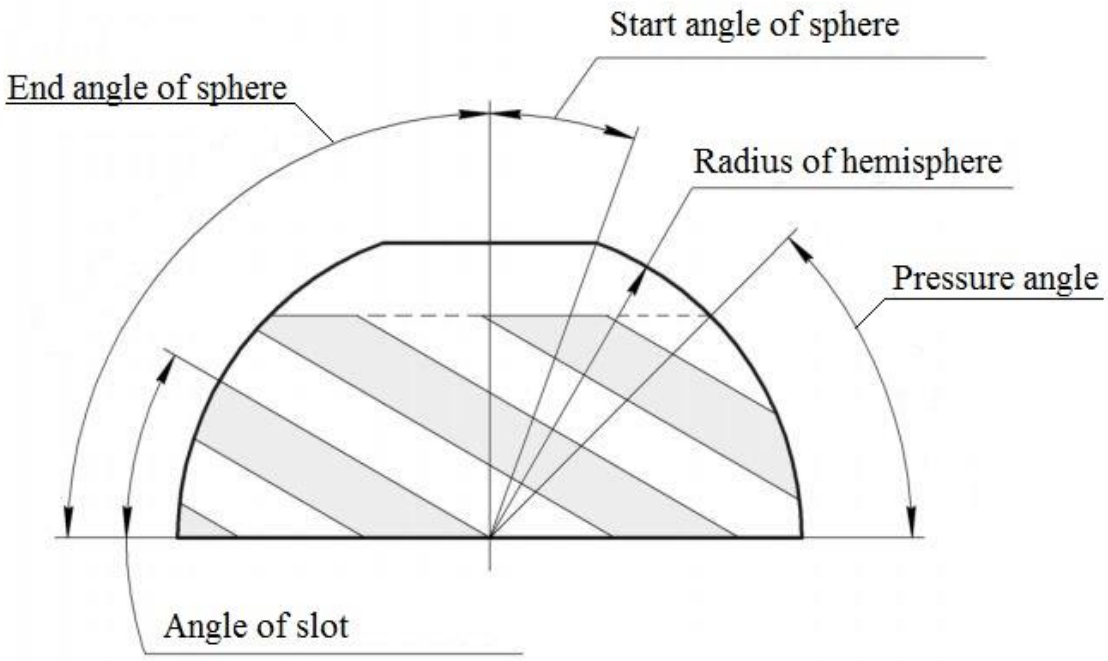

Fig.2. Sketch of hemisphere aerodynamic bearing

Aerodynamic bearing are widely used due to the small level of its own vibration (caused by the high degree of damping in a layer of gas lubrication). Reduced own vibration excludes the impact of external dynamic perturbation to the device. The weak dependence of gas viscosity and temperature causes the normal operation of gas bearings in a wide temperature range [3]. Also, it promotes good heat dissipation and less local overheating parts of giromotors. The difficulty of ensuring operability of multiple launches, significant moment of resistance to rotation, power consumption and high cost are disadvantages in comparison with the GDB race ball bearing giromotors subject to the same factor of quality [4]. The main problem of the gas-dynamic bearings is to provide the required load-bearing capacity, especially in the case of compact bearing. For work GDB in conditions of overloading and ensure the required resources by quantity of starts and stops of the gyro with GDB requires sufficient load-bearing capacity. Increasing the bearing capacity allows to reduce the duration of the dry friction forces during start - stops, therefore, runout is reduced and GDB resource increases. The load-bearing capacity can be increased by injection of gas, gap decreasing between the working surfaces of the supports, increasing eccentricity, bearing profiling.

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PRODUCTION AND APPLICATION OF HIGH-PRECISION RESISTORS

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Measurement of current and its subsequent control are important issues in electronics. More and more electrical appliances are to be controlled and we should increase their efficiency.

External voltage may distort the results of measurement of electrical devices. To minimize the influence of external voltage there are ultra precision resistors. These resistors are physically optimized to minimize the error of external factors (operating time, temperature, frequency and voltage). The error of resistor resistance depends on the material, design of the component and its production process.

Long-term stability of parameters is very important for a variety of sensors. This stability is possible when we use materials that are not subject to corrosion and have thermal and structure resistance [1].

To determine the possibility of the work of resistors at different temperatures, we use the formula:

$$\mathbf{U = R^* I + U_{th} + U_{ind} + Ui_{ext}},$$

U_{th} – thermo electromotive force
U_{ind} – induced voltage
U_{iext} – voltage drop at terminals