DIAGNOSIS OF BEARING INSTALLATION DAMAGE IN GAS TURBINE ENGINES

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The work is devoted to solving the problem of constructing a measuring channel based on an analog interface for diagnosing damage to bearing assemblies in gas turbine engines at an early stage of their occurrence.

The reliability of gas turbine engines (GTE) is due to the durability of elements and components, which during operation are under the influence of mechanical, acoustic, gas and temperature loads.

One of the key components of the gas turbine engine is a bearing assembly, namely a rolling bearing. An important task of practical diagnostics is to improve methods and means of vibrodiagnostics of bearing assemblies in the gas turbine engine at an early stage of damage (defects) based on the construction of a measuring channel with improved metrological characteristics.

To solve the problem of early vibration diagnostics of bearing units of the gas turbine engine, the standard points for measuring vibration parameters were determined and the optimal piezoelectric accelerometer of Brüel & Kjær type 4378/4379 with metrological characteristics satisfying the operating conditions of measurements was selected. The normalization of vibration parameters of the bearing units of the gas turbine engine is carried out. Analysis of the peculiarities of vibration processes allowed to determine the frequency range of bearing vibrations of the gas turbine engine, which in the operating state is from 100 Hz to 3 kHz.

The measuring channel of early vibration diagnostics of bearing units of GTD on the basis of application of N-channel quadrature tracking notch filters (TNF) and the new charge measuring amplifier is offered [1]. The proposed measuring channel differs from the existing ones by improved metrological characteristics - speed is increased 5 times, signal-to-noise ratio is increased by 55 dB, accuracy is increased 2.5 times (in relation to modern vibration control systems of GTE IB90-СФ).

Using the least squares method, the function of transforming the measuring channel of the system in the form of linear regression is obtained [2]. The budget of the main error of the measuring channel of the system (δad = 0,042%, γ = 0,016%, σ = 0,185%) is made. The calculations prove that the main error of the measuring channel will consist of the sum of random components of the errors of the quadrature TNF and the SCR detector and will not exceed 1%.

The conformity of the developed measuring channel to the requirements of standards, metrological support is determined and the conformity to the declared technical characteristics is confirmed.

On the basis of the carried out researches the modeling complex for carrying out the vibration analysis of rolling bearings for the purpose of revealing of character of damages at an early stage of their occurrence is developed.

The Electronics Workbench software environment simulated a pulse filter, which showed that the frequency response has a significant height of the side "petals" and therefore such a filter is most suitable for reducing network interference when allocating a constant voltage component.

As a result of the research, a new N-channel tracking quadrature notch filter with window overlap coefficient k = 0.5 was proposed (Fig. 1), which, due to the reduction of the height of the side "petals" of the filter frequency response by approximately 20 dB, has a higher equivalent quality factor in the operating frequency band.

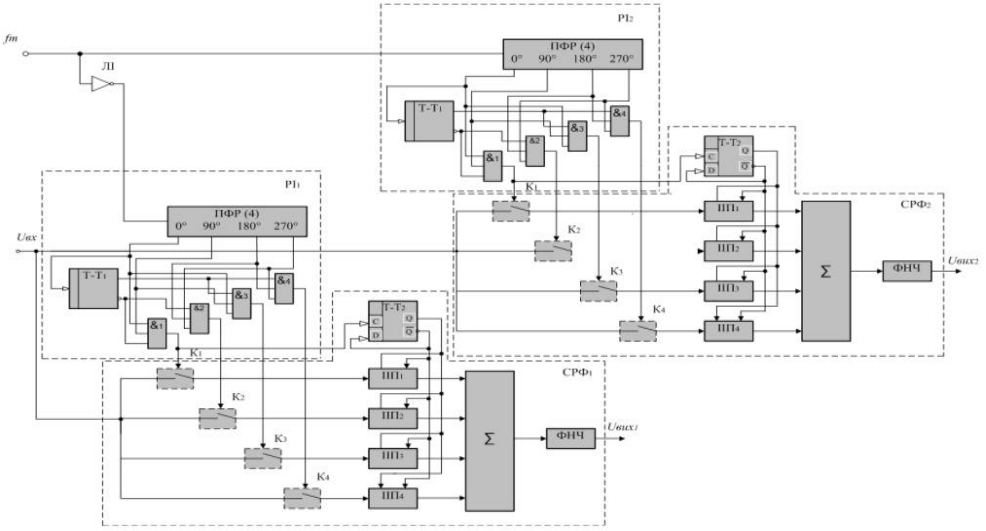

Fig.1. Scheme of N-channel tracking quadrature notch filter with the coefficient of overlap of "windows" k = 0,5: LI - logic inverter; ПФР - divider phase splitter by 4; PI_1, PI_2 - pulse distributor for 4 with an overlap coefficient k = 0.5; СРФ1, СРФ2 - tracking notch filters; TT_1, TT_2 - T-trigger; $\&_1$-$\&_4$ - schemes of logical multiplication; θ_1-θ_4 - control signals "window"; K1-K4 - analog switches; IIP1-IIP4 - iterative integrating converters; ∑ - adder; ФНЧ - low pass filter; f_m - clock frequency.

The tools and methods developed in the work can be used in the process of creating control systems and diagnostics of any rolling bearings of rotary machines based on the results of vibration measurements on non-rotating parts.

The area of practical use of the results is the possibility of measuring the vibration parameters of gas turbine engines to diagnose bearing assemblies to determine the nature of the damage at an early stage.

References

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