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HOLOMETRY METHODS IN SOLVING TASKS OF EXPERIMENTAL DEVELOPMENT OF AERO-ENGINES PARTS AND UNITS

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Analysis of various holometry methods their advantages and disadvantages as applied to solving tasks of aircraft engines development is given. A unique structural design of holographic interferometer is described.This interferometer provides application of holometry methods both for extensive engine control and for engine structural vibration strength development. Experemental study results are shown.

Keywords: Holography:Interferometry:Vibration & Stress Analysis

Holometry methods are the most effective means of obtaining information about stress-strained state of aeroengine parts and units in the process of their structural strength development. Special place in this process has vibration study as most of in-service engine failures are of vibration origin and dynamic characteristics knowledge allows to predict engine structure behaviour in conditions of real service.

Analysis of possibilities of holometry methods and methods based on speckle shows that the task to be solved and type of object to be investigated define the necessity of application

of this or that method in the process of structure vibration study.The most suitable method for vibration modes study is the traditional Powell & Stetson averaging method but it is time consuming because it requires recording of holographic image for every natural frequency /1/. More operative is real-time method but practically it gives no quantitative information on vibration amplitude distribution. In order to determine parts vibration modes the most preferable methods are electronic speckle-interferometry methods as they do not require photographic methods.But if the task of research is to get fields of vibrational displacements of element surface one should use stroboscopic or two-pulse methods. Stroboscopic method that can be used in real time scale is the most efficient for complex vibrational processes investigation. As for large-scale objects study one should prefer double-pulsed method. Therefore the need of using various holographic methods in process of investigation prompts to have versatile holographic interferometer. The described interferometer depending on the type of radiation source provides vibration studies of engine various parts by means of different methods. He-Ne laser is used to study objects of <0.5m diameter. For large-scale objects study ion laser of original design is used with 7mm discharge channel diameter generating TEM_{00q} mode with base band width less than 30MH and power output 3W. Double pulsed active Q-switched ruby laser is used in some cases when object vibrations should be recorded in the process of rotation.

Holographic interferometer optical scheme is so mounted that direction of lighting and direction of observation are collinear. For this purpose a beam splitter is fitted into a

widened object beam. All investigated parts have retro-reflecting coating that provides laser energy saving. Collinearity lighting and observation points simplifies significantly the process of holographic interferometer sensitivity vectors definition. For objects illumination a divergent beam is applied. Two additional mirrors are installed in orthogonal planes in this divergent beam near the object so that they illuminate the object and direct its reflected radiation from retroreflecting coating to hologram. If there is a necessity to record stroboscopic hologram electro-optical radiation modulator is installed in laser source output. Holograms are recorded on thermoplastic film or on photographic material. When photographic plates are used there is a provision of their processing in the place of exposure.

While investigation natural frequencies and modes of vibration the manner of vibration excitation is of paramount importance. A number of piezoelectric exciters are designed. Piezoelectric exciter of a special design is usefull for vibration excitation of the most critical engine elements - turbine and compressor blades. It provides blade vibration excitation in the place of its attachment without contact with the blade. This kind of vibration excitation excludes missing of separate modes of vibration that can be met in poor point exciter location and excludes also distortion of mode due to attached exciter mass.

Fringe patterns from holograms made available with the help of high resolution TV camera are input to computer memory. A programis developed to get data on investigated element surface vibrational displacement from fringe patterns /2/.

Efficiency of the described holographic interferometer application for experimental engine development can be proved with many examples. Acoustic phenomena can also be successfully investigated with the use of holometry. They allow to reveal the main sources of noise in various designs of disk brakes and to help in solving problems of noise reduction or elimination.

References.

1. Powell R.L. & Stetson K.A., JOSA, 55(1965), p.1593

2. Davydov A.N., Krainyukov N,I., Khramov A.G. & Shaposhnikov Yu.N, Report in this paper.

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