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CREATION OF THE NEW COMPLEX STANDARD FOR MEASUREMENTS OF MECHANICAL MOTION QUANTITIES

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Abstract: One of the main directions of creation of the new Russian Standards in the field of mechanical motion quantities is designing complex standard which permits to reproduce a group of mechanical values. The new standard contains three Standard setups. The first one intended for constant linear acceleration reproduction is based on the method of being tested device inclination in the Earth gravitational field. In this case a surface of free liquid is chosen as local horizontal plane. The second one is the double centrifuge working in three modes and reproducing constant and variable linear accelerations as well as these both together. The third one is the centrifuge with inclined axis of rotation. The last setup reproduces separately or together constant and variable linear accelerations, constant angular velocities, variable angles.

In combination these setups permit to reproduce: constant linear acceleration in the range from 2,5x10 $^{-5}$ to 500 m/s ^{2}, harmonic linear accelerations in the frequency range from 0,05 to 30 Hz and amplitude range from 10 $^{-4}$ to 300 m/s^{2}, constant angular velocities in the range from 0,3 to 180 rad/s, variable angles from 0,2 angular seconds to 360 degrees.

The next step of development of the standard will be designing one setup which permit to substitute the written above.

Keywords: acceleration, velocity, angle, centrifuge, standard setup, mechanical motion quantities

1 INTRODUCTION

In [1] are shown drawbacks of the traditional ways for creating standard setups for mechanical motion quantities reproduction and is suggested the setup which can substitute more than five existing standards and a group of other test setups. Investigations in this direction are continuing and their first step was designing of new standard for reproduction of mechanical motion quantities. We mean that these quantities for solid body are three linear displacements of its mass center and three angular displacement around of mass center and all time derivatives of these displacements (linear and angular velocities, accelerations etc.).

2 NEW STANDARDS

The new standard contains three setups. The first setup realizes a weil known method of being tested device inclination in the Earth gravity field when acceleration along device measuring axis is

$$g \sin \alpha \qquad (1)$$

where g is free fall acceleration, α is angle between device measuring axis and horizontal plane.

In this setup it is used absolute method of horizontal plane determination when this plane is chosen as surface of free liquid. A surface of platform for mounting the device being tested is set in horizontal plane using a special sheer interferometer. This setup reproduces constant linear acceleration in the range from 2,5x10 $^{-5}$ to 10 m/s with minimum uncertainty 5x10 $^{-5}$ M/S.

The second setup is combined double centrifuge (Fig. 2) which works in a few modes.

When the turntable is motionless we have ordinary centrifuge reproducing constant acceleration in accord with expression

$$a = \Omega^2 R \qquad (2)$$

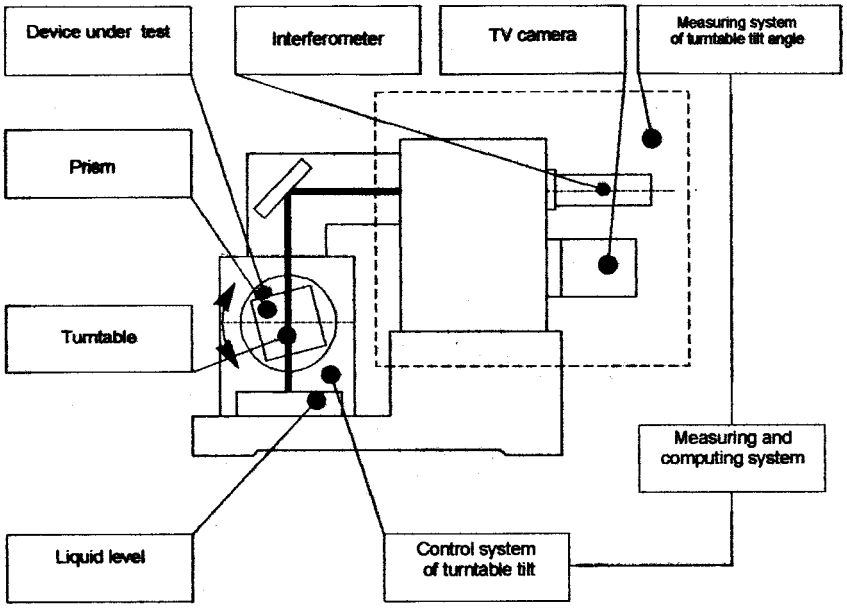

Figure 1. Setup on the base of the being tested device inclination in the Earth gravity field

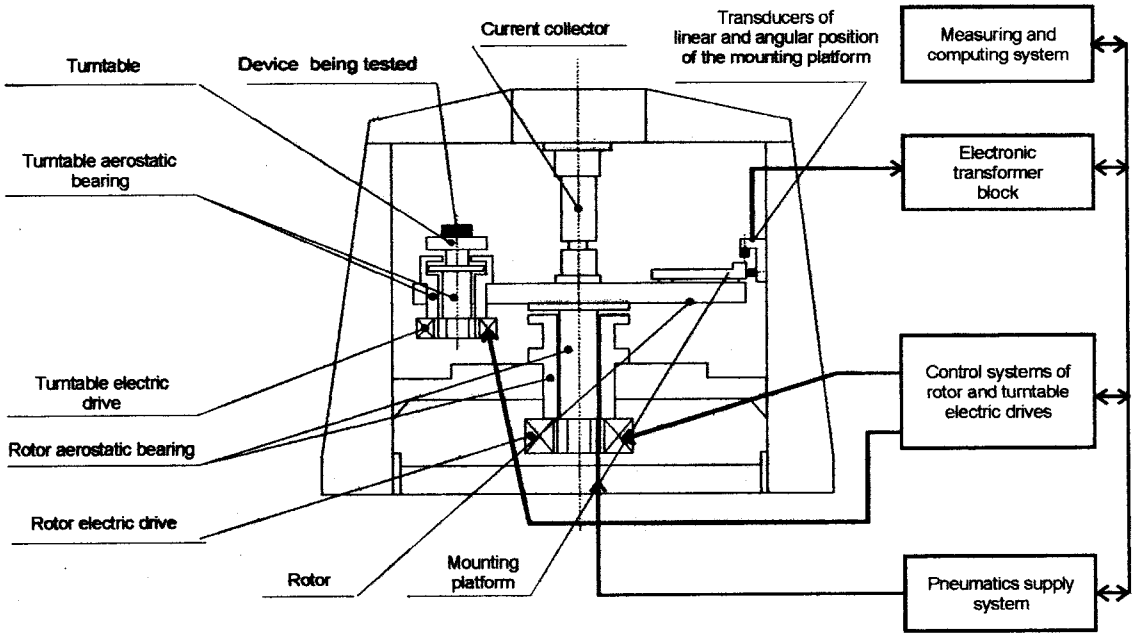

Figure 2. Combined double centrifuge

where ù is angular velocity of the rotor, R_1 is the distance between axis of rotor and the mass Center of device sensitivity element. The acceleration range is from 5 to 300 m/s^2 , the uncertainty is 10^{-5}. If the rotor and the turntable are rotating, then an expression for acceleration is

$$a = \Omega^2 R_1 \cos w t + (\Omega \pm v)^2 r \qquad (3)$$

where *co* is angular velocity of turntable, R, is distance between axes of the rotor, r is distance between turntable axis and the mass center of device sensitive element. In this mode it is reproduced both constant and harmonic linear accelerations. When r=0 the setup reproduces harmonic linear acceleration in the amplitude range 5 ... 300 m/s^2 with uncertainty no more than $3x10^{-3}$ and in the frequency range 0,5 ... 30 Hz. The main setup systems and blocks and connection between them are shown in the above Figure.

The third standard setup is the centrifuge with inclined axis of rotation (Fig. 3).

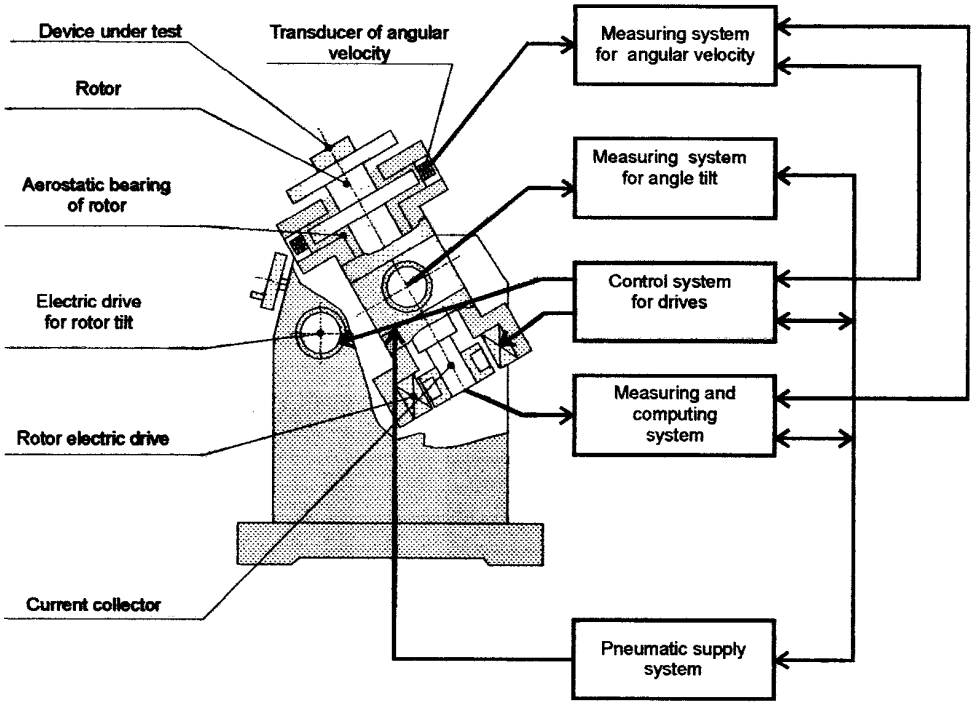

Figure 3. Centrifuge with the inclined axis of rotation

This setup reproduces a few quantities worked in three main modes. If rotating Platform is inclined about the plumb bob vertical at angle 9 and the mass center of the sensitive element is located on the axis of rotation, reproduced acceleration is

$$a = g \sin j \cos v\ t \qquad (4)$$

The amplitude range is from 10^{-4} to 10 m/s^2, the minimum uncertainty is $2x10^{-4}$, the frequency range is from 0,05 to 30 Hz. In the second mode in the process of the platform rotation, angles from 0,2 angular seconds to 3600 are reproduced using the goniometer method [2] with the uncertainty less than 0,1 angular second. And in the third mode may be reproduced angular velocities in the range from 0,3 to 190 rad/s with uncertainty less than $2x10^{-6}$. To additional point to emphasize is that after some investigations it is possible to use modes of reproducing

- constant linear acceleration (identical the first setup),
- both constant and variable linear acceleration,
- variable angular accelerations.

Metrological characteristics of standard setup were received on the base of designing modern systems and blocks shown above in figures 2 and 3 among which may be noted highly precise electric drives with frequency controlled motors, aerostatics bearings with high cross rigidity, measurement systems of moving platform during the rotation of these platform, special ring lasers and others.

REFERENCES

[1] A.Y. Sinelnikov, Lines of investigations for creating of new means for metrological assurance the fields of low frequency motion parameters and gravimetry in: Proceedings of the XIV World Congress (Tampere, 1-6 June 1997), Tampere, Finland
[2] Yu.V. Filatov. D.P. Lukianov and R. Probst, Dynamic angle measurement by means of a ring laser, Metrologia 34, (1997) 43-351

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