Technical sciences / Mechanics

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DYNAMIC ERROR OF STABILIZATION

Introduction. The basis for the practical determination of the stabilization error was the method of measuring the mean error of analog two-plane stabilizers 2E36, which was developed in the 80 of last century [1]. This mean error should not exceed ± 1 t.d. (1 thousandth distance = 3.6 angular min.) [2] in each of the guidance planes: horizontal (HN) or vertical (VN). The verification of the mean error was performed as part of the customer's product on a typical route [3] during periodic tests on two series stabilizers once a year.

The aim of this work is to analyze the literature data on the definition and study of dynamic stabilization error.

Analysis of literature data and problem statement

From the beginning of creation of domestic analog and digital stabilizers check of stabilization error was carried out by a method and in terms similar to stabilizers 2E36. There were no other checks on the accuracy of stabilization.

On the other hand, it should be borne in mind that modern mobile objects move at high speeds, they are subject to significant overloads and uncontrolled mechanical disturbances. Therefore, the requirements for measuring accuracy, measuring instruments, control of the main technical parameters of stabilizers are especially relevant because they relate to state security.

In [1], materials on measuring the mean stabilization error of analog stabilizers 2E36 and stabilizers with a similar construction model by the method of filming are presented. It is shown that this process is carried out only as a part of the main product [2], in the conditions of a typical route. This method of processing the results is quite time consuming, routine and takes a long time to calculate the error manually.

It is clear that the method of filming at the time of its development (mid-80 of the last century) was progressive and was carried out using a film camera, which was fixed on a stabilized in two planes of the product. The film camera recorded the movement of the stabilized part of the product on the channels of horizontal and vertical guidance when moving the product on a typical route.

The disadvantages of this method include the fact that the tests were performed only on two sets of stabilizer once a year during the standard tests. This may be due to objective difficulties due to the complexity of the tests. To reduce the complexity allowed the use of the device (device PS) from the stabilizer kit 2E26M [3]. The aircraft device is an electronic measuring device designed to determine the magnitude of the mean error and the percentage of time of unstabilized state of the product stabilizer 2E26M in the planes of HN and VN.

The device received information from the stabilizer control unit from the angle sensors via vertical and horizontal guidance channels and compared these values with values that did not exceed the relevant permissible norms for this typical route. The use of this device has greatly facilitated the measurement of the mean error.

Overcoming the difficulties of measuring the stabilization error was implemented in the stabilizer 2E52 [4-6], which was developed with new technical characteristics. The documentation for the stabilizer 2E52 established requirements for checking the average and dynamic errors [5] (as part of the main product) of the stabilization, which should not exceed 2 t. d. (according to 1988) when processing the sinusoidal signal $A = 2.5\sin\omega t$.

It should be noted that stabilizers 2E36 and 2E52 have different circuit design principles. Stabilizer 2E36 is built on the principle of "force" stabilization, which provides the following:

- optoelectronic device OEM "rigidly" [6] is connected to the units BO and B;

- guidance of the BO and B units is performed directly by means of the stabilizer control panels. With this principle of construction of guidance from the control panel stabilizer B and BO have to apply large moments because they have significant masses and moments of inertia, which leads to significant errors.

In the stabilizer 2E52 [6] the guidance units B and BO and the sighting device for monitoring objects are made on the principle of "independent" stabilization, namely, the units B and BO do not have a rigid connection with the monitoring device. This stabilizer uses a stabilized field of view (SFV) device as an object tracking device. The principle of operation of this stabilizer is that the field of view of the SFV device is performed using the control panels of the stabilizer, and the guidance of B and BO is carried out by signals from the angle sensors of the SFV device.

A review of the technical literature [7] shows that the structure and the required parameters of the stabilizer are ultimately determined by the specified accuracy of the stabilizer. In this case, the evaluation criteria may be different, but the accuracy requirements focus on the maximum stabilization error [8]. In most cases, the determining factor is the value of the stabilization angle: maximum, mean or root mean square.

Various publicly available publications [1–10] give only a superficial idea of the facts of control of dynamic stabilization error only in stabilizers, built on the principle of "independent" stabilization.

Conclusion: unresolved issues include, firstly, the inability to verify the dynamic stabilization error on stabilizers built on the principle of "rigid" stabilization, and secondly, the lack of definition of technical requirements and method of measuring dynamic error.

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