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Measurement of airplane alignment in flight mode

The measurement of the airplane alignment in the flight mode by using a capacitive liquid converter is proposed. The sensor construction, the placement of sensors on the airplane, the functioning of the sensors system are considered. The obtained results allow to increase the safety of flights.

Proper placement of cargo and its reliable attachment to the aircraft is important for safety. In all cases, the placement of the load on the airplane must be carried out in accordance with the summer centering constraints. The alignment of the aircraft should not exceed the permitted limits. The deviation of the loading placement worsens the stability and controllability of the aircraft.

At present, measurements of the position of the center of mass (CM) of the aircraft after loading by passengers and cargo before departure are not made. The alignment control is performed by calculations using a special program [1]. Input data of the program are documentation about passengers, their seats in the cabin, cargo, and other loading: mail, special purpose cargo. The aircraft service is carried out by the airport's service department

Errors in software calculations, inaccuracies in the placement of cargo, inadequate balancing of the position of the aircraft's CM by pilot reduce the safety of flights

Development of an automated system for determining the position of the CM in flight will help to solve this problem, significantly improve the process of piloting the aircraft, improve its controllability, reduce the pilot's load.

For solving this problem it is recommended to develop a device for measuring centrifugal accelerations, which is based on a fluid pendulum with a capacitive angle converter.

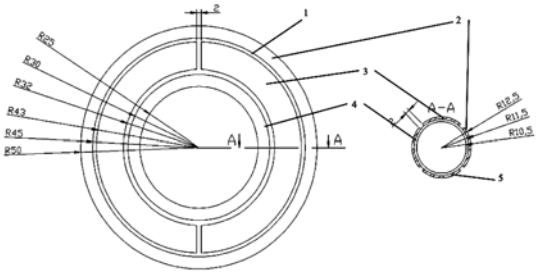

Fig.1. Design of the sensor.

Figure 1 shows the design of the measuring device for centrifugal acceleration of aircraft.

The measuring device is a glass tube 1 in the form of a torus. The cavity of the tube is filled with distilled water, the level of which is set exactly by the center of the torus.

On the surface of the torus, a metallized coating is applied, which afterwards is divided into certain areas. These sites are the electrodes of a differential capacitive converter. The electrodes 2, 4 are grounded, the high-potential electrode 3 is divided vertically in half, its right and left parts are connected to the arms of the transformer bridge, the output signal from the low potential electrode 5 is fed to the amplifier with high input resistance. (Fig.2.)

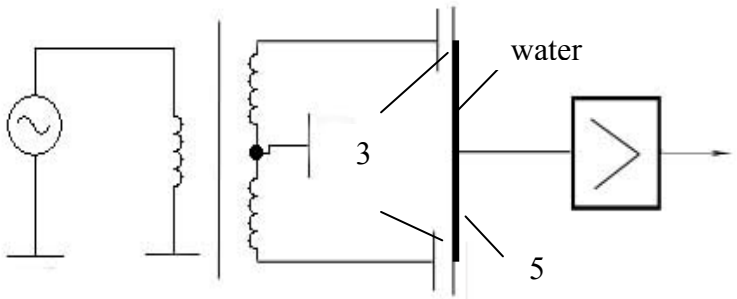

Fig.2. Schematic diagram of the converter

The principle of operation of the device is shown in Fig.3. As described above, the liquid pendulum is a torus in which the liquid moves when a centrifugal acceleration appears on the airplane and generates an angle α. The resulting angle is converted by a capacitive converter into an electrical signal.

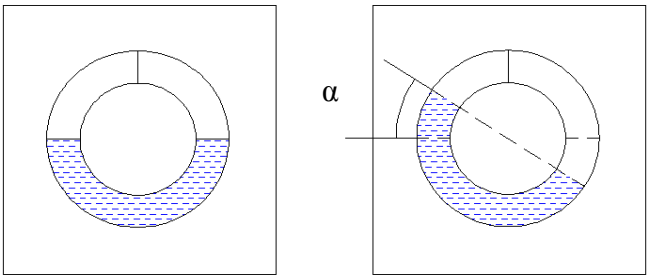

Fig. 3. The principle of operation of the centrifugal acceleration meter

Measuring devices are installed in the front and back of the fuselage, in the right and left wing, at the top and bottom of the hull (the chassis is retracted into flight mode) at equal distances from the calculated position of the aircraft's center of mass (CM). If the CM position is shifted from the calculated position, the difference in the readings of the opposite sensors will be different from zero. In addition, the angular position of the aircraft in space also affects the readings of the sensors [2].

Therefore, you need to correct the reading by entering the current values of the course, roll and pitch.

In Fig.4. The distribution of forces is shown for the longitudinal displacement of the aircraft CM.

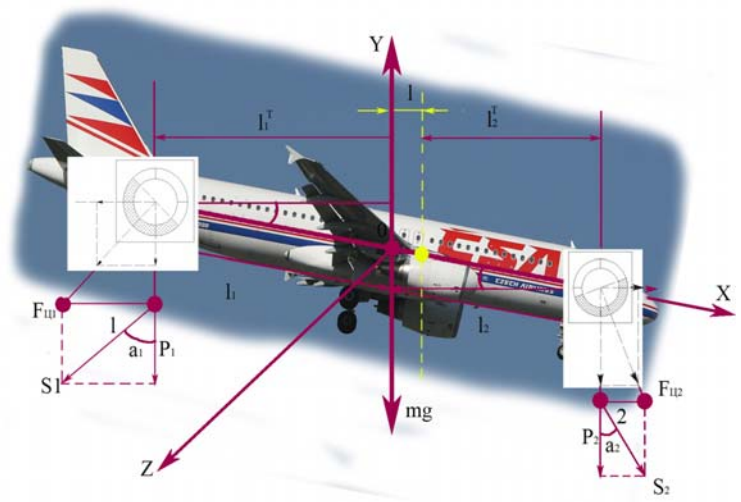

Fig. 4. Moving the CM position to the front of the fuselage

Alignment of the CM position can be obtained by transferring fuel from the supply tank to the tail tank. Similarly, a lateral offset can be achieved by transferring fuel from the supply tank or one wing to another wing.

Conclusion. To improve flight safety, you need to have accurate information about the position of the aircraft's CM in flight mode. This will ensure sufficient stability and controllability of the aircraft. At present, there are no devices for determining the position of the center of mass in flight mode. To solve the problem, it is proposed to create a device for measuring the centrifugal acceleration of an aircraft. A liquid pendulum with a capacitive converter was developed. The complex of the developed sensors is installed on the aircraft along the 3-axis symmetrically with respect to the calculated position of the CM. The implementation of the complex will significantly improve the safety of flights.

References

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2. 2. A. P. Kozlov, O. V. Melnikov, Yu. N. Kemenjash The system of airplane centre-of-mass position-finding in the flight mode / 1990-5548 Electronics and control systems. 2011. №4 (30).