L 61705-65 EEO-2/EEC(k)-2/EWG(v)/EED-2/EWA(c)/EWT(d)/T/EEC(j)/FSS-2 Pn-4/Po-4/Pe-5/Pq-4/Pg-4/Pk-4/Pl-4 BC

ACCESSION NR: AP5016241 UR/0373/65/000/003/0156/0159

AUTHOR: Krementulo, V. V. (Moscow)

TITLE: The stability of the motion of a gyroscope in a Cardan suspension in the presence of a moment about the rotor axis

SOURCE: AN SSSR. Izvestiya. Mekhanika, no. 3, 1965, 156-159

TOPIC TAGS: Cardan suspension, gyroscope motion, gyroscope mounting, gyroscope stability, Lyapunov Chetayev method, perturbation

ABSTRACT: The stability of certain motions of a heavy gyroscope in a Cardan suspension was studied with the help of the Lyapunov-Chetayev method in the bounds of a commonly applied model. In the model selected it is assumed that the moment acting about the z axis is such that a certain steady motion ($\dot{\varphi} = \omega$ = a constant) occurs. The solution is carried out for two conditions: 1) the moment is external to the mechanical system studied; 2) the moment is internal. In the internal approach, the ring and rotors together form an electric motor (synchronous or nonsynchronous) and the moment M_z is internal in respect to the system. If the moment M_z is created with the help of a device not appearing in the system (rotor + inner ring + outer ring), then M_z is external in respect to the system. The internal moment case was studied for a heavy gyroscope with the axis of the outer ring vertical, with the

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inner ring and rotor together forming a nonsynchronous electric motor. The solution is similar to the treatment using another model (a torque relative to the z spin axis is generated by a motor and is entirely used in overcoming the moment of the forces of resistance, so that there is a cyclic integral which expresses the constancy of the components of the absolute transient angular speed of the rotor on the z axis). Both perturbed and unperturbed motions were considered. The treatment of the external moment solution was compared with similar earlier studies. In this paper, different external moments were investigated and the integral involved was not expressed in a Lyapunov function. The conditions for some of the real roots of the equation were expressed on the basis of Hurwitz criteria. In both types of moments discussed, the necessary and sufficient conditions for stability are presented. Orig. art. has: 18 formulas.

ASSOCIATION: none

SUBMITTED: 11Jun64 ENCL: 00 SUB CODE: NG

NO REF SOV: 008 OTHER: 000

Card 2/2

L 20999-66 EWT(d)/FSS-2/EEC(k)-2 BC

ACCESSION NR: AP5013132 UR/0373/65/000/002/0069/0075

AUTHOR: Krementulo, V. V. (Moscow)

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B

TITLE: On the stability of motion of some adjustable gyroscopic instruments on a movable base

SOURCE: AN SSSR. Izvestiya. Mekhanika, no. 2, 1965, 69-75

TOPIC TAGS: gyroscope, gyroscope stability, gyroscope motion, approximation method, stability criterion

ABSTRACT: The stability of a spherical gyro-vertical compass with aerodynamic suspension and of a gyro-horizontal compass in the presence of dissipative forces was studied analytically. The equations of motion of the gyro-vertical are written first, and are followed by the particular solution

$$\alpha = \beta = 0, \quad \alpha^{\cdot} = \beta^{\cdot} = 0, \quad \rho = \gamma^{\cdot}\alpha^{\cdot}\sin\beta = \omega.$$

The angular momenta are expressed by

$$M_x^{(2)} = (C - A)\,\Omega\nu + C\omega\nu, \quad M_y^{(2)} = A\nu^{\cdot}, \quad M_z^{(2)} = C(\omega^{\cdot} + \Omega^{\cdot}).$$

where A is the equatorial moment of inertia of the gyroscope, C is the axial

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ACCESSION NR: AP5013132

moment of inertia, and ω is the angular velocity around the z-axis. From these, perturbation equations are obtained and the following Lyapunov function is defined

$$2V = A(y_1^2 + y_2^2) + Cy_3^2 + [(C - A)(\Omega^2 - \nu^2) + H\Omega]x_1^2 + + [(C - A)\Omega^2 + H\Omega]x_2^2 + \ldots \quad (H = C\omega).$$

It is shown that the sufficient conditions for the derivative of V to have the opposite sign of V and hence insure stability to the gyro-vertical compass are:

$$(C - A)(\Omega^2 - \nu^2) + \frac{CA}{K}\Omega^{\cdot}\Omega > \lambda_1 > 0$$

for all $t \geqslant t_0$,

$$(C - A)\Omega^2 + \frac{CA}{K}\Omega^{\cdot}\Omega > \lambda_2 > 0$$

$$2K(C - A)\nu^{\cdot}\nu - C^2\nu^{\cdot 2} > 0 \qquad (t > t_0)$$

and

$$(A - C)\Omega^{\cdot}\Omega - {}^1/_2 CAK^{-1}(\Omega^{\cdot}\Omega)^{\cdot} > 0 \qquad (t > t_0).$$

A small example is given to illustrate this point. Next, the exact equations of motion for the horizontal gyrocompass are written with the following expression for the angular momenta: $M_x^{(1)} = -K(\alpha^{\cdot}\psi_1 + \beta^{\cdot}\cos\gamma)$, $M_y^{(1)} = -K(\alpha^{\cdot}\psi_2 + \gamma^{\cdot})$

$$M_z^{(1)} = -K(\alpha^{\cdot}\psi_3 + \beta^{\cdot}\sin\gamma) \qquad (K > 0).$$

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The motion is described by $\alpha = \beta = \gamma = 0, \quad \alpha^{\cdot} = \beta^{\cdot} = \gamma^{\cdot} = 0$

with the following two conditions for asymptotic stability:

$$mlR + C - A > \lambda_1 > 0, \quad mgl + (C - B)\,\Omega^2 > \lambda_2 > 0$$
$$g - \nu v - R\Omega^2 > \lambda_3 > 0 \quad (t \geq t_0)$$

$$4K(B - C)\,\Omega^{\cdot}\Omega - B^2\Omega^{\cdot 2} - C^2 v^{\cdot 2} > \varkappa_1 > 0$$
$$4K(mlR + C - A)\,v^{\cdot}v + (A - mlR)^2 v^{\cdot 2} < -\varkappa_2 \leqslant 0 \quad (t \geq t_0)$$
$$\Delta_2 > \varkappa_3 > 0 .$$

In all above the parameters v, Ω, H are assumed to be functions of time. Orig. art. has: 29 formulas.

ASSOCIATION: none

SUBMITTED: 12Feb64 ENCL: 00 SUB CODE: ME

NO REF SOV: 008 OTHER: 000

Card 3/3 BK

L 23444-66 EWT(1) IJP(c)

ACC NR: AP6007577 SOURCE CODE: UR/0040/66/030/001/0042/0050

AUTHOR: Krementulo, V. V. (Moscow)

ORG: none

33
31

TITLE: Optimum flywheel stabilization of a rigid body having one stationary point B

SOURCE: Prikladnaya matematika i mekhanika, v. 30, no. 1, 1966, 42-50

TOPIC TAGS: flywheel, gyroscope, rigid body motion, dynamic system

ABSTRACT: The analytical design problem of providing optimum stabilization of a rigid body having one stationary point is solved by using a theory similar to the simple Lyapunov method. The equations of motion for steady state and the perturbed equations of motion are derived for three identical flywheels directed along three orthogonal axes. Then the optimum stabilization problem is formulated to find the phase coordinate functions v_i so as to minimize

$$\int_{t_0}^{\infty} \Omega(p_1, p_2, p_3, \alpha_{11}, \ldots, \alpha_{33}, v_1, v_2, v_3)\, dt$$

and to make the zero solution

$$p_i = 0, \quad \alpha_{ik} = 0 \qquad (i, k = 1, 2, 3)$$

asymptotically stable (where p_i, α_{ik} are the angular velocity and position coordinates). The methods described by N. N. Krasovskiy (O stabilizatsii neustoychivykh

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ACC NR: AP6007577

d'izheniy dopolnitel'nymi silami pri nepolnoy obratnoy svyazi. PMM. 1963, t. 27, vyp.4) are used to solve the optimizing problem, and equations for the phase coordinate control functions (flywheel moments) are derived. The author thanks N. N. Krasovskiy and G. K. Pozharitskiy for their advice. Orig. art. has: 41 formulas.

SUB CODE: 17,13 SUBM DATE: 05Jul65/ ORIG REF: 003

2/2 W

SE: 06/14/2000 CIA-RDP86-00513R00082

SOURCE CODE: UR/0424/66/000/006/0011/0018

ACC NR: AP7002688

AUTHOR: Krementulo, V. V. (Moscow)

ORG: none

TITLE: The use of flywheels for the optimum stabilization of the rotary motion of a solid body with a fixed point

SOURCE: Inzhenernyy zhurnal. Mekhanika tverdogo tela, no. 6, 1966, 11-18

TOPIC TAGS: motion stability, spacecraft stability, astrionic stabilization, gyroscope motion equation, Euler equation, Volterra equation, Poisson equation

ABSTRACT: This work is a generalization of research performed previously and aimed at the optimization of flywheel control, and the determination of the optimum stability of the initial equilibrium position with respect to speed and coordinates. The motion of the system is defined by three Euler-Volterra equations, nine Poisson equations (kinematic), and three equations of the rotary motion of the flywheels. The problem is somewhat simplified for the case of a symmetrical gyrostat; the Euler-Krylov angles and their vectorialization lend themselves to some additional simplifications, so that the gyrostat motion is defined completely by 12 equations. To solve the stabilization problem, a "shortened" system of equations is introduced. The fundamental theorem of Lyapunov's second method is used for the solution of the analytical design problem of

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regulators. The functions obtained are positive definites, and include quadratic forms. The excitations of the system are expressed in terms of the excitations of the Krylov angles. In the framework of the suggested stabilization system, the smaller the angular rotation velocity, the easier it is to stabilize the rotation. It is more difficult to make a rapidly-rotating gyroscope asymptotically stable, than a slowly rotating gyroscope. The results can be applied to the spin-stabilization of spacecraft. Orig. art. has: 36 formulas.

SUB CODE: 20,12,22/ SUBM DATE: 19Apr66/ ORIG REF: 011/ OTH REF: 001

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Kravchenko, S.F.

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Krementulo, V.V.

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