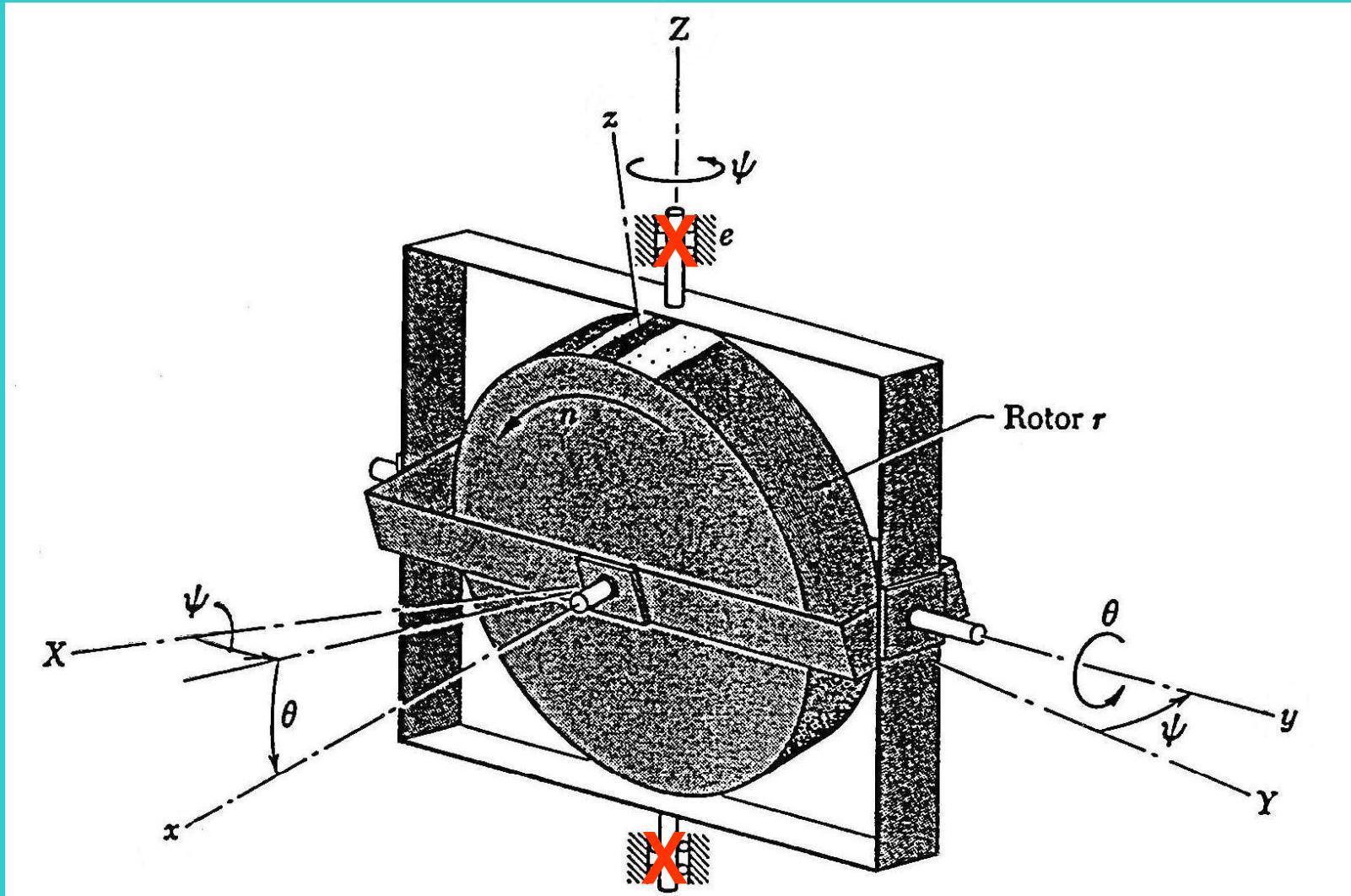
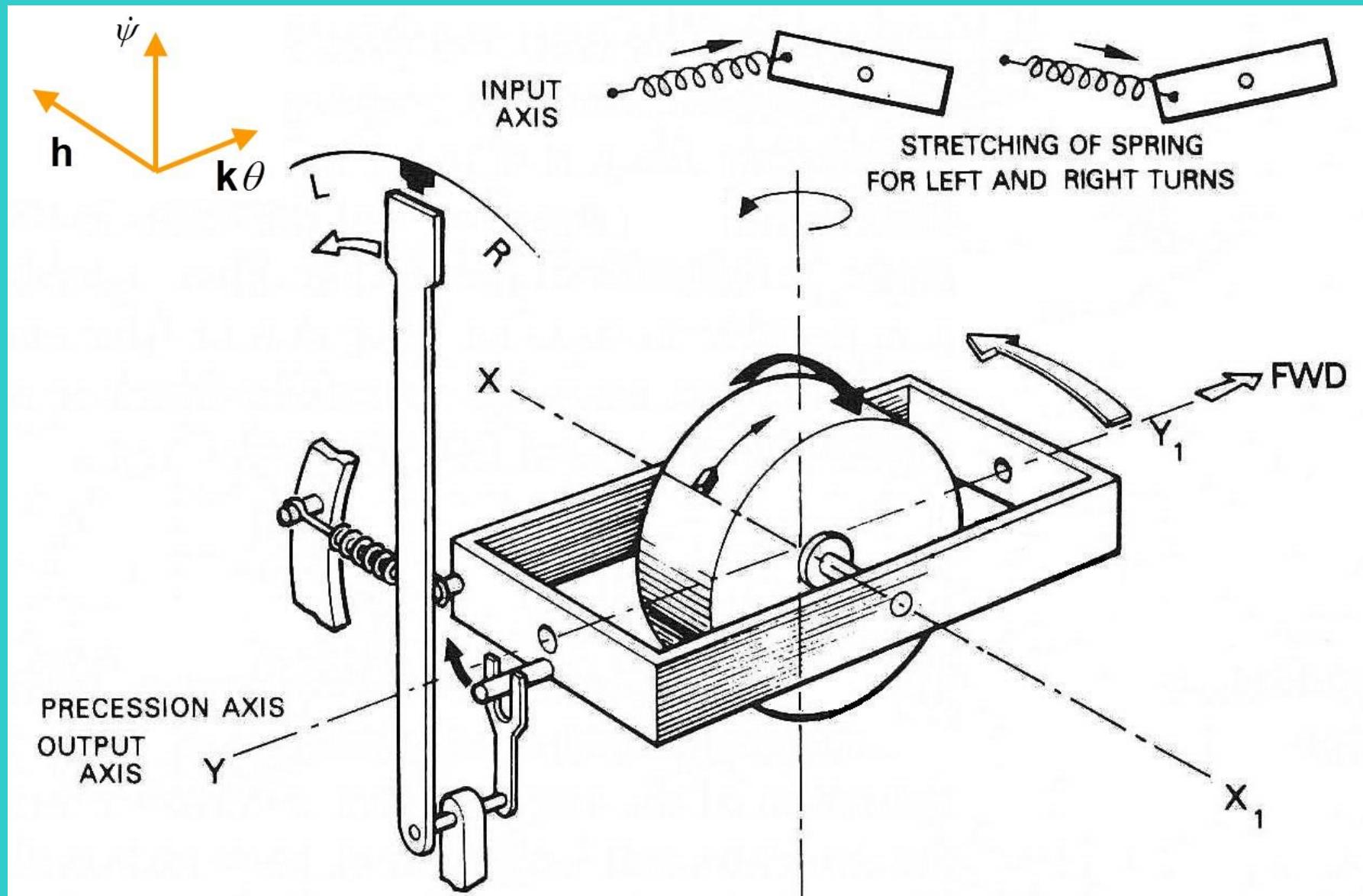


Soppressione di un grado di libertà

$$\mathbf{J}_y \ddot{\theta} + \mathbf{b} \dot{\theta} + \mathbf{k} \theta = -\mathbf{h} \dot{\psi} + \mathbf{M}_u$$



Indicatore di virata

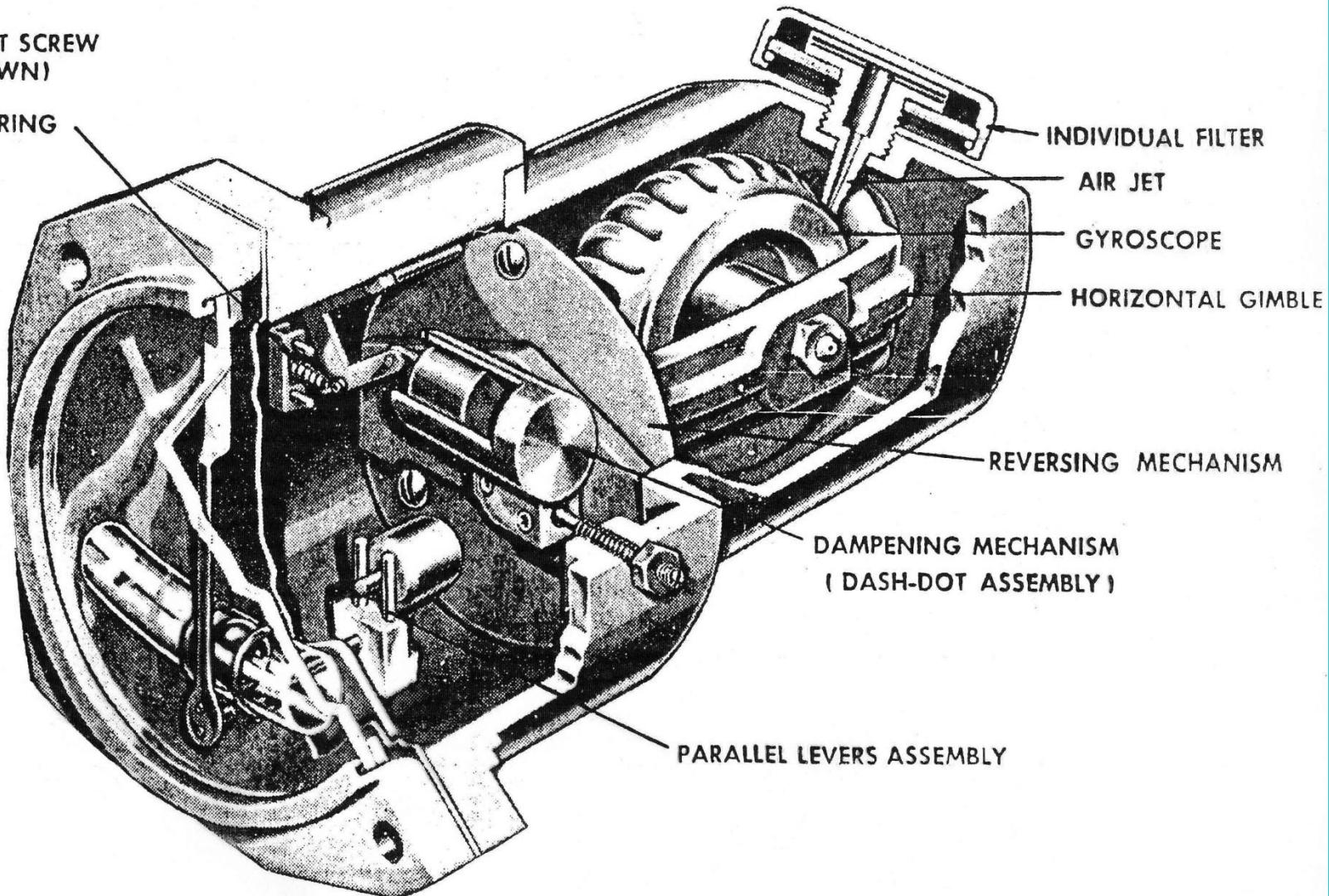


Il telaio ruota in senso opposto all'angolo di bank

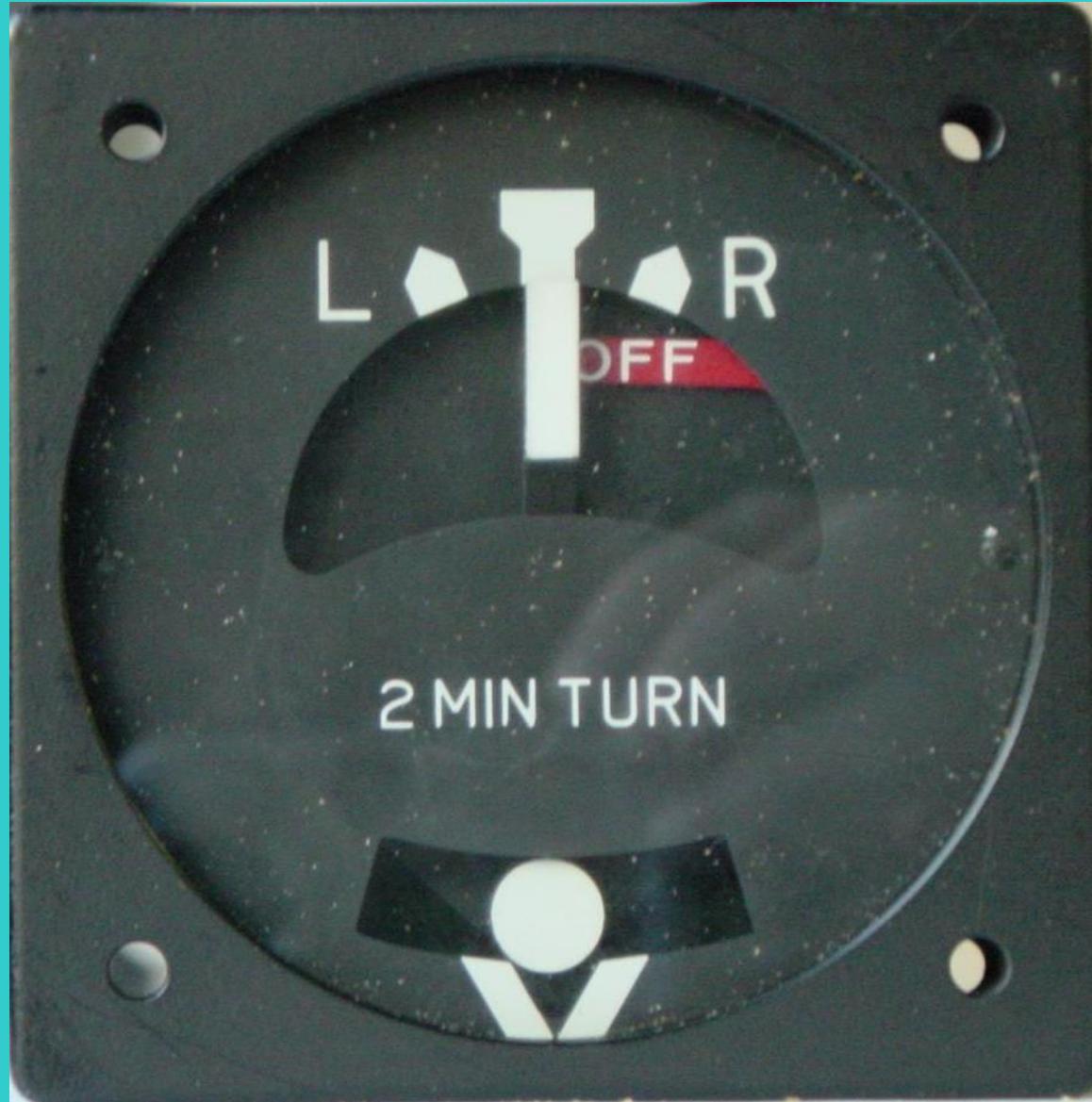
Virosbandometro

SENSITIVITY SET SCREW
(NOT SHOWN)

SENSITIVITY SPRING



Quadrante di virosbandometro



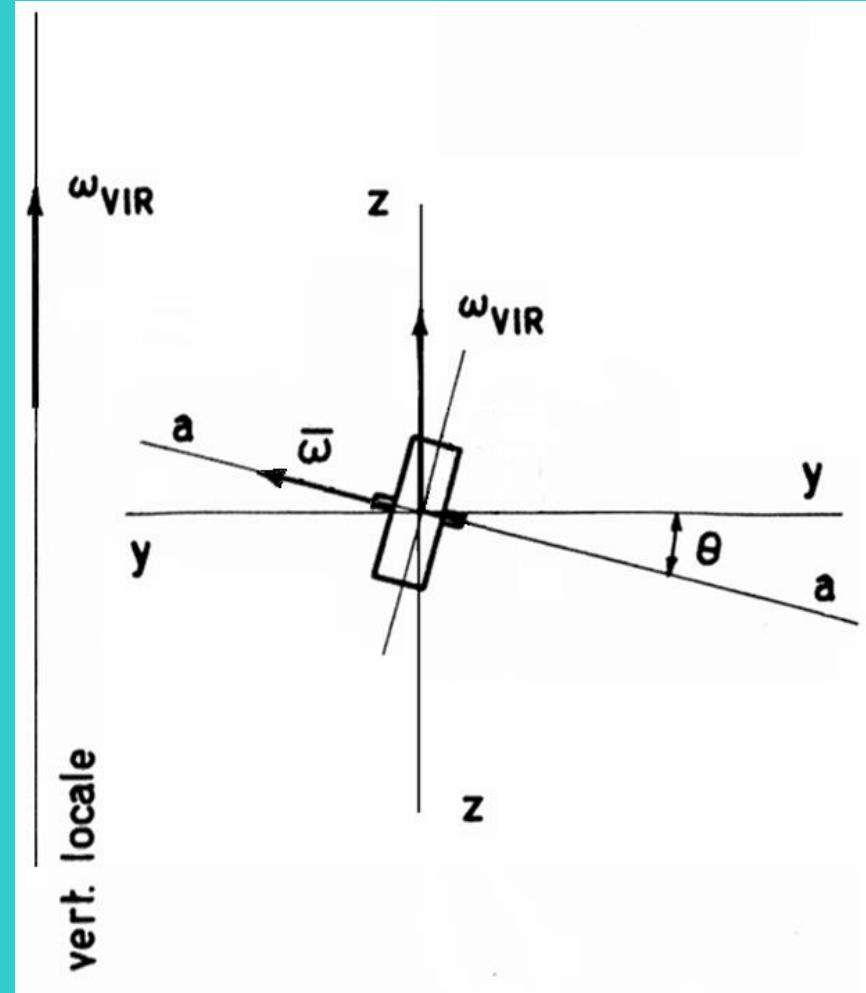
Indicatore di velocità di virata

Da: $\mathbf{J}_y \ddot{\theta} + \mathbf{b} \dot{\theta} + \mathbf{k} \theta = -\mathbf{h} \dot{\psi} + \mathbf{M}_u$

nella situazione a regime con $\ddot{\theta}$ e $\dot{\theta}$ nulle
e $\mathbf{M}_u = 0$, adottando la notazione in figura,
nell'ipotesi di virata piatta, $\phi = 0$, si ha:

$$\mathbf{k} \theta = -\mathbf{h} \dot{\psi} \Rightarrow \mathbf{k} \theta = -\mathbf{h} \omega_{VIR} = -\mathbf{J} \bar{\omega} \omega_{VIR}$$

da cui: $\theta = -\frac{\mathbf{J} \bar{\omega}}{\mathbf{k}} \omega_{VIR}$



Nell'ipotesi di un angolo di bank $\phi \neq 0$

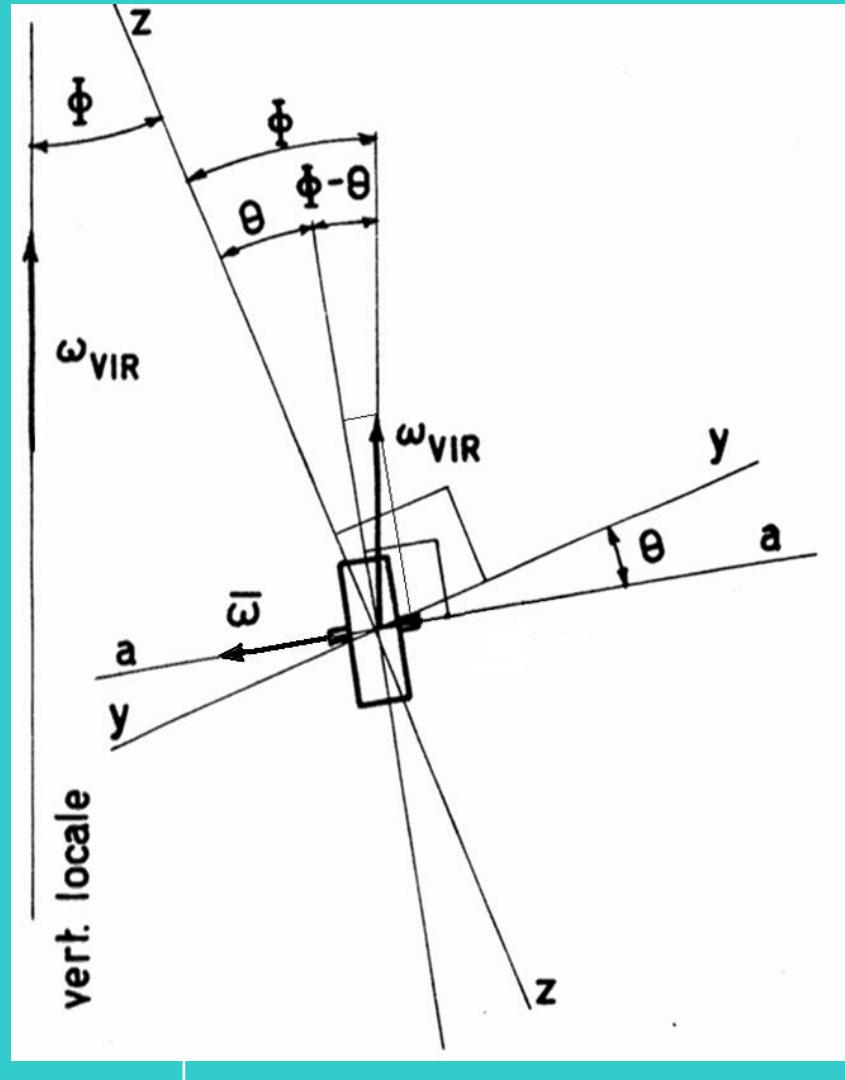
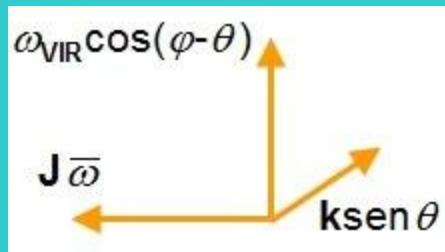
$$\mathbf{k} \sin \theta = -\mathbf{h} \dot{\psi} = -\mathbf{h} \omega_{VIR} \cos(\phi - \theta)$$

$$\mathbf{h} \omega_{VIR} (\cos \phi \cos \theta + \sin \phi \sin \theta) = -\mathbf{k} \sin \theta$$

dividendo per $\cos \phi \sin \theta$ si ha:

$$\cot \theta = -\frac{\mathbf{k}}{\mathbf{J} \bar{\omega} \omega_{VIR} \cos \phi} - \tan \phi$$

$$\tan \theta = -\frac{\mathbf{J} \bar{\omega} \omega_{VIR} \cos \phi}{\mathbf{k} + \mathbf{J} \bar{\omega} \omega_{VIR} \sin \phi}$$



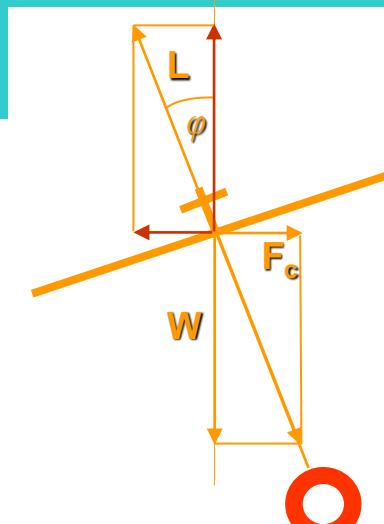
Sbandometro

$$r_{\text{VIR}} = \frac{v_{\text{VIR}}}{\omega_{\text{VIR}}}$$

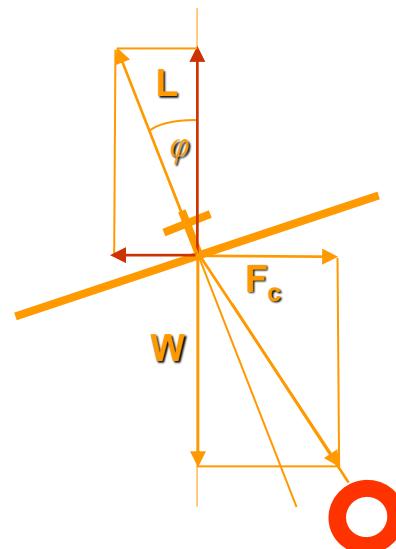
$$\tan \phi = \frac{v_{\text{VIR}} \omega_{\text{VIR}}}{g}$$

$$n = \sqrt{1 + \tan^2 \phi} = \frac{1}{\cos \phi}$$

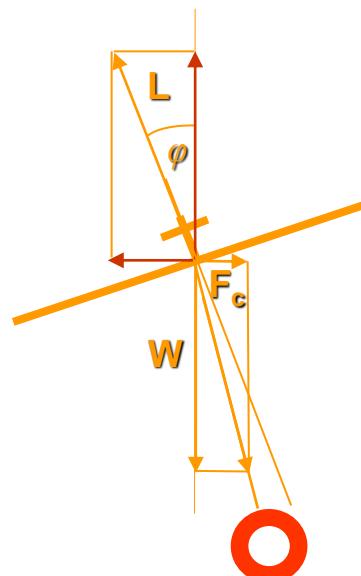
$$F_c = \frac{W}{g} \frac{v_{\text{VIR}}^2}{r_{\text{VIR}}} = \frac{W}{g} \omega_{\text{VIR}} v_{\text{VIR}}$$



Corretta

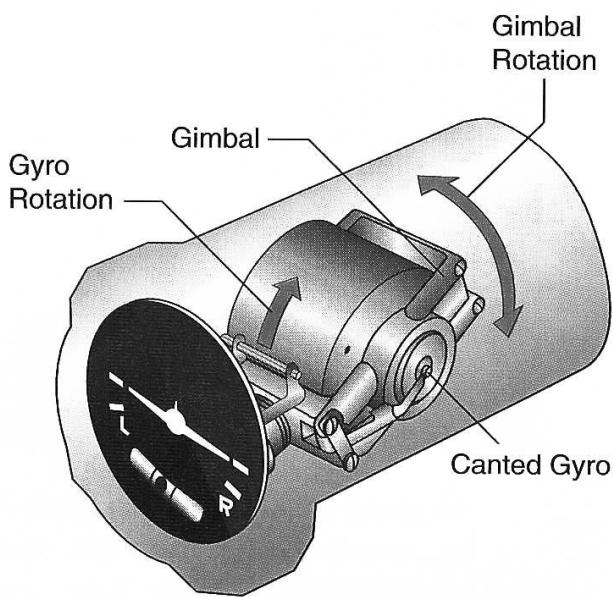


Derapata



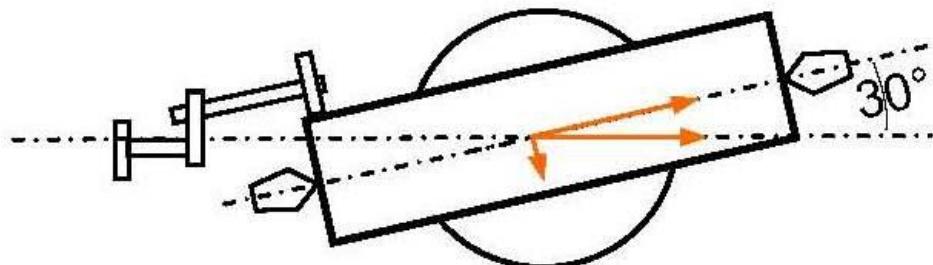
Scivolata

Turn coordinator

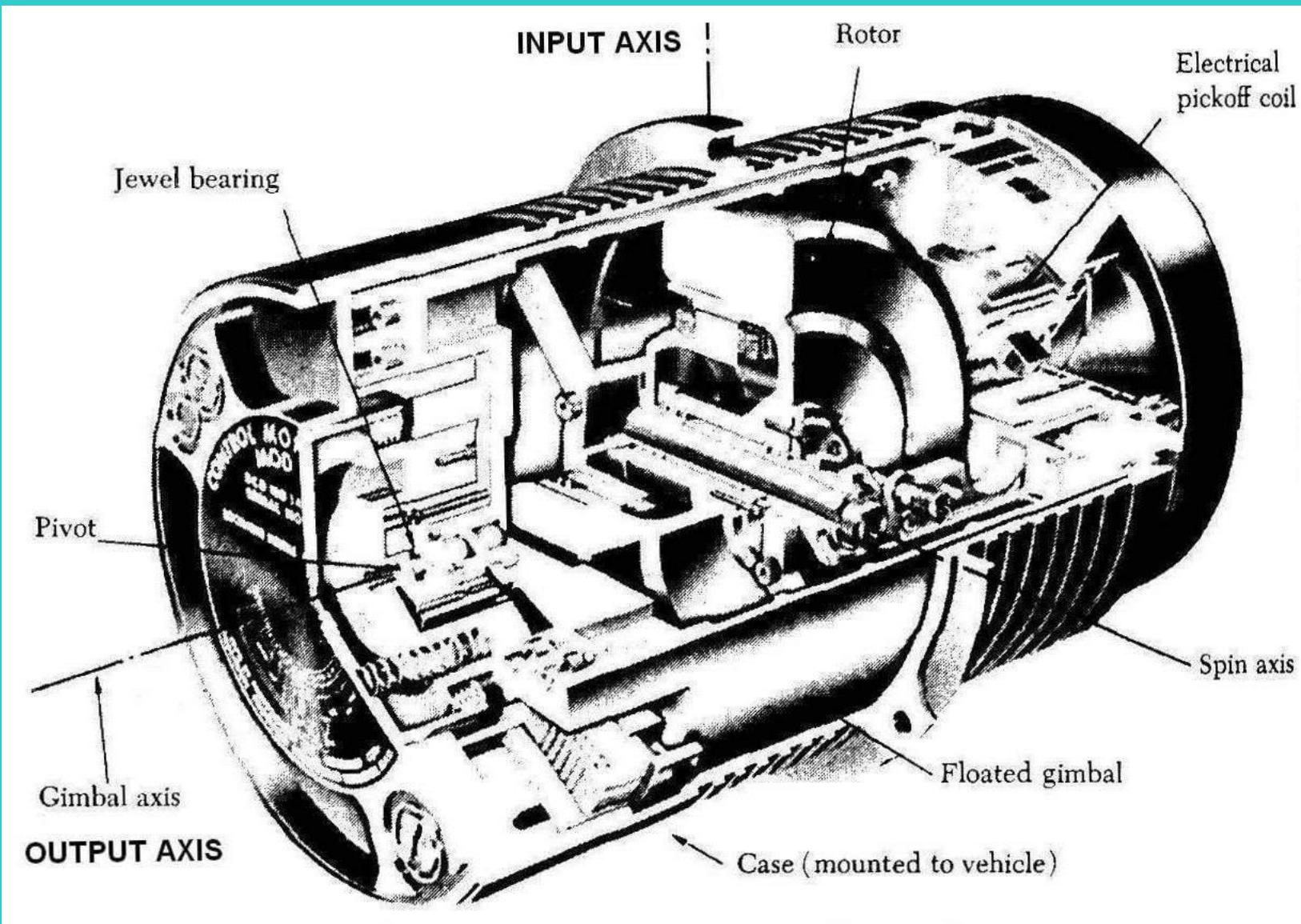


TURN COORDINATOR

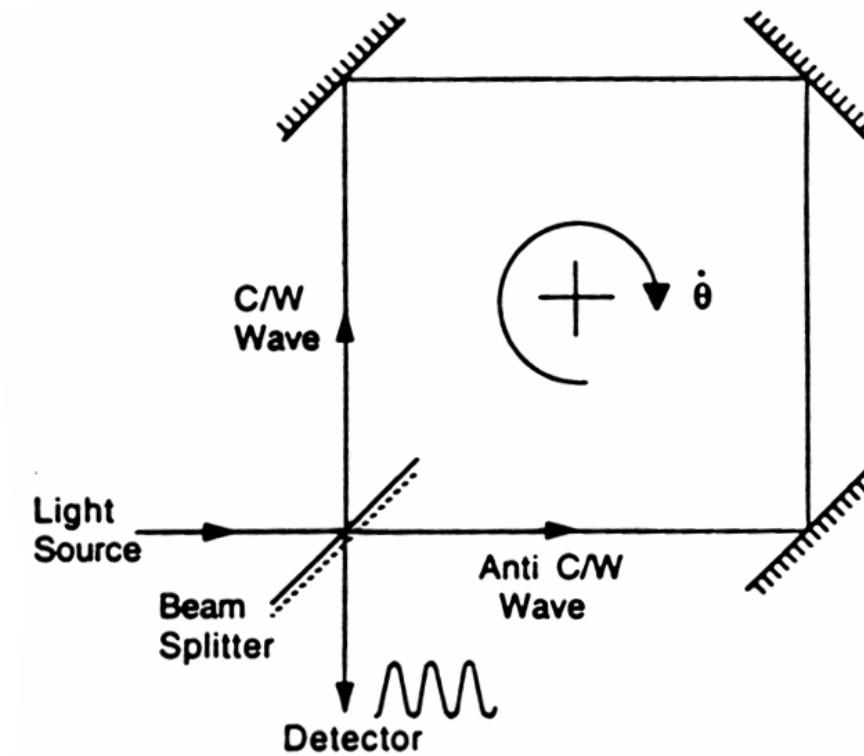
The gimbal in the turn coordinator is set at an angle, or canted, which allows its gyro to sense both rate of roll and rate of turn.



Floated single-axis gyro

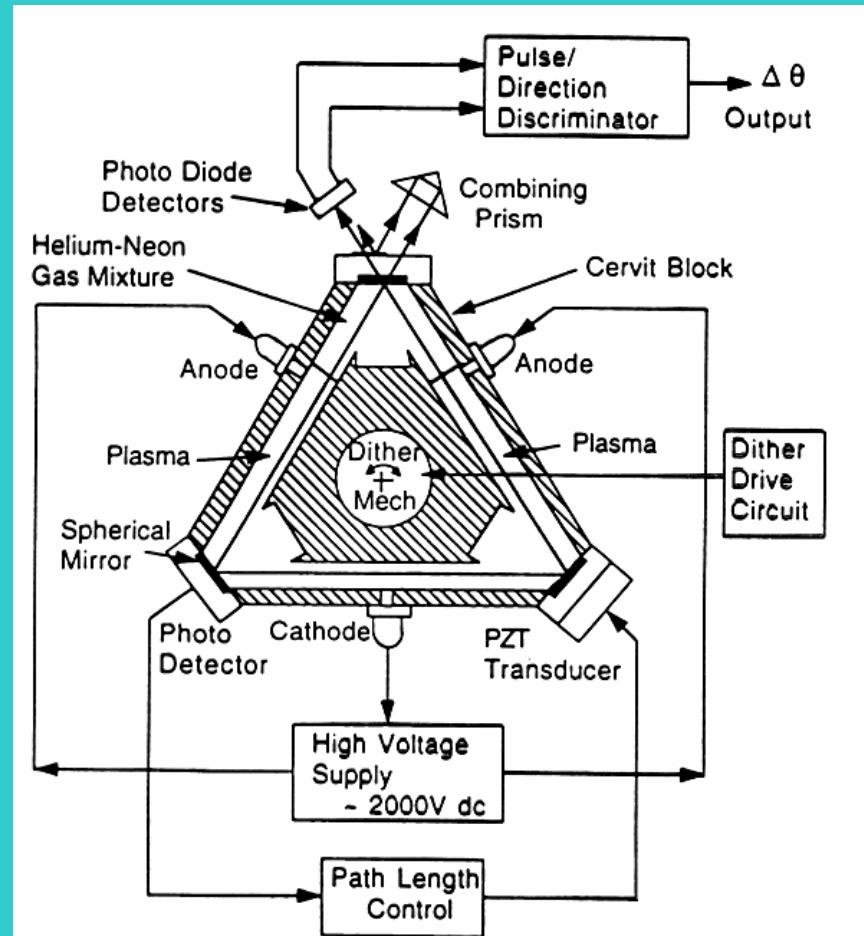
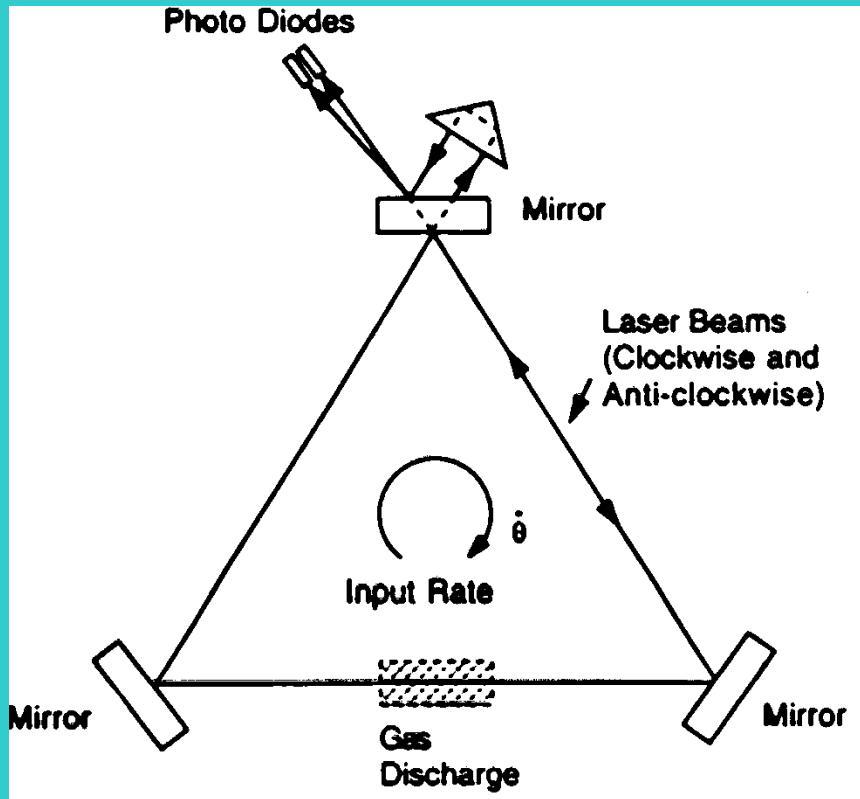


Ring laser gyro

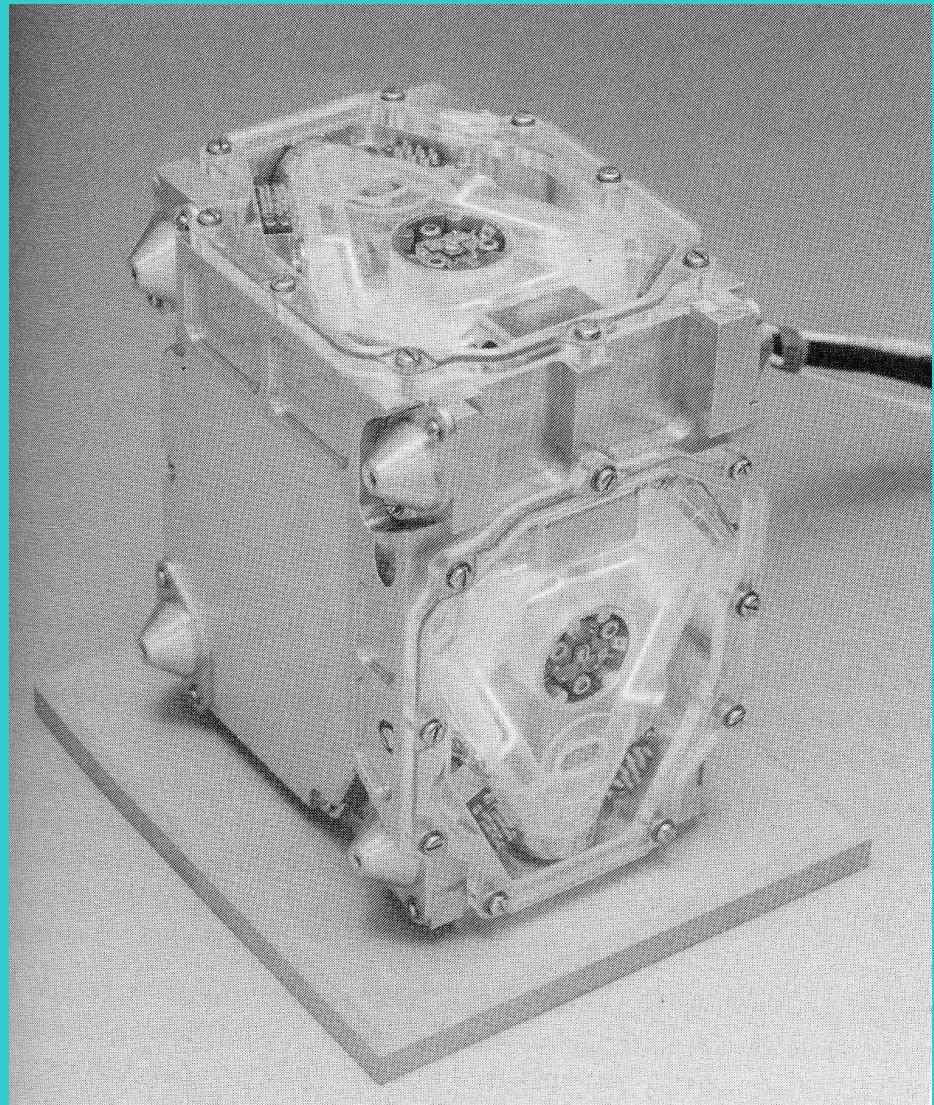


The clockwise and anti-clockwise waves interfere to produce a fringe pattern which shifts when Interferometer is subjected to Input Rate, $\dot{\theta}$.

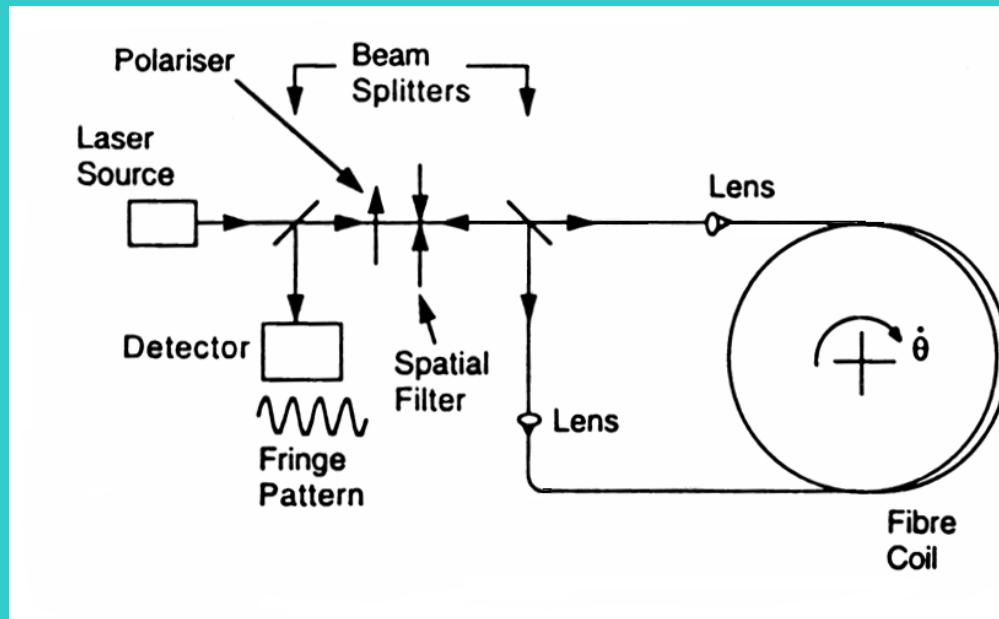
Ring laser gyro



Ring laser gyro



Fiber laser gyro



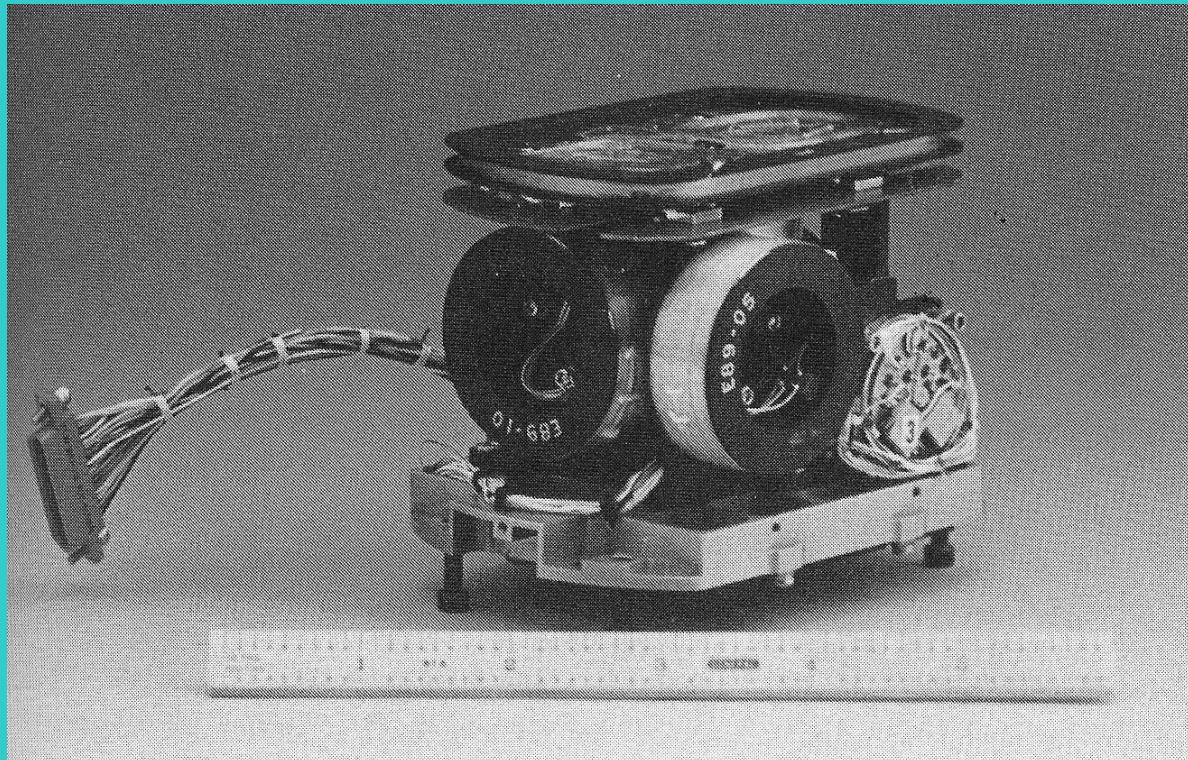
Fiber laser gyro

Casi numerici

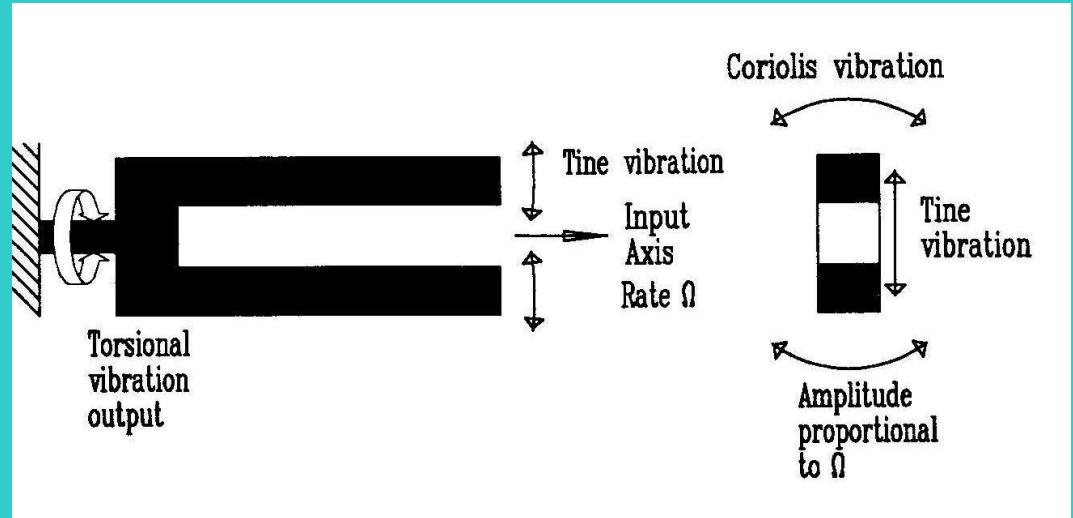
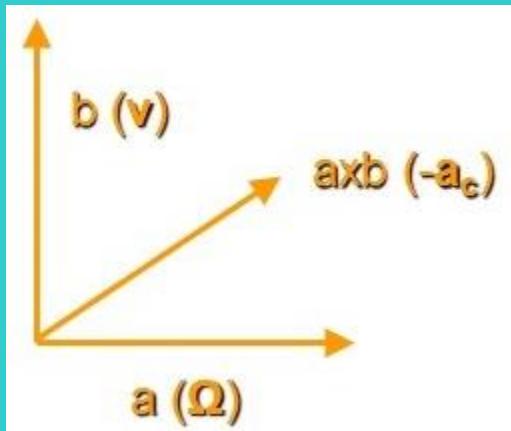
$L = 200 \text{ m}$, $D = 70 \text{ mm}$, $\lambda = 1.3 \times 10^{-6} \text{ m}$, $\dot{\theta} = 10^\circ/\text{s} \Rightarrow \Phi_s = 2.26^\circ$

Se $\dot{\theta} = 15^\circ/\text{h} \Rightarrow \Phi_s = 3.38 \text{ arcsec}$

Si misura sino a $0,01^\circ/\text{h}$



Tuning fork gyro



$\mathbf{a}_c = -2\Omega \wedge \mathbf{v}$ da cui:

$$\mathbf{a} = \frac{4\mathbf{v}\Omega}{K} \text{ dove:}$$

\mathbf{a} è l'ampiezza dell'oscillazione dovuta all'accelerazione di Coriolis

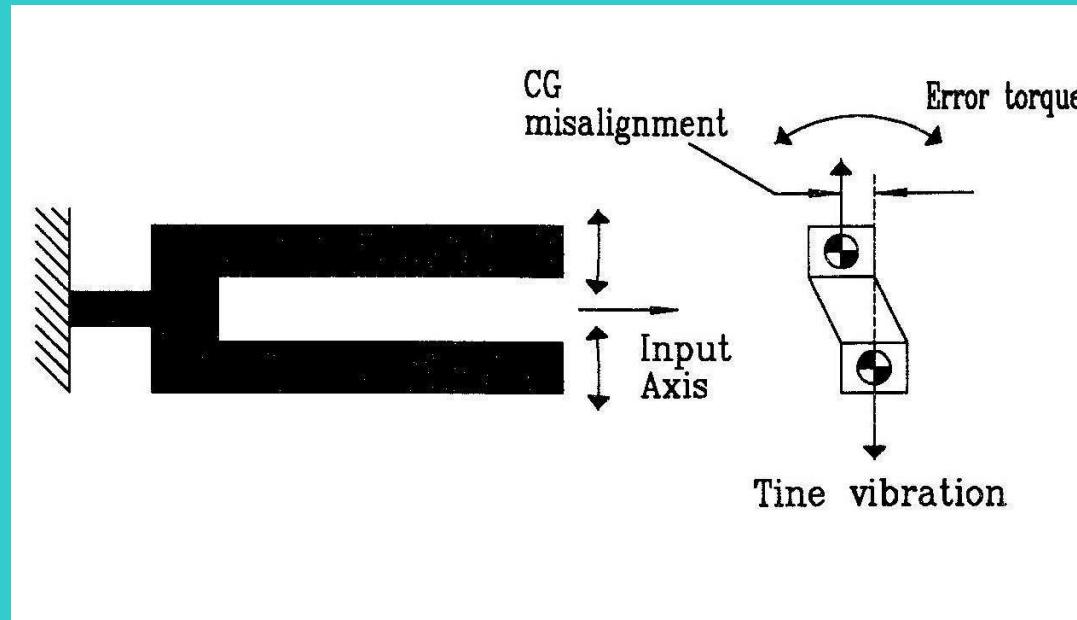
$\mathbf{v} = v_0 \sin \omega_f t$ è la velocità delle estremità dei rebbi della forchetta

ω_f è la frequenza di oscillazione dei rebbi (tines)

Ω è la velocità angolare di input

K è la rigidezza torsionale dello stelo della forchetta

Micro Electro Mechanical Systems



Problemi dovuti alle variazioni delle caratteristiche meccaniche dei metalli con la temperatura e al disallineamento dei baricentri dei rebbi che può provocare una torsione.

Oggi si impiegano oscillatori al quarzo e questi rate gyro possono essere considerati dei MEMS (Micro Electro Mechanical Systems).