Verstellprinzipe für Verstellpropeller / Principle of the adjustment of Controllable Pitch Propellers ©

Betrachtung ohne Reibung zur Tendenzanalyse / Consideration without Friction for Analysis of Tendencies

<table>
<tr>
<td></td>
<td>Die Zapfen des Jochs wirken über Gleitsteine direkt auf die Nuten der Lagerteller (Propellerfügel)
Die Kurbelstangen werden reduziert auf Gleitsteine
Crosshead (yoke) with pins acting by means of slide pieces direct on the grooves of the bearing plates (propeller blades)
The connecting rods are reduced to slide pieces</td>
<td>Joch mit Zapfen wirkt über Kurbelstangen auf die Zapfen der Lagerteller (Propellerflügel)
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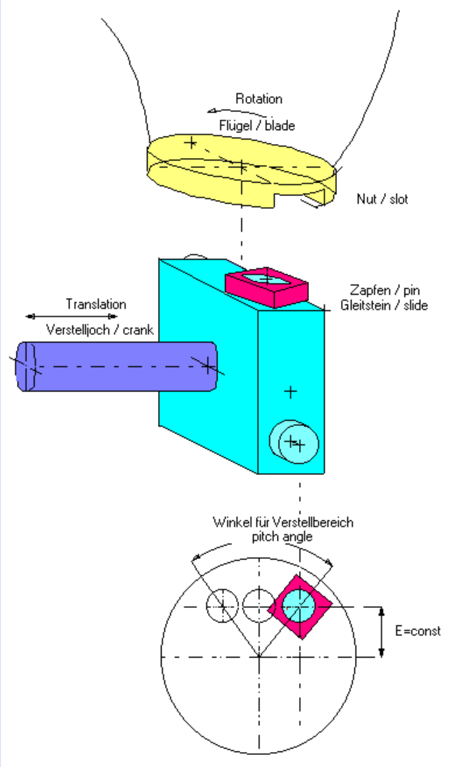
<td>Verstellprinzip

Principle of adjustment</td>
<td>
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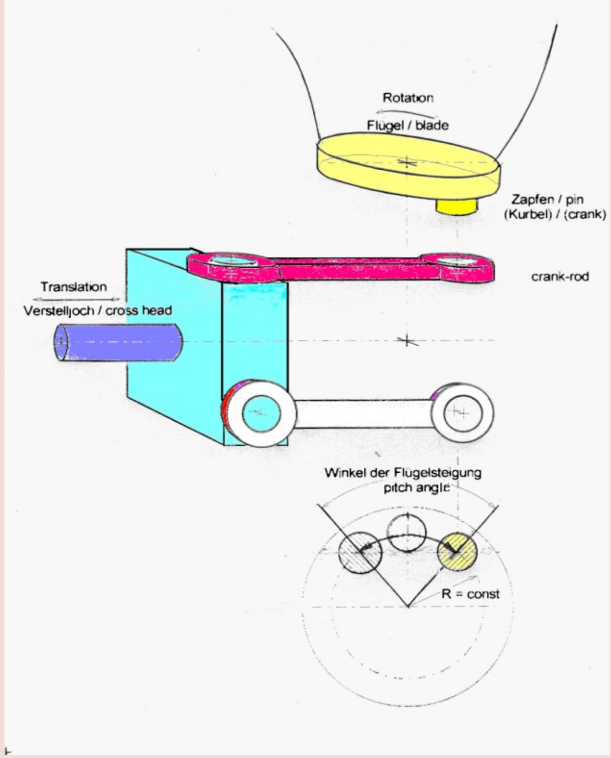
<td>
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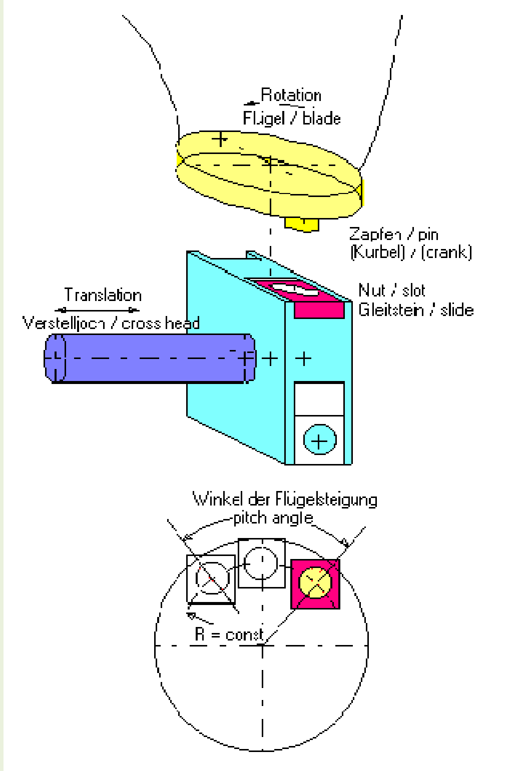
<td>
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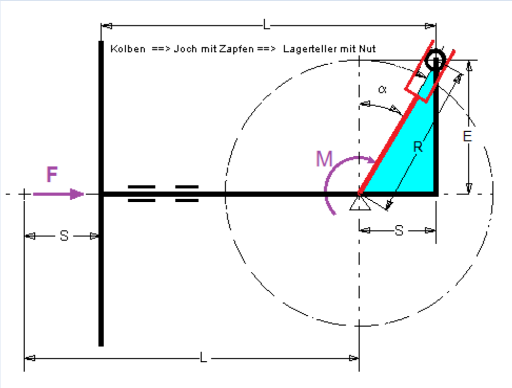
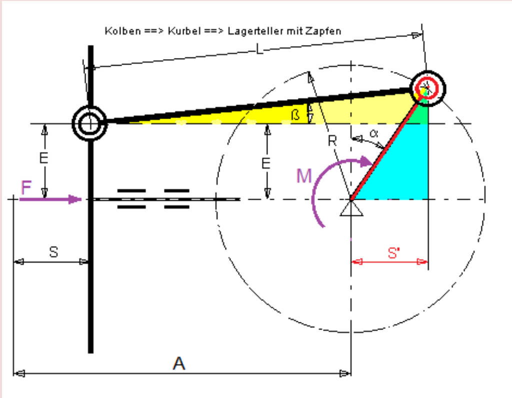
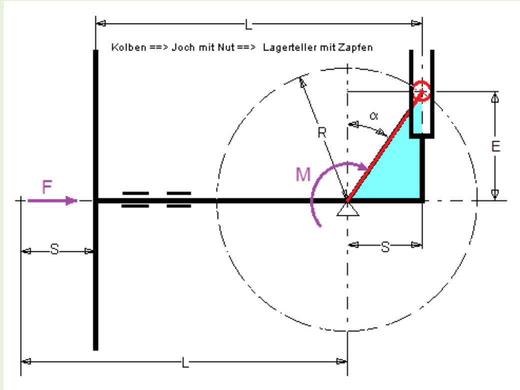
Geometrische Bedingungen Geometric conditions			
	abgeleitete Version ← Derived version	← **Basisversion** → basis version	→ **abgeleitet Version** derived version
Definitionen Definitions	$E = const.,\ L = 0,\ A = 0,\ R(\alpha) = \frac{E}{\cos\alpha}$	$E = const.,\ L = const.,\ A = \sqrt{L^2 - (R-E)^2} = const.,\ R = const.$	$E(\alpha) = R \cdot \cos\alpha,\ L = 0,\ A = 0,\ R = const.$
Verstellweg Adjusting *travel*	$S(\alpha) = E \cdot \tan\alpha$	$S(\alpha) = R \cdot \left[\sin\alpha + A - \sqrt{\left(\frac{L}{R}\right)^2 - \left(\cos\alpha - \frac{E}{R}\right)^2} \right]$	$S(\alpha) = R \cdot \sin\alpha$
Dimensionsloser Verstellweg Dimensionless travel	$\frac{S(\alpha)}{E} = \tan\alpha$	$\frac{S(\alpha)}{R} = \left[\sin\alpha + \frac{A}{R} - \sqrt{\left(\frac{L}{R}\right)^2 - \left(\cos\alpha - \frac{E}{R}\right)^2} \right]$	$\frac{S(\alpha)}{R} = \sin\alpha$
Änderung des Weges nach dem Winkel Derivation of the travel with respect to the angle	$\frac{dS}{d\alpha} = R \cdot \frac{1}{\cos\alpha} = E \cdot \frac{1}{\cos^2\alpha}$ $\frac{d\alpha}{dS} = \frac{1}{R} \cdot \cos\alpha = \frac{1}{E} \cos^2\alpha$	$\frac{ds}{d\alpha} = R \cdot \left[\cos\alpha - \frac{\sin\alpha \cdot \left(\cos\alpha - \frac{E}{R}\right)}{\sqrt{\left(\frac{L}{R}\right)^2 - \left(\cos\alpha - \frac{E}{R}\right)^2}} \right]$	$\frac{ds}{d\alpha} = R \cdot \cos\alpha$ $\frac{d\alpha}{dS} = \frac{1}{R} \cdot \frac{1}{\cos\alpha}$

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Differenzielle Arbeit Differential work	$M \cdot d\alpha = F \cdot dS$		
Kraft: $F = M \cdot \frac{d\alpha}{dS}$ Adjusting Force	$F = M \cdot \frac{d\alpha}{dS} = \frac{M}{R} \cdot \cos\alpha = \frac{M}{E} \cdot \cos^2\alpha$	$F = \frac{M}{R} \cdot \frac{\sqrt{\left(\frac{R}{L}\right)^2 - \left(\cos\alpha - \frac{E}{R}\right)^2}}{\cos\alpha \cdot \sqrt{\left(\frac{R}{L}\right)^2 - \left(\cos\alpha - \frac{E}{R}\right)^2} - \sin\alpha \cdot \left(\cos\alpha - \frac{E}{R}\right)}$	$F = M \cdot \frac{d\alpha}{dS} = \frac{M}{R} \cdot \frac{1}{\cos\alpha}$
dimensionslose Kraft: $\frac{F}{M/R} = R \cdot \frac{d\alpha}{dS}$ Dimensionless force	$\frac{F}{M/E} = \cos^2\alpha$	$\frac{F}{M/R} = \frac{\sqrt{\left(\frac{R}{L}\right)^2 - \left(\cos\alpha - \frac{E}{R}\right)^2}}{\cos\alpha \cdot \sqrt{\left(\frac{R}{L}\right)^2 - \left(\cos\alpha - \frac{E}{R}\right)^2} - \sin\alpha \cdot \left(\cos\alpha - \frac{E}{R}\right)}$	$\frac{F}{M/R} = \frac{1}{\cos\alpha}$
Moment $M = F \cdot \frac{dS}{d\alpha}$	$M = F \cdot \frac{dS}{d\alpha} = F \cdot R \cdot \frac{1}{\cos^2\alpha} = F \cdot E \cdot \frac{1}{\cos^2\alpha}$	$M = F \cdot R \cdot \left[\cos\alpha - \frac{\sin\alpha \cdot \left(\cos\alpha - \frac{E}{R}\right)}{\sqrt{\left(\frac{L}{R}\right)^2 - \left(\cos\alpha - \frac{E}{R}\right)^2}}\right]$	$M = F \cdot \frac{dS}{d\alpha} = F \cdot R \cdot \cos\alpha$
dimensionsloses Moment $\frac{M}{F \cdot R} = \frac{1}{R} \cdot \frac{dS}{d\alpha}$ dimensionless moment	$\frac{M}{F \cdot E} = \frac{dS}{d\alpha} = \frac{1}{\cos^2\alpha}$	$\frac{M}{F \cdot R} = \left[\cos\alpha - \frac{\sin\alpha \cdot \left(\cos\alpha - \frac{E}{R}\right)}{\sqrt{\left(\frac{L}{R}\right)^2 - \left(\cos\alpha - \frac{E}{R}\right)^2}}\right]$	$\frac{M}{F \cdot R} = \frac{dS}{d\alpha} = \cos\alpha$
Info zur Ableitung Info about the derivation	$\tan\alpha = \frac{S(\alpha)}{E}$	$\frac{S(\alpha)}{R} = \left[\sin\alpha + \frac{A}{R} - \sqrt{\left(\frac{L}{R}\right)^2 - \left(\cos\alpha - \frac{E}{R}\right)^2}\right]$	$\sin\alpha = \frac{S(\alpha)}{R}$

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Beispiel Example	**J+Z** – Joch mit Zapfen Yoke with Pin	**J+K** - Joch mit Kurbelstange Yoke with connecting rod	**J+N** - Joch mit Nut Yoke with nut
Bedingungen Conditions	$A=0,\quad \frac{E}{R(\alpha=0°)}=1,\quad L=0$	$\frac{A}{R}=\sqrt{\frac{L^2}{R}-(1-\frac{E}{R})^2}=2\ ,\quad \frac{E}{R}=1\ ,\quad \frac{L}{R}=2$	$\frac{A}{R}=0\ ,\quad \frac{E}{R}=1\ ,\quad \frac{L}{R}=0$
Verstellweg Adjusting travel	$\left(\frac{S(\alpha)}{E}\right)_{J+Z}=\tan\alpha$	$\left(\frac{S(\alpha)}{R}\right)_{J+K}=\left[\sin\alpha+\frac{A}{R}-\sqrt{\left(\frac{L}{R}\right)^2-\left(\cos\alpha-\frac{E}{R}\right)^2}\right]$	$\left(\frac{S(\alpha)}{R}\right)_{J+N}=\sin\alpha$
Verstellmoment Adjusting Moment	$\left(\frac{M(\alpha)}{F\cdot E}\right)_{J+Z}=\frac{dS}{d\alpha}=\frac{1}{\cos^2\alpha}$	$\left(\frac{M(\alpha)}{F\cdot R}\right)_{J+K}=\left[\cos\alpha-\frac{\sin\alpha\cdot\left(\cos\alpha-\frac{E}{R}\right)}{\sqrt{\left(\frac{L}{R}\right)^2-\left(\cos\alpha-\frac{E}{R}\right)^2}}\right]$	$\left(\frac{M(\alpha)}{F\cdot R}\right)_{J+N}=\frac{dS}{d\alpha}=\cos\alpha$

Dimensionsloser Verstellweg Dimensionless adjusting travel	**Dimensionsloses Moment bei konstanter Verstellkraft *F*** Dimensionless moment relating to a constant adjusting force