Torque Calculations for Rotary Actuators

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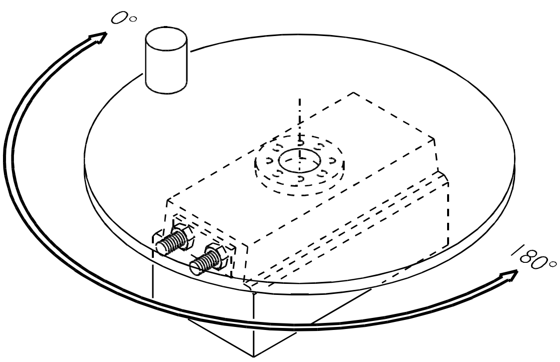
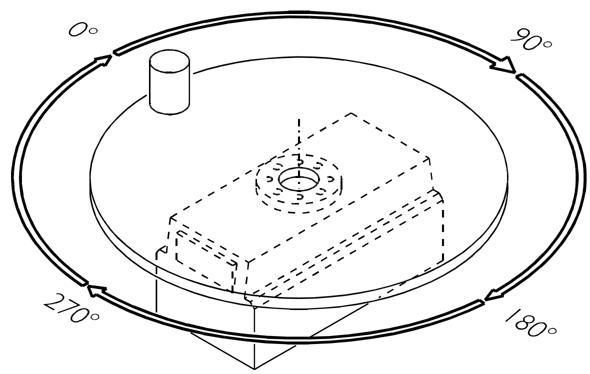
The rotary units:

They convert the linear motion of pneumatic cylinders into rotating intermittent movement of a shaft, on which it is possible to flange the load to rotate.
The rotation can be alternated (swiveling actuator) or keeping the same direction (indexing table).
In the choice of a rotary units the factors to consider are the torque, the kinetic energy and the loads on the pinion.





The torque:

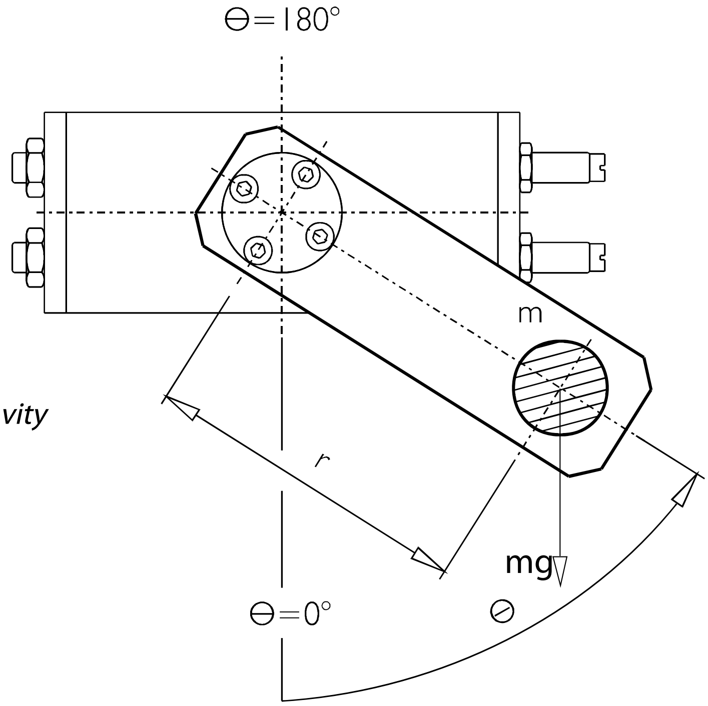
It must be sufficient to counteract the resistant forces,
like the gravity of an eccentric mass: C > m g r

C = *torque*

m = *mass*

g = *acceleration of gravity*

r = *eccentricity*



Kinetic Energy Calculation for Rotary Actuators

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Kinetic energy

The kinetic energy, due to the inertia of the rotating masses, must be lower than the maximum admissable value, typical of each rotary unit. Shock-absorbers must be used when the kinetic energy is high.

$$E = \frac{1}{2} J \omega^2_{max} = \frac{1}{2} J \left(2 \frac{\theta}{t}\right)^2 = \frac{2J\theta^2}{t^2}$$

$$E = 0,0006092 \frac{J\alpha^2}{t^2}$$

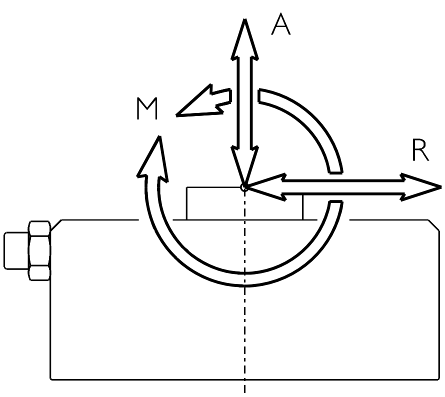
where:

kinetic energy	E	$\left[\frac{Kg \cdot cm^2}{s^2}\right]$
moment of inertia	J	$[Kg \cdot cm^2]$
maximum angular speed	ω_{max}	$\left[\frac{rad}{s}\right]$
swiveling angle in radiants	θ	[rad]
swiveling angle in degrees	α	[deg]
swiveling time	t	[s]

Loads on the pinion

Dynamic and static loads must be lower than the maximum permitted ones.

$A < A_{max}$
$R < R_{max}$
$M < M_{max}$



Kinetic Energy Calculation Example

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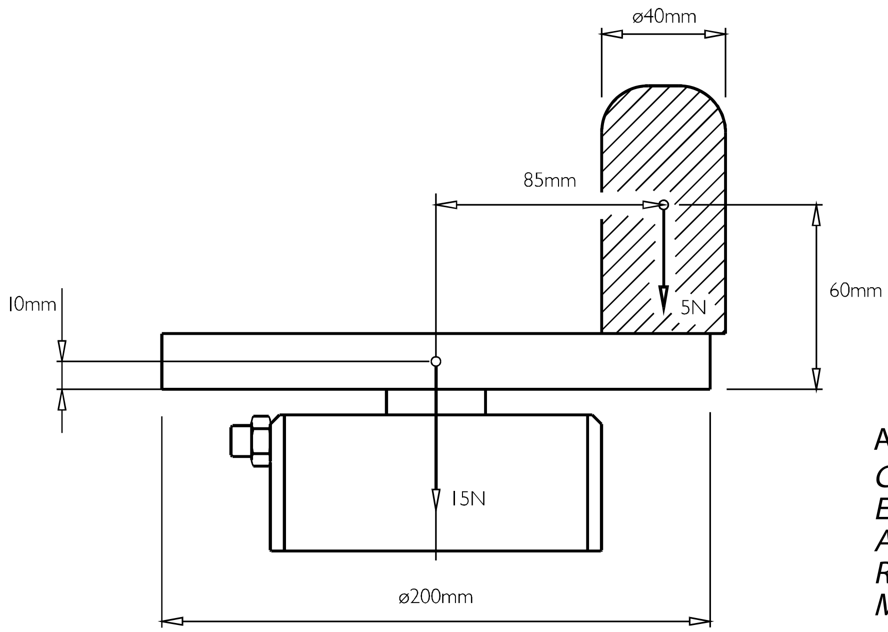
Calculation example:

Verify the choice of the swiveling unit Gimatic AT-16180-R to rotate 180° (π radiants) in 1.4 seconds the masses below the vertical axis of rotation:
a cylinder ø200mm, weighing 15N, centered on the axis of rotation
a cylinder with 85mm eccentricity, ø40mm, weighing 5N.



AT-16180-R :

$C = 1930$ Nmm
$E_{max} = 1600$ Kg cm^2 s^{-2}
$Ad^{max} = 30$ N
$Rd^{max} = 20$ N
$Md^{max} = 0.6$ Nm

$$J = \frac{1}{2} \cdot 1.5kg \cdot (10cm)^2 + \frac{1}{2} \cdot 0.5kg \cdot (2cm)^2 + 0.5kg \cdot (8.5cm)^2 = 112kgcm^2$$

$$E = \frac{2 \cdot 112kgcm^2 \cdot \pi^2}{(1.4s)^2} = 1128kgcm^2s^{-2} < 1600kgcm^2s^{-2} = E_{max}$$

$$Ad = 15N + 5N = 20N < 30N = Ad^{max}$$

$$Rd = 0$$

$$Md = 5N \cdot 85mm = 425Nmm < 0.6Nm = Md^{max}$$

If the axis of rotation were horizontal*:*

$$C_r = 5N \cdot 85mm = 425\ Nmm < 1930\ Nmm = C$$

$$Ad = 0$$

$$Rd = 15N + 5N = 20N = Rd^{max}$$

$$Md = 15N \cdot 10mm + 5N \cdot 60mm = 450Nmm < 0.6\ Nm = Md^{max}$$

Engineering & Reference