Eléments de Machine
Cours de Construction Mécanique
Première Année
Sections MicroTechnique et Génie Mécanique

Bertrand Lacour

Organisation du Cours

14 séances:

1. Introduction
2. Cycle de Vie – Matériaux, Produit et Développement
3. Energie & Puissance
4. Matériaux
5. Frottement
6. Guidages
7. Accouplements
8. Transmission de Mouvement et de Couple
9. **Transformation de Mouvement et de Couple**
10. Ressorts

9. Transformation de Mouvement et de Couple

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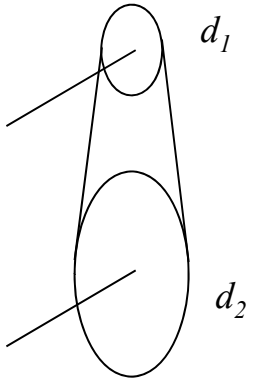
9. Transformation de Mouvement et de Couple

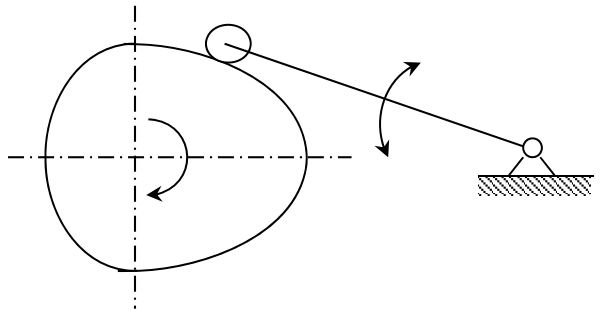
1. Introduction
2. Cames

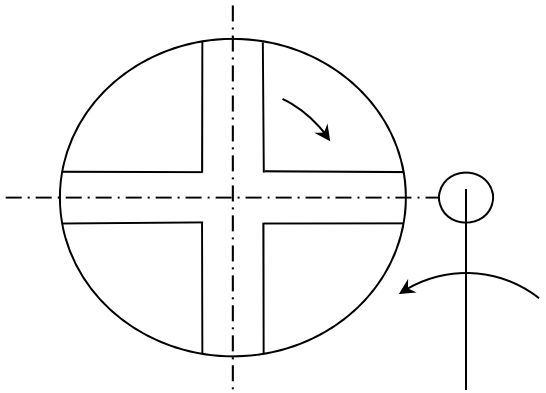
9.1. Introduction

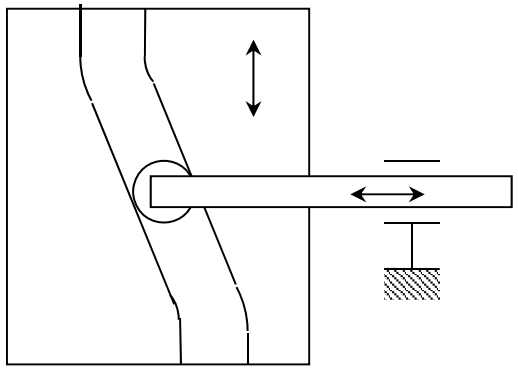
Rotation - translation - quelconque

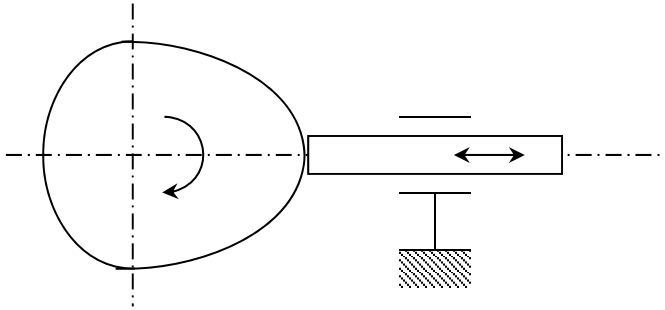
Continu - variable - discontinu



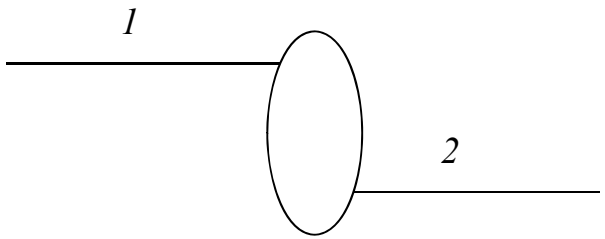








9.1. Introduction



Rapport de transmission $$i = \frac{\omega_1}{\omega_2}$$

Puissance - Couple $$P_1 = M_1\ \omega_1 \qquad P_2 = M_2\ \omega_2$$

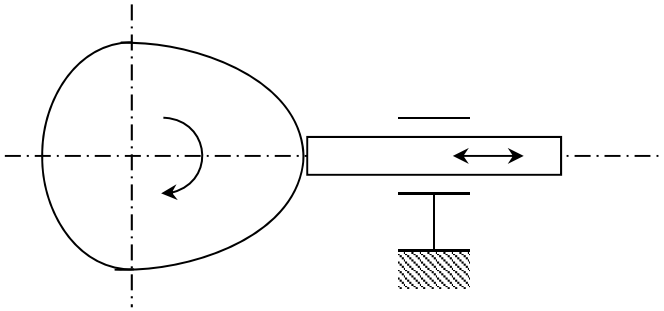
Rendement $$\eta = \frac{P_2}{P_1} = \frac{M_2\ \omega_2}{M_1\ \omega_1}$$

9.1. Introduction

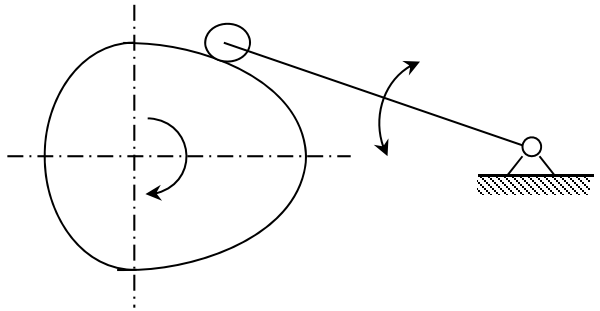
Loi d'espace	$y(x), x(\alpha)$
Lois de mouvement	$x(t), \alpha(t)$
Vitesse	$\frac{dx}{dt}, \frac{d\alpha}{dt}$
Accélération	$\frac{d^2x}{dt^2}, \frac{d^2\alpha}{dt^2}$
Saut (Jerk)	$\frac{d^3x}{dt^3}$

9.2. Cames

Principes



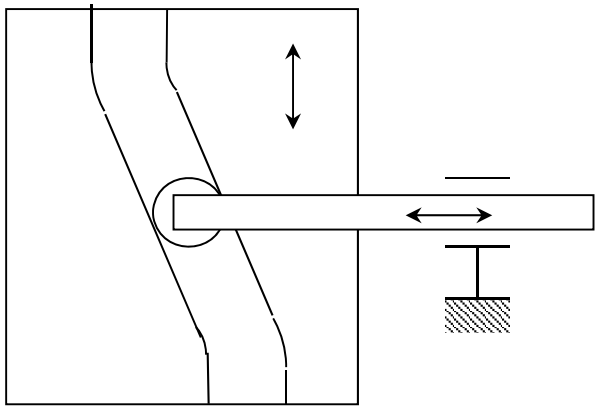
Rotation continue
Translation alternative



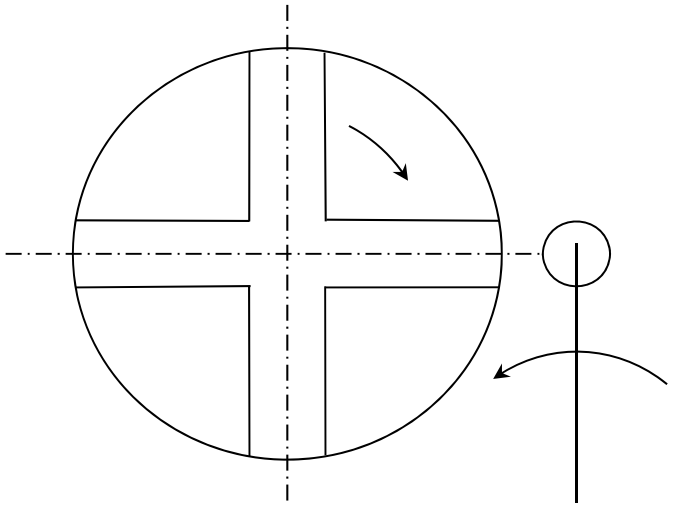
Rotation continue
Rotation alternative

9.2. Cames

Principes



Translation
Translation



Rotation continue
Rotation Discontinue

Lois de transformation de mouvement

Loi d'espace

$$y = y\left(x\left(t\right)\right)$$

Loi de vitesse

$$\frac{dy}{dt} = \frac{dy}{dx}\frac{dx}{dt}$$

Loi d'accélération

$$\frac{d^2y}{dt^2} = \frac{d^2y}{dx^2}\left(\frac{dx}{dt}\right)^2 + \frac{dy}{dx}\frac{d^2x}{dt^2}$$

Loi de Jerk

$$\frac{d^3y}{dt^3} = \frac{d^3y}{dx^3}\left(\frac{dx}{dt}\right)^3 + 3\frac{d^2y}{dx^2}\frac{dx}{dt}\frac{d^2x}{dt^2} + \frac{dy}{dt}\frac{d^3x}{dt^3}$$

Lois de transformation de mouvement

Exemple - Came à vitesse constante:

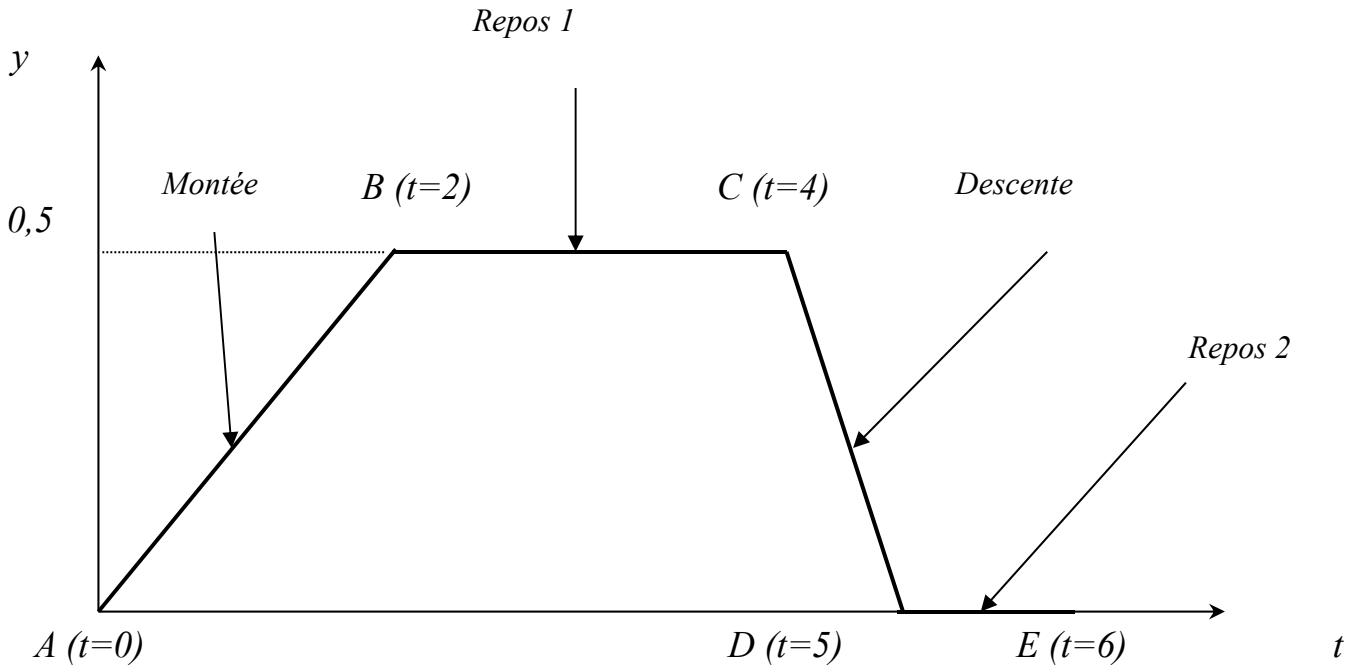
$$\frac{dx}{dt} = \omega \quad et \quad \frac{d^2x}{dt^2} = \frac{d^3x}{dt^3} = 0$$

Détermination de la loi de mouvement:

- Satisfaire la loi d'espace désirée
- Eviter les sauts

Lois de transformation de mouvement

Exemple – Mouvement du suiveur



Lois de transformation de mouvement

Exemple – Mouvement du suiveur

Fonctionnement sans saut, choc ou saccade

Repos 1 et repos 2

$$y(A) = 0 \qquad \frac{dy}{dt}(A) = 0 \qquad \frac{d^2y}{dt^2}(A) = 0$$

$$y(B) = 0{,}5 \qquad \frac{dy}{dt}(B) = 0 \qquad \frac{d^2y}{dt^2}(B) = 0$$

Lois de transformation de mouvement

Exemple – Mouvement du suiveur

6 coefficients

Polynome degré 5

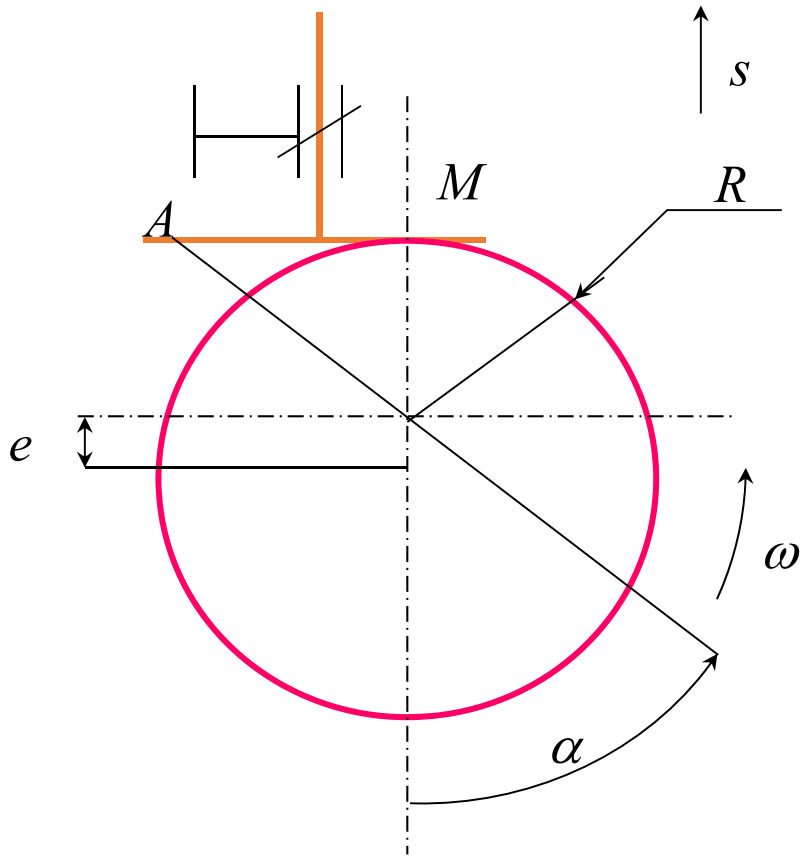
$$y(t) = a_0 + a_1 t + a_2 t^2 + a_3 t^3 + a_4 t^4 + a_5 t^5$$

$$\longrightarrow \quad y = 5t^3 - \frac{15}{2} t^4 + 3t^5$$

Lois de transformation de mouvement - Exemples

Vitesse constante		Faibles vitesses
Accélération constante	$y = 2\ t^2$	Saccade au point d'inflexion Vitesse moyennes
Saut constant	$y = 3\ t^2 - 2\ t^3$	Saccade infinie Vitesses faibles
Loi polynomiale		Bien adaptée Vitesses élevées
Loi harmonique	$y = \frac{1}{2}(1 - \cos \pi\ t)$	Saccade infinie début et fin Vitesses moyennes
Loi cycloïde	$y = t - \frac{1}{2\pi} \sin 2\pi\ t$	Ni saut ni saccade Vitesses élevées

Cas d'une came excentrique et d'un suiveur a surface plane



$$s = e\left(1 - cos\alpha\right)$$

$$\frac{ds}{dt} = e\ sin\alpha$$

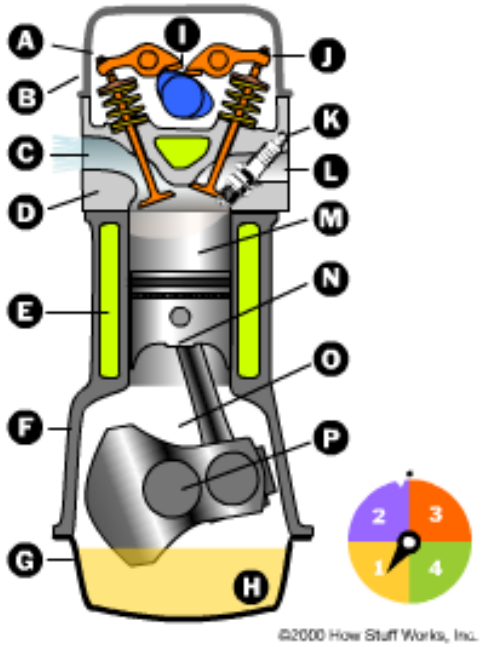
$$\frac{d^2s}{dt^2} = e\ cos\alpha$$

$$\frac{d^3s}{dt^3} = -e\ sin\alpha$$

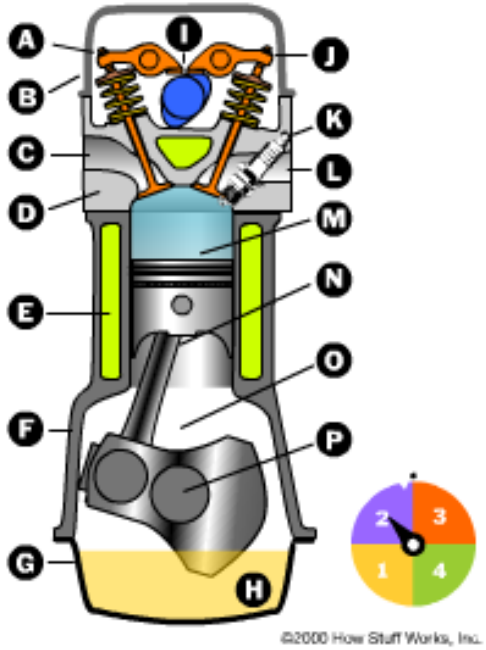
9.2. Cames

Moteur 4 temps

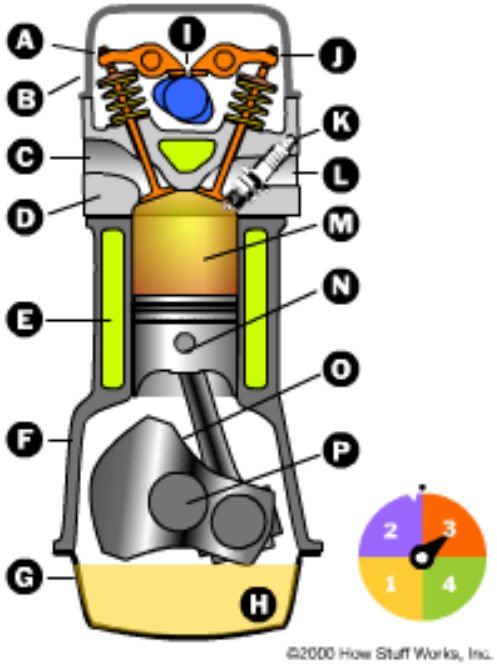
Admission



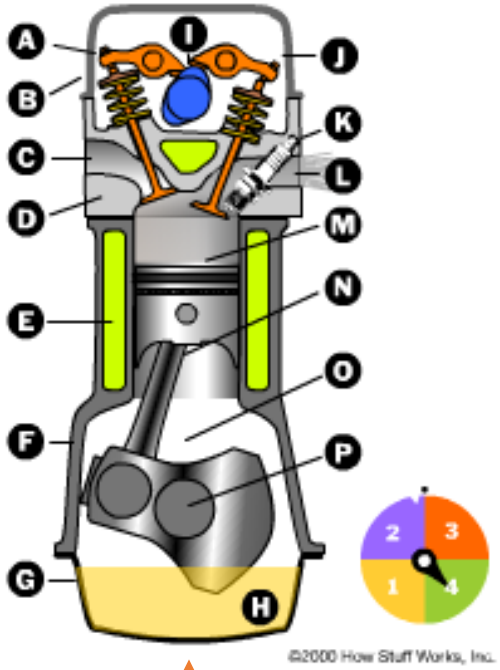
Compression



Explosion

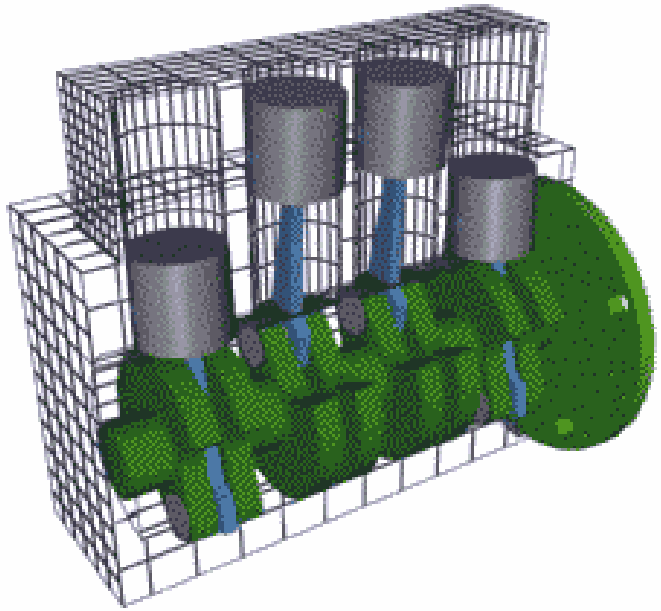


Echappement

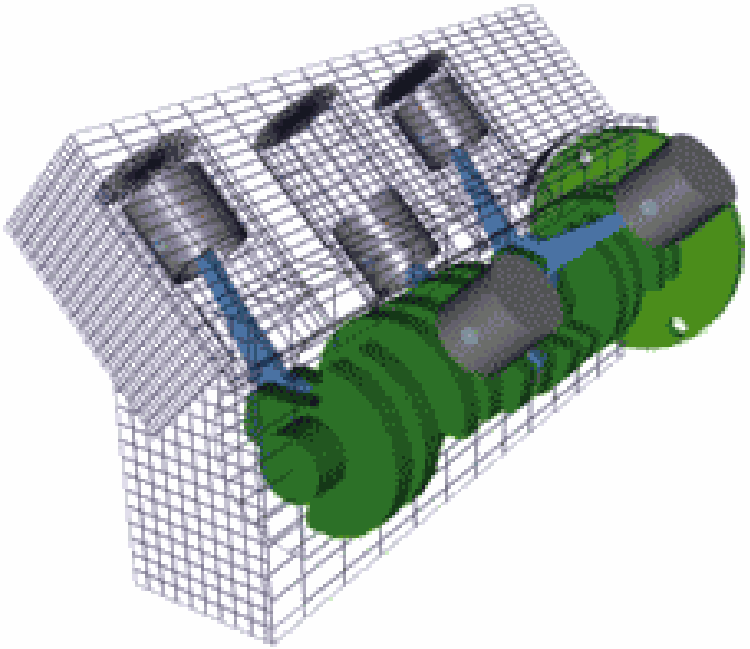


9.2. Cames

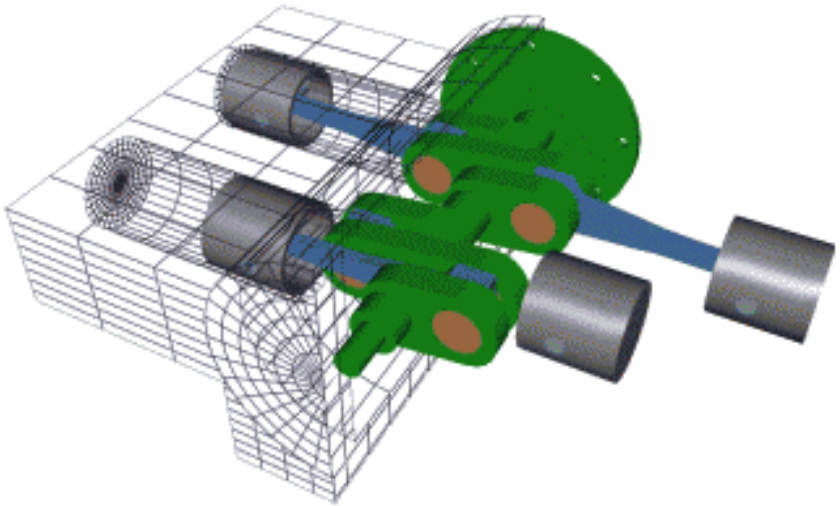
4 Cylindres en ligne



V6



4 Cylindres à plat



Arbre à cames