Combustion forces applied on a conventional engine:

In an Internal Combustion engine, gases pressure generates a force $\vec{F_g}$ which is applied to the piston on one hand, and to the motor head $-\vec{F_g}$ on the opposite direction on the other hand.

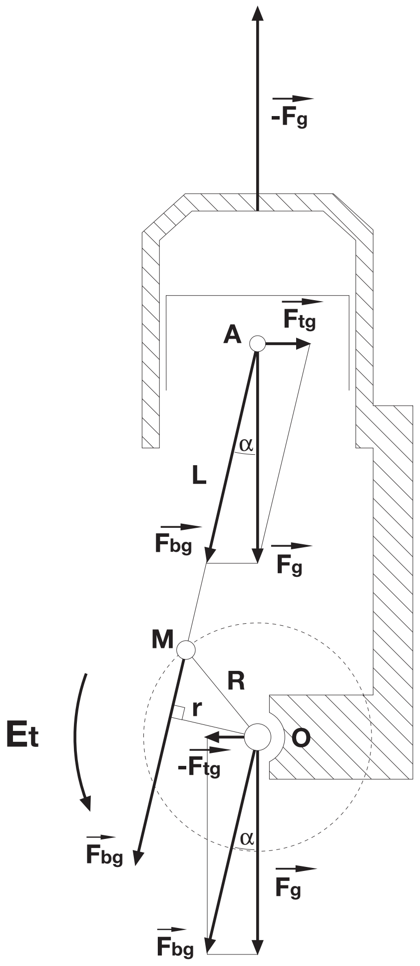
This force applied to the piston gives two forces applied on the piston pin: one force $\vec{F_{bg}}$ applied in the rod axis, and one force $\vec{F_{tg}}$ applied radially to the piston which generate a lateral thrust applied to the cylinder.

With $\quad Fbg = \dfrac{Fg}{\cos\alpha} \quad$ and $\quad Ftg = - Fg \, . \, tg\alpha$

The force $\vec{F_{bg}}$ applied to the rod is in turn applied to the crankpin and to the engine block via the main bearing.

This gives the following scheme:

The resultant of the forces applied to the engine block is null:



$$\boxed{E_t = OA \times F_{tg}}$$

on Ox: $\vec{F_g} - \vec{F_g} = 0$, on Oy: $\vec{F_{tg}} - \vec{F_{tg}} = 0$

The forces momentum applied to the engine block (combustion momentum) is :

$\boxed{M_{comb} = - OA \, . \, F_{tg}}$ $\qquad$ ($\sum$ Momentum/Oz)

In addition, the engine torque applied to the crankshaft is equal to the product of the $\vec{F_{bg}}$ force by the radius r.

And: $r = OA \, . \, \sin\alpha$

Then, the Engine torque $E_t = -OA \, . \, \sin\alpha \, . \, F_{bg} = -OA \, . \, \sin\alpha \, . \, \dfrac{Fg}{\cos\alpha} = -OA \, . \, Fg \, . \, tg\alpha$

with $- Fg \, . \, tg\alpha = Ftg$

As a result: $\boxed{E_t = OA \, . \, F_{tg}}$

It can be verified that the torque applied to the engine block is equivalent to that applied to the crankshaft, but in the opposite direction.

From the mechanical point of view, it is the force applied by the piston to the cylinder which makes the engine rotate.

The same method can be used to calculate the torque applied to the crankshaft due to inertia forces generated by reciprocating parts. However, the average value of this torque is null, contrary to the average torque resulting from gases expansion after combustion on which depends engine torque for vehicle motion.