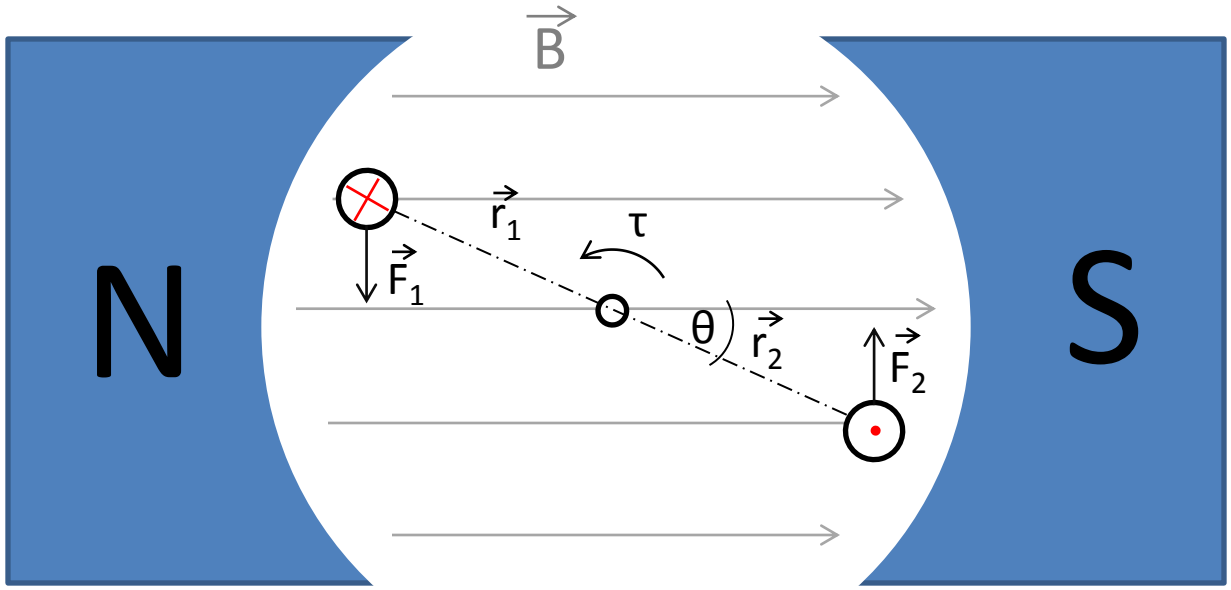
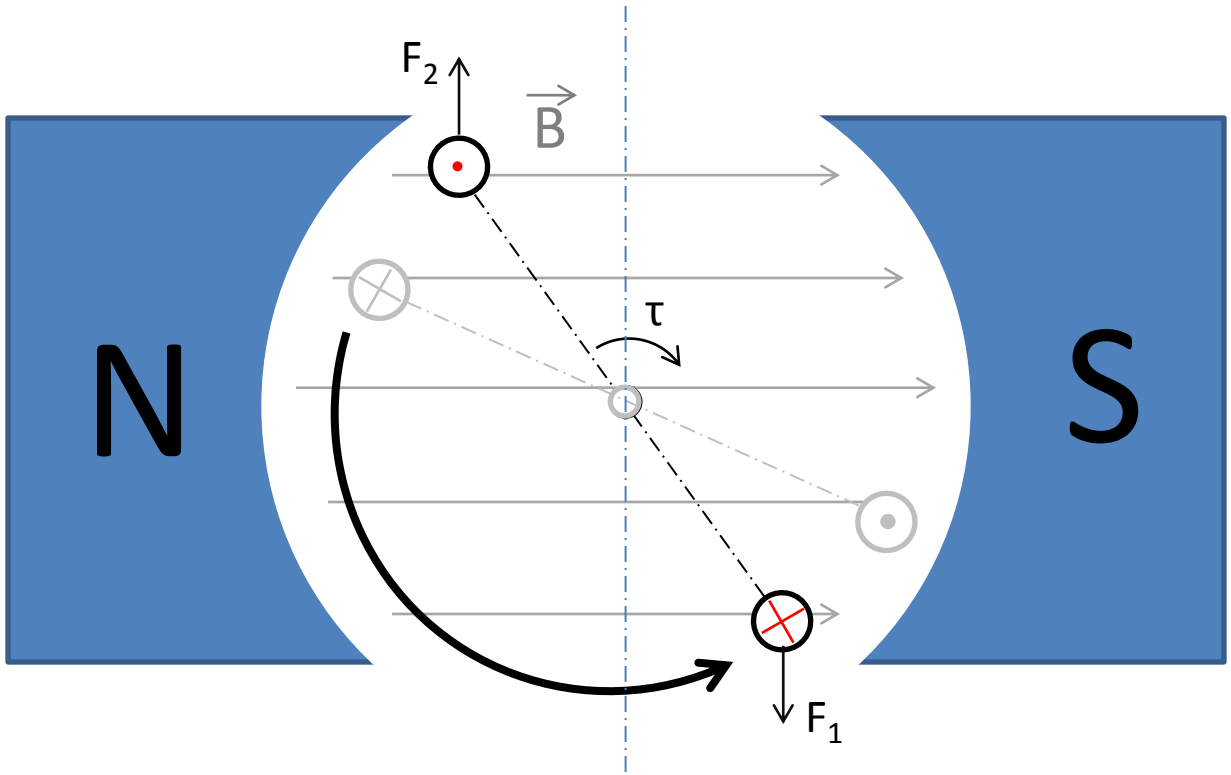
DC Motor: Current loop in a magnetic field

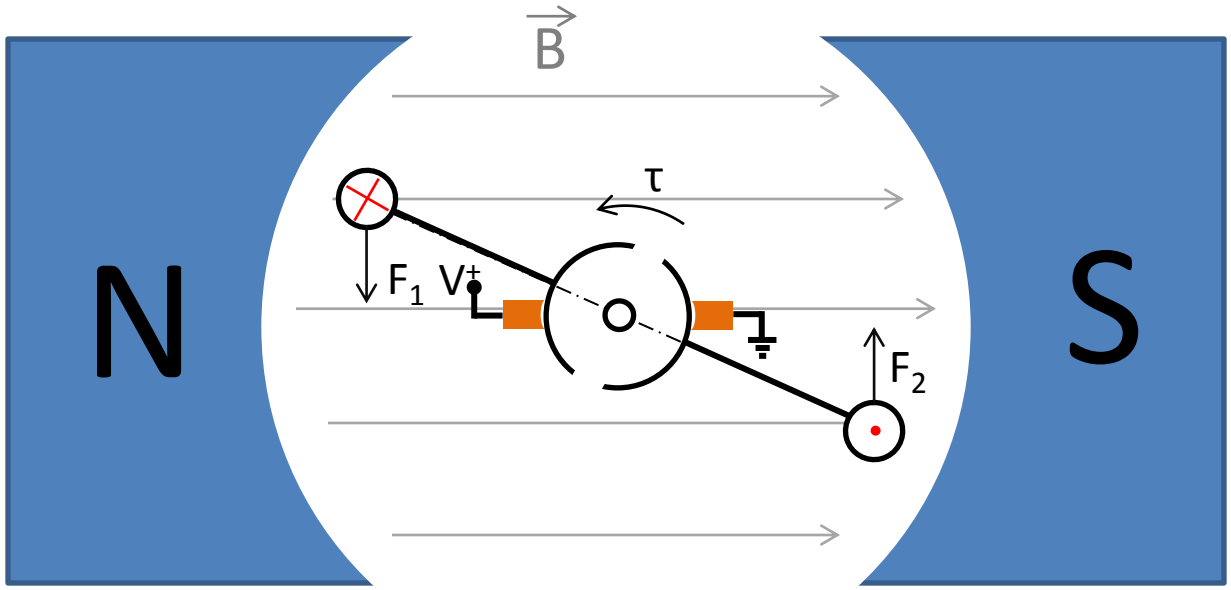


$$\vec{F} = i\vec{l} \times \vec{B}$$

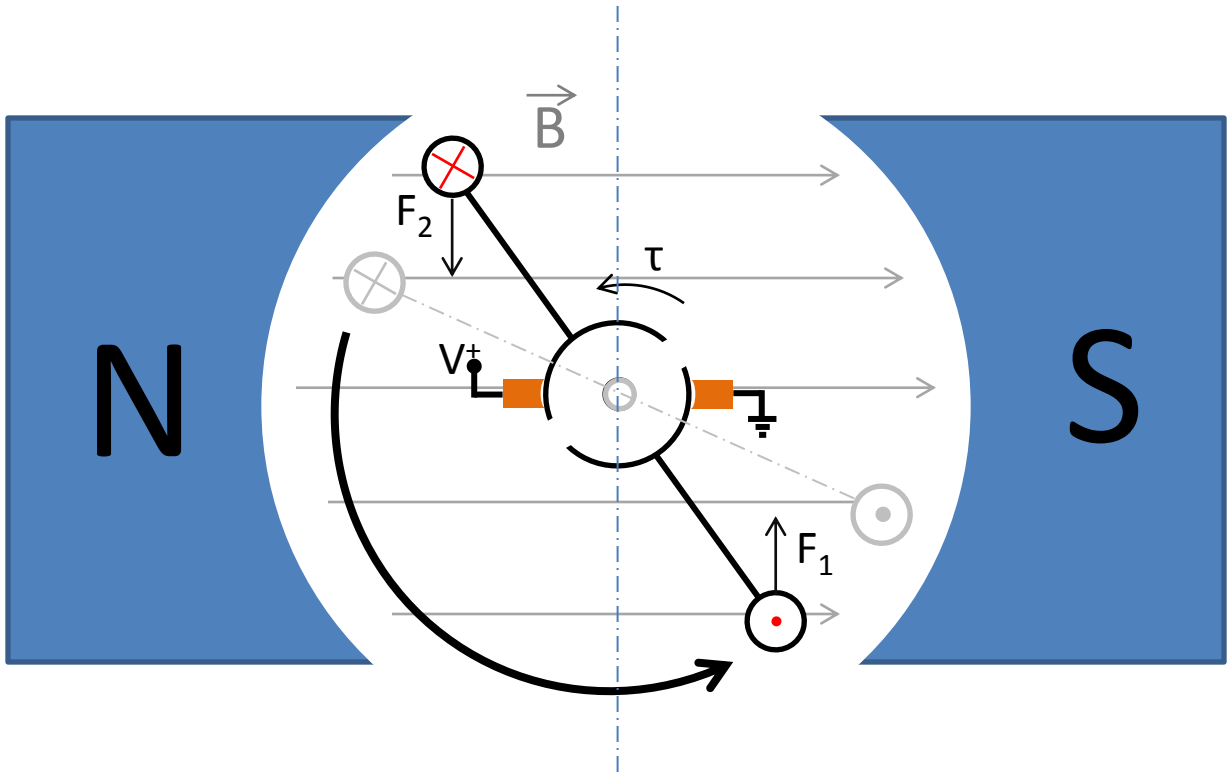
$$\tau = \vec{r}_1 \times \vec{F}_1 + \vec{r}_2 \times \vec{F}_2$$



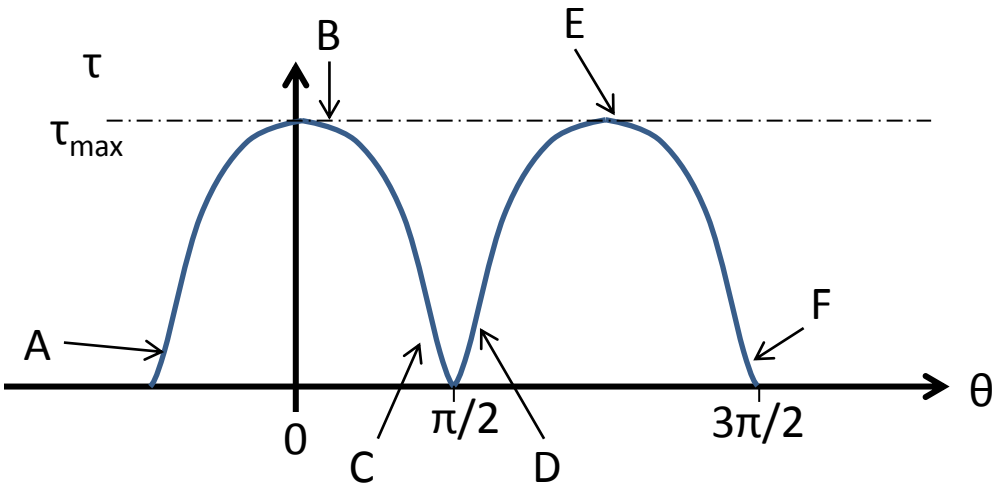
Rotating past the θ = π/2 line (blue) is a problem if current in the loop is in the same direction, because it would cause the reversal of the torques.



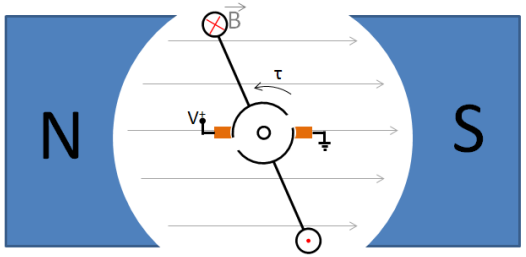
So, we add a commutator to *reverse* the current through the loop when the coils turn past $\theta = \pi/2$



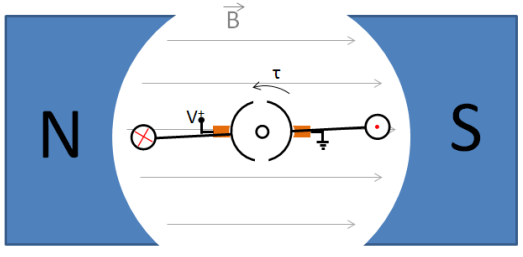
Now always positive torque !



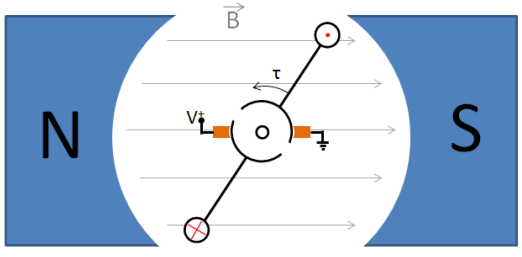
It works, but big torque ripple with only two segment commutator.



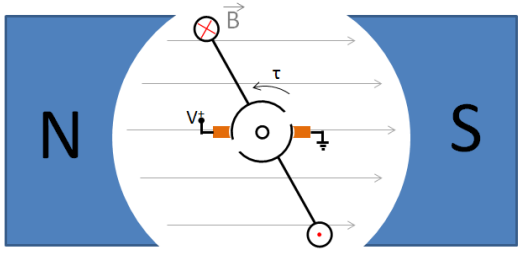
A



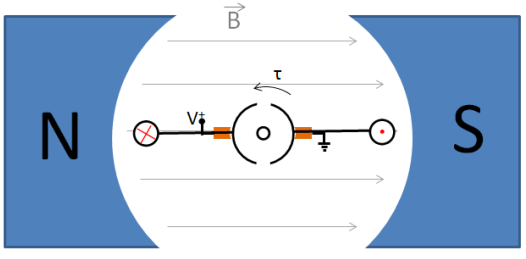
B



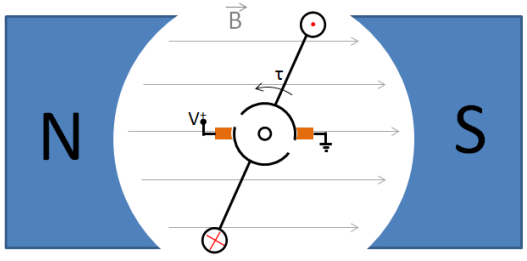
C



D (commutator just reversed the current directions)

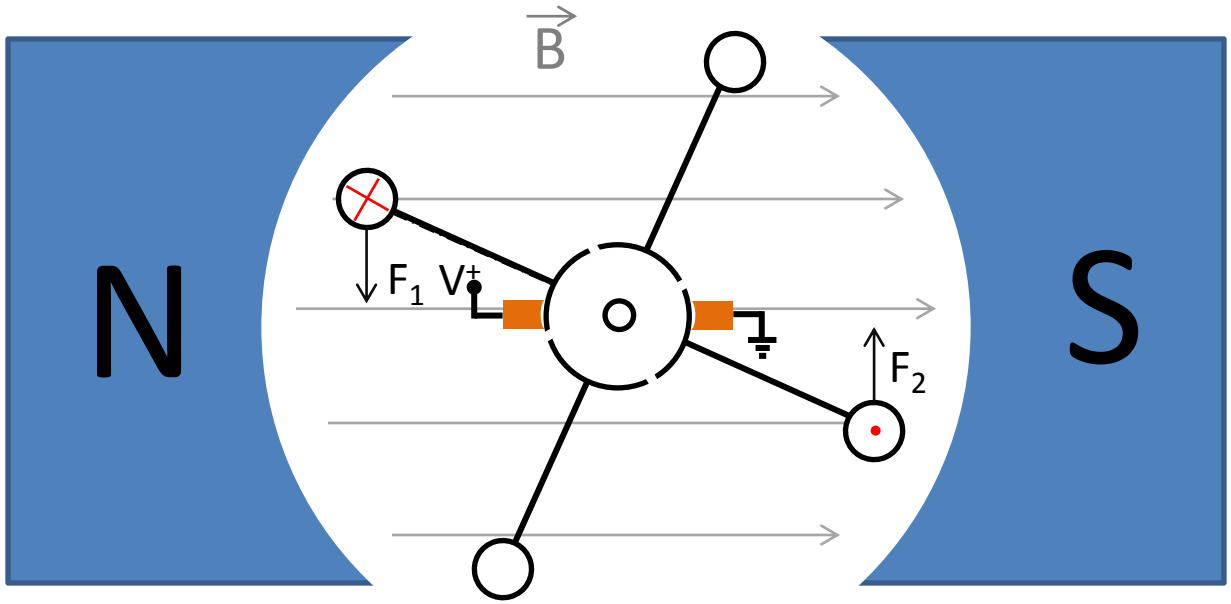


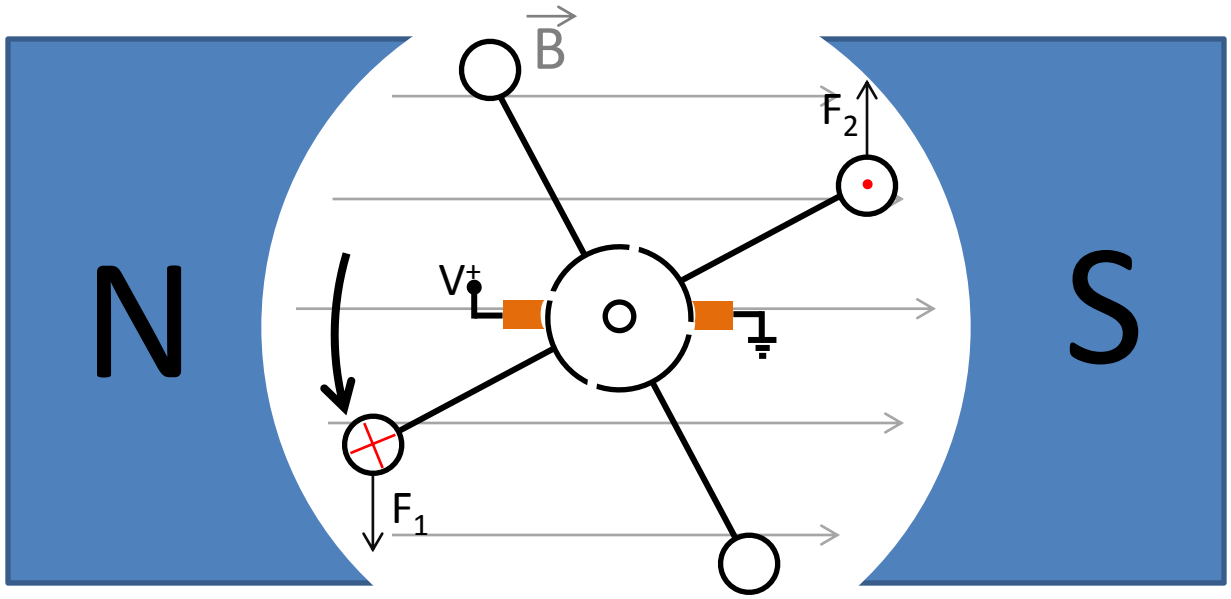
E

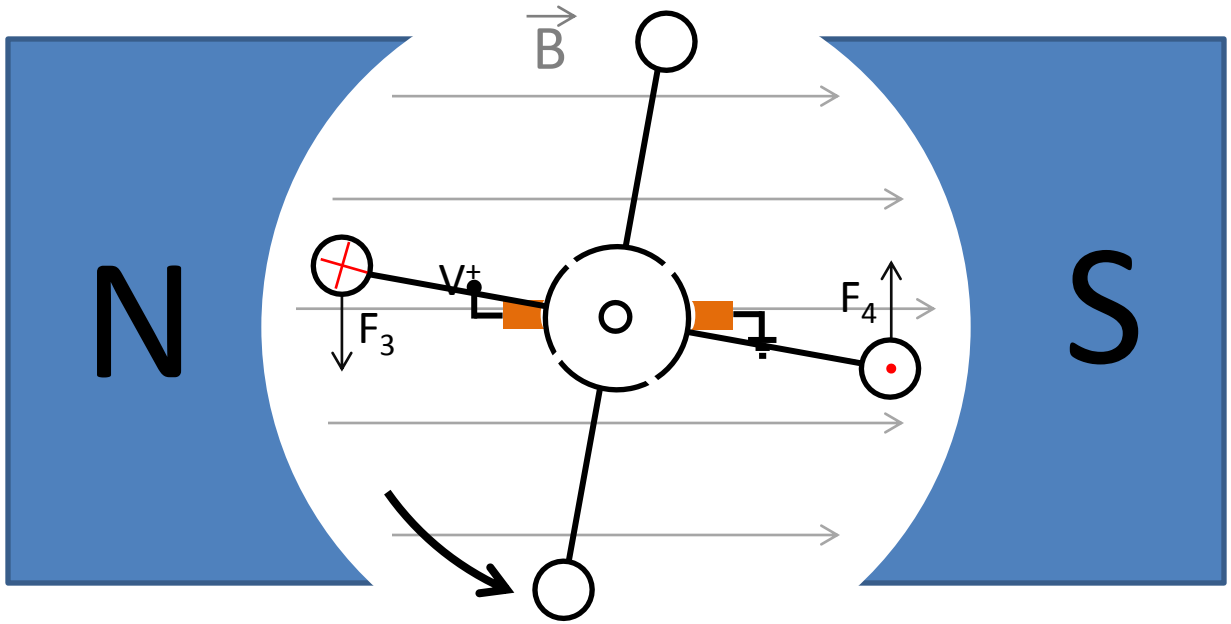


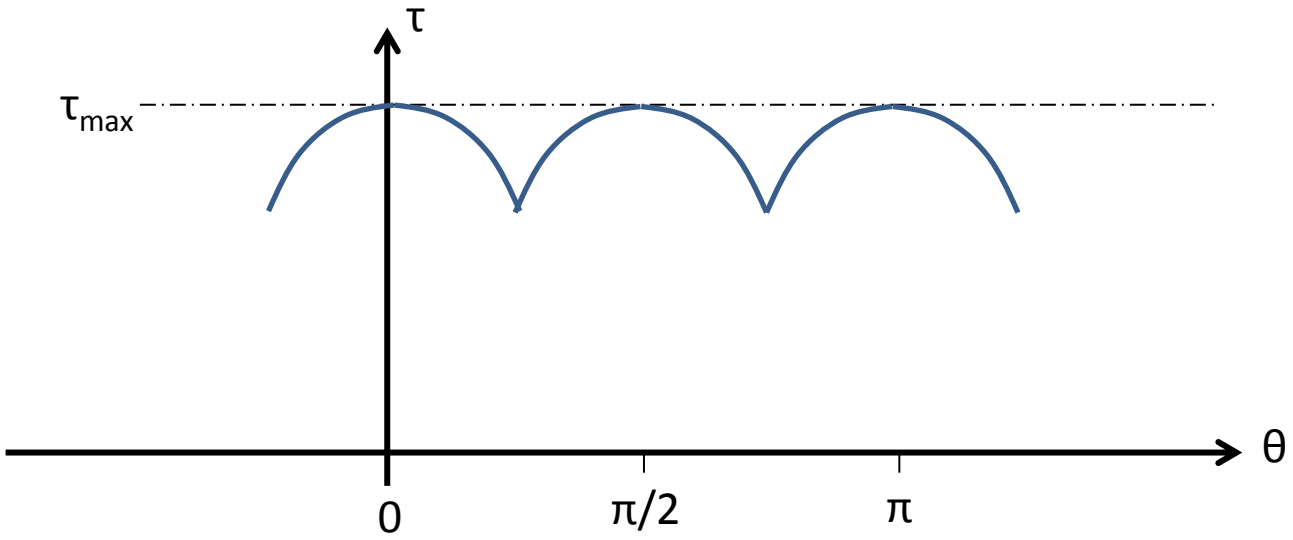
F

Four segment commutator → reduced torque ripple.
(Current passing only through one winding at a time)




B
F2
N
V+
S
F1


B
N
S
V
F3
F4



Now, less torque ripple.

Same principle applies to a 6-segment commutator design, like we discussed in class