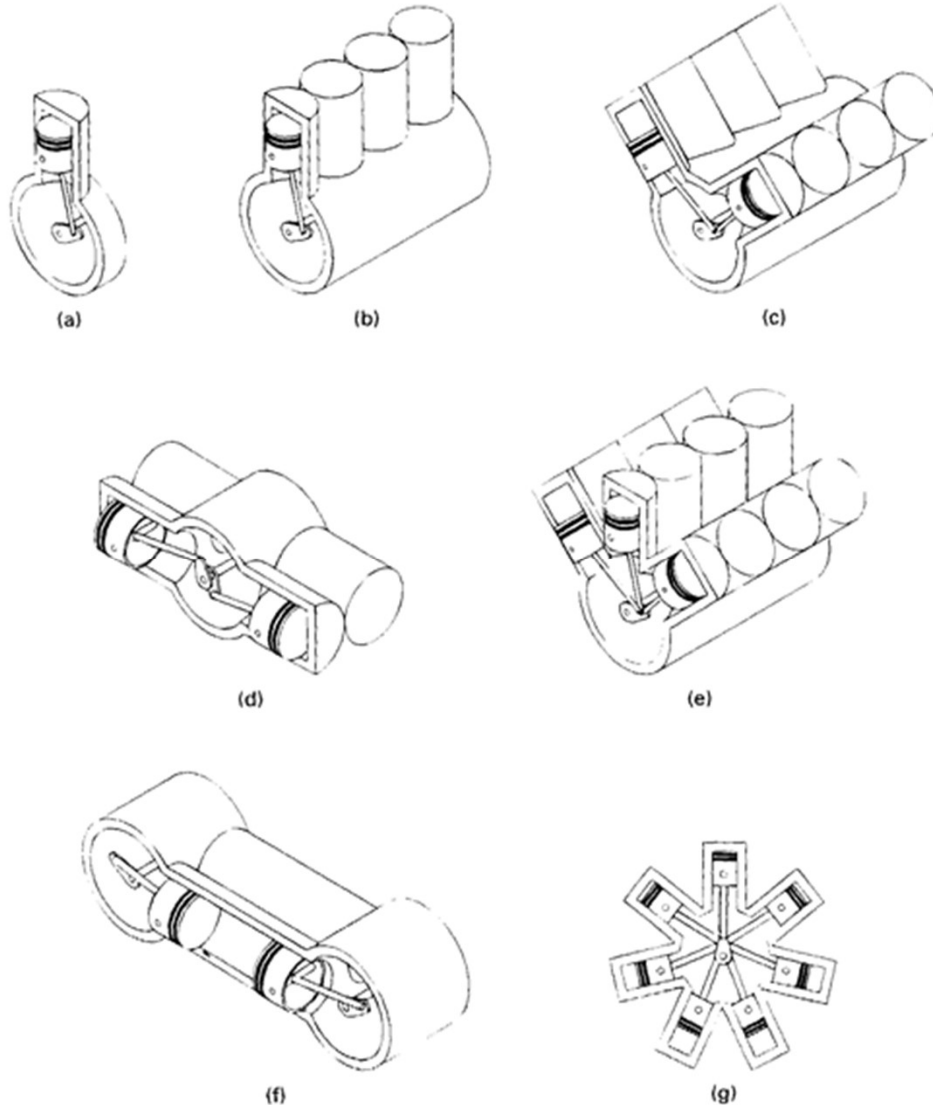


Engine Dynamics

Assoc. Prof. Dr. Levent YÜKSEK

Most common engine designs



In-line engines

Cylinders are positioned on a straight line in In-line engines. Firing order is to be selected considering the thermal load of the cylinder head. Opposite side cylinders are selected with consecutive order. Most common application can be summarized as;

Num. of cylinders	Firing order
4 $af=720/4=180^\circ$	1-3-4-2
	1-2-4-3
5 $af=720/5=144^\circ$	1-2-4-5-3
6 $af=720/6=120^\circ$	1-5-3-6-2-4
	1-4-2-6-3-5
8 $af=720/8=90^\circ$	1-6-2-5-8-3-7-4

V-type engines

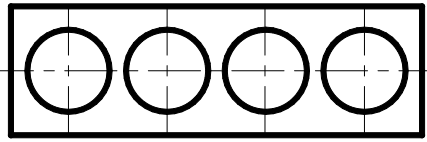
In V-type engines left and right bank cylinder groups are positioned with a pre-defined V angle. V-type engines actually are combined in-line engines. That's why each of the in-line engine is called a bank. For example a V6 engine is comprised of two identical in-line 3 cylinder engines. In V-type engines a primary difference is seen in crankshaft design where the big-ends of each connecting rod is mounted either same journal or individual journals(bearings). Firing order of individual journal design is not complicated and equal firing interval can be obtained but common-bearing type designs limit the possible firing orders due to V-Angle.

<u>Num. of cylinders</u>	<u>Firing order</u>
4 $af=720/4=180^\circ$	L1-R1-L2-R2
6 $af=720/6=120^\circ$	L1-R1-L3-R3-L2-R2
8 $af=720/8=90^\circ$	L1-R1-L4-L2-R2-L3-R3-R4

In-line engine example

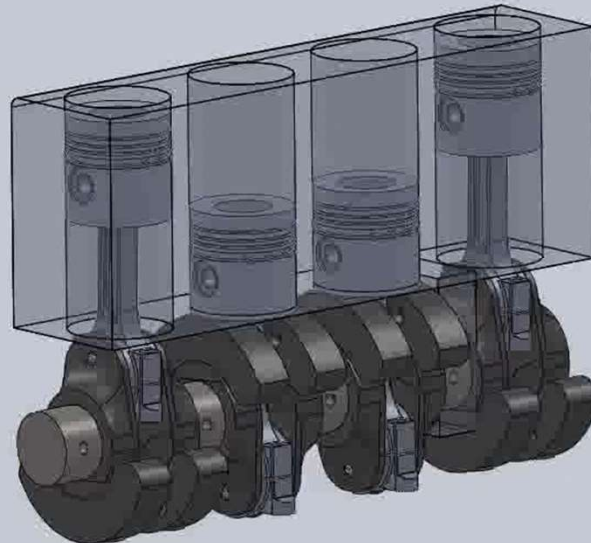
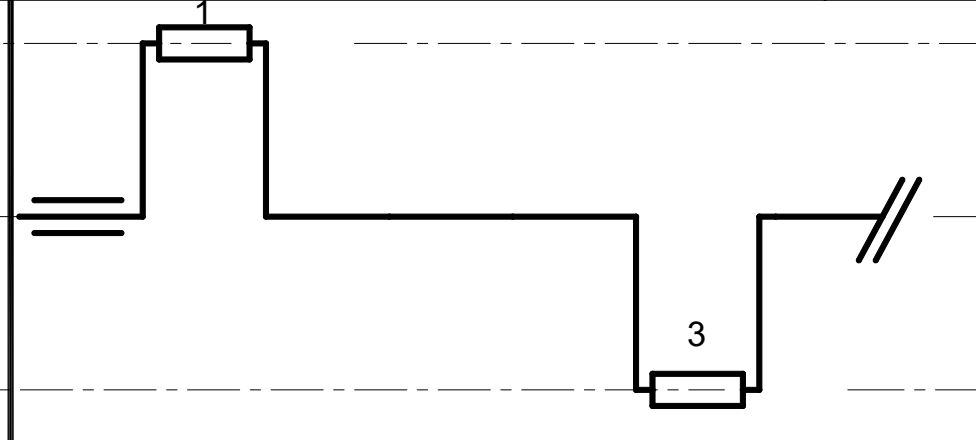
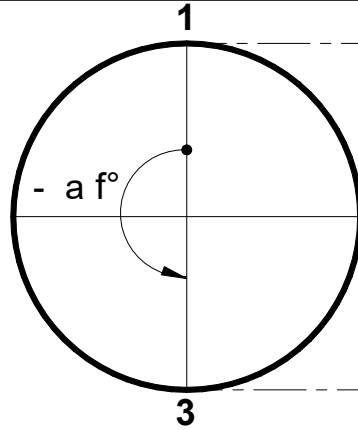
- Initially an arbitrary way of rotation should be considered as positive.
- Four stroke-I4 Engine
- Firing order 1-3-4-2
- $\alpha_f = 720/\text{number of cylinders}$
- $\alpha_f = \frac{720}{4} = 180^\circ$ *Crank angle*
- $\alpha_v = 0$

14

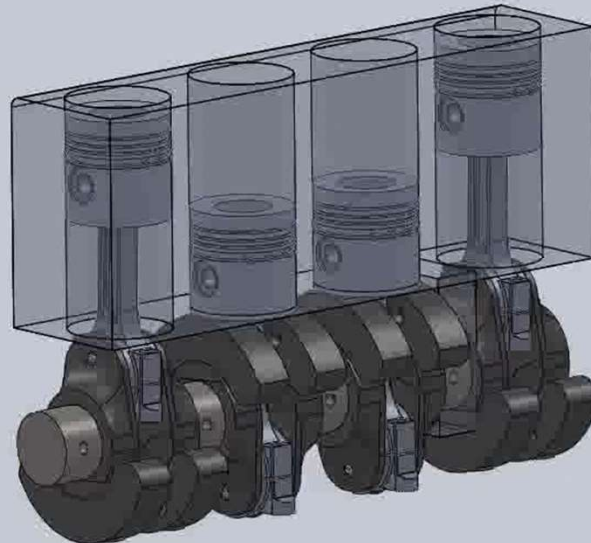
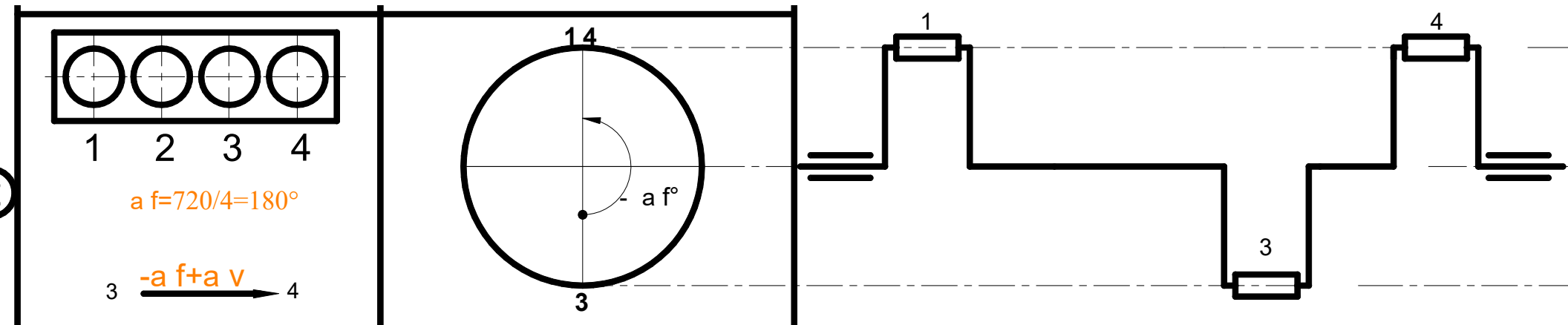


$$a f = 720/4 = 180^\circ$$

$$1 \xrightarrow{-a f + a v} 3$$

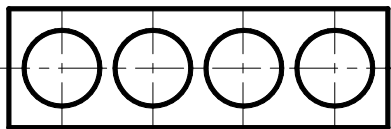


14



14

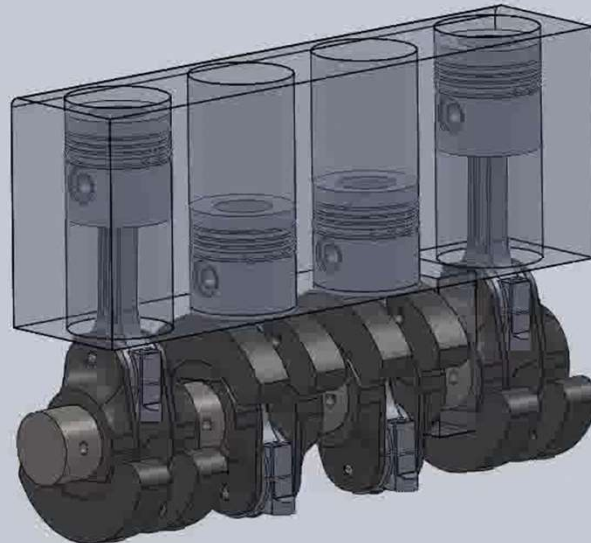
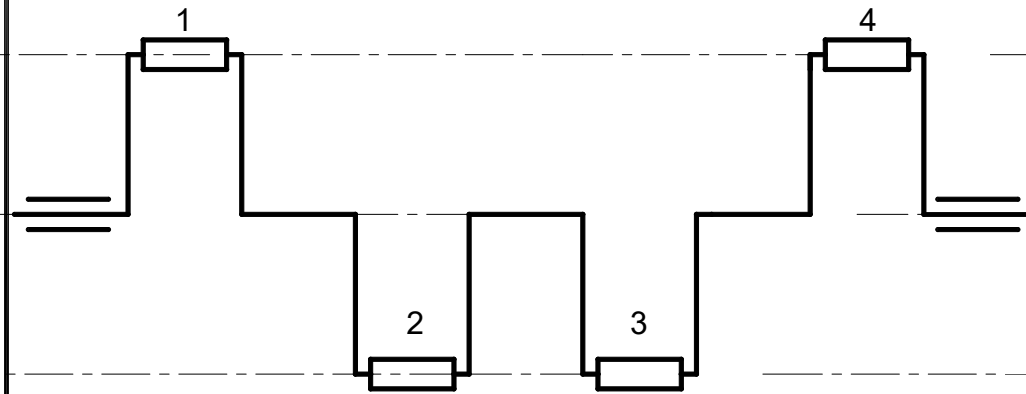
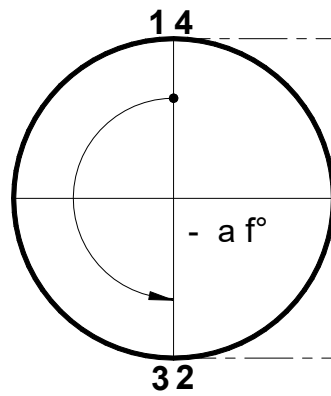
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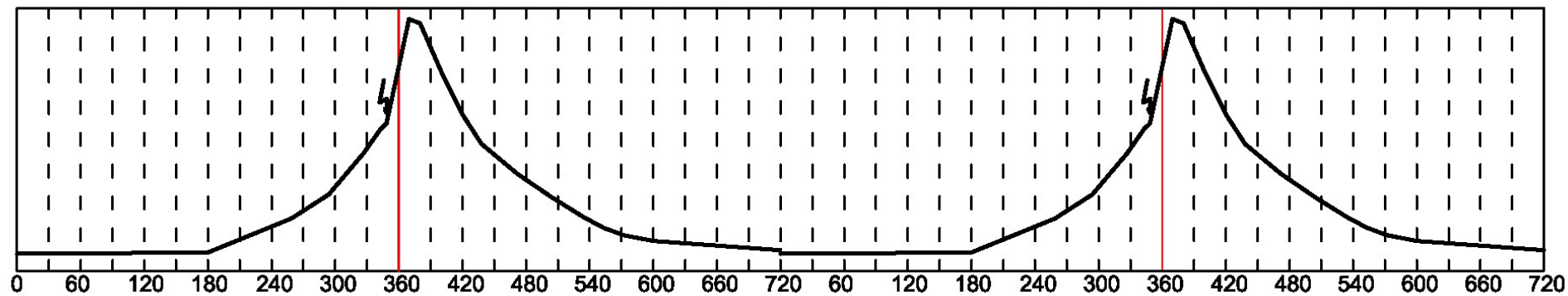
1 2 3 4

$$a f = 720/4 = 180^\circ$$

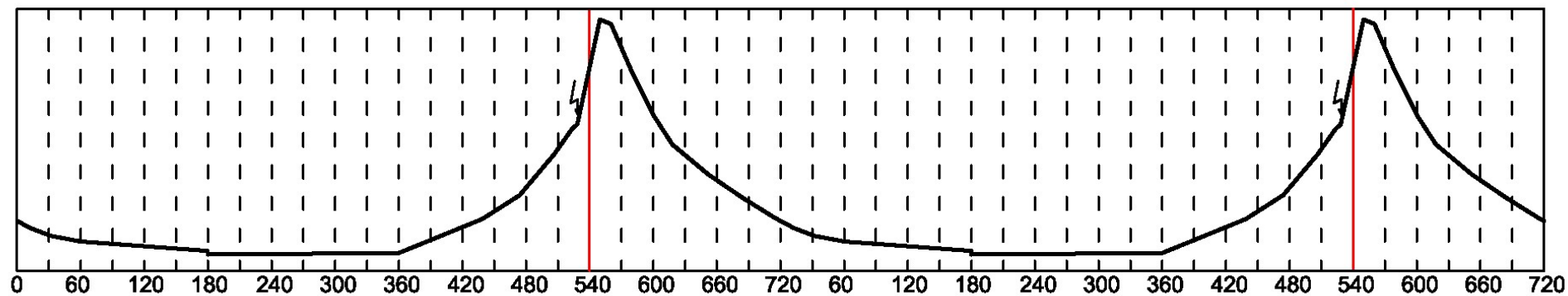
$$4 \xrightarrow{-a f + a v} 2$$



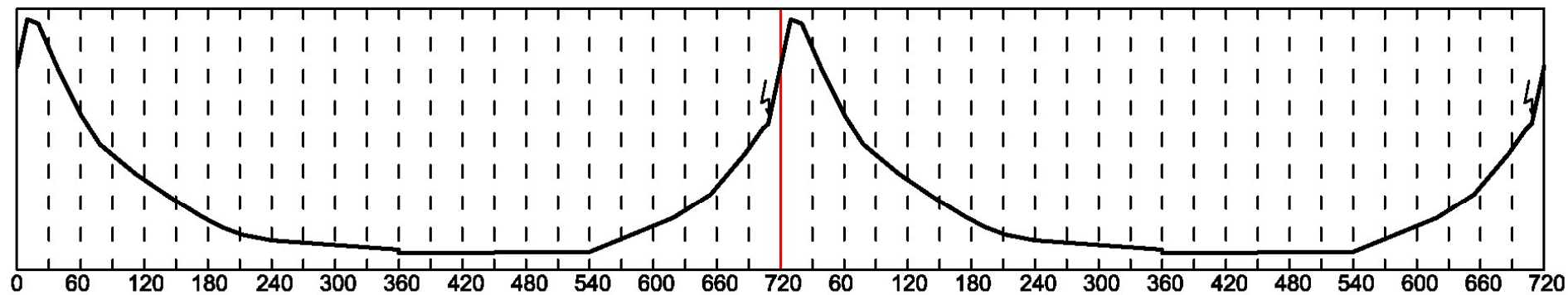
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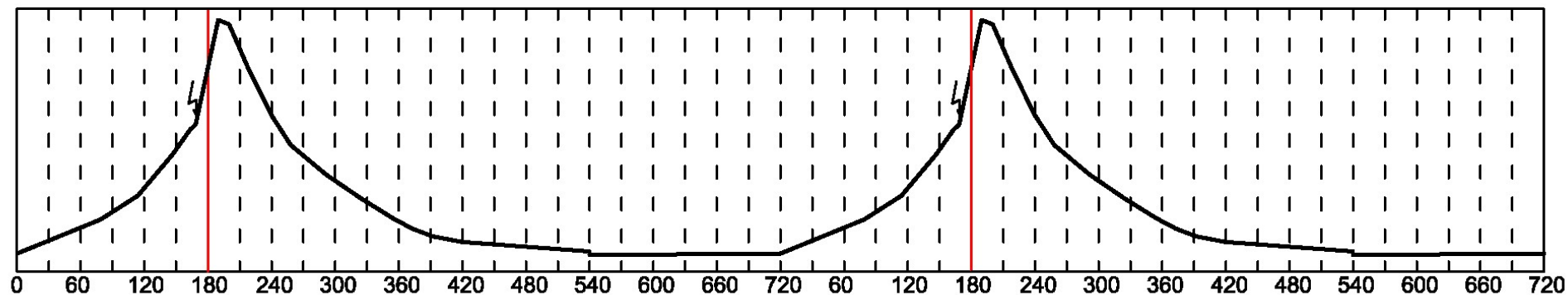
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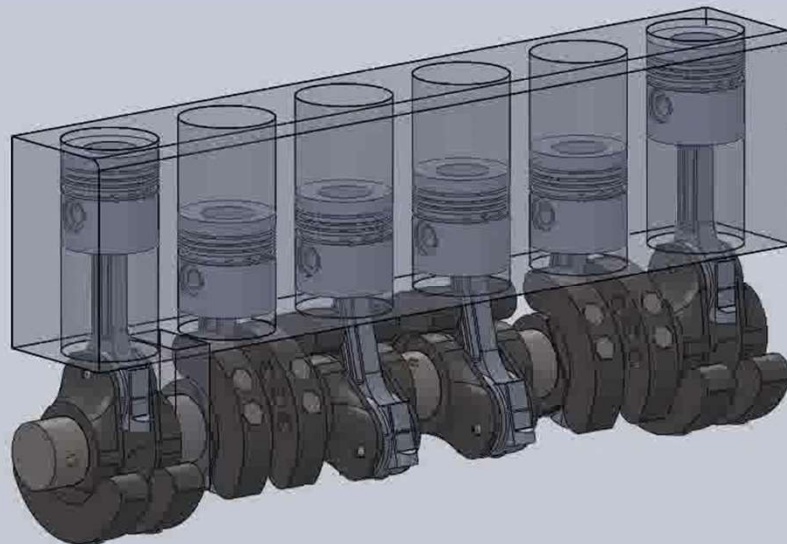
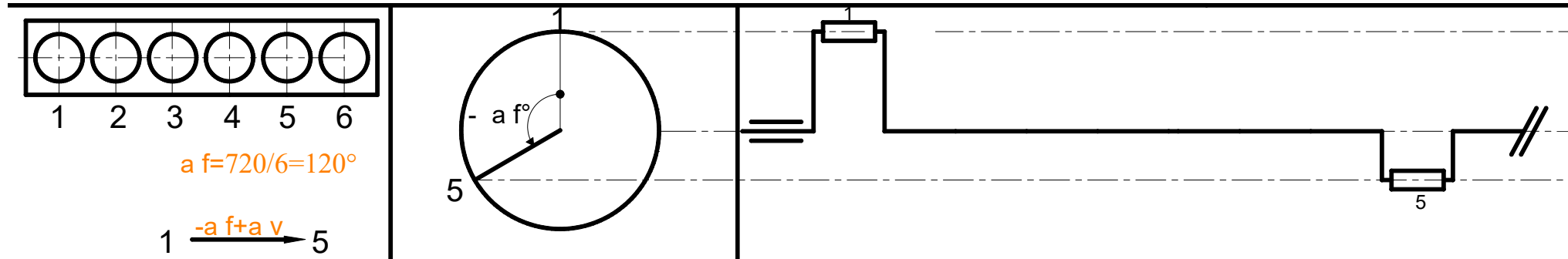
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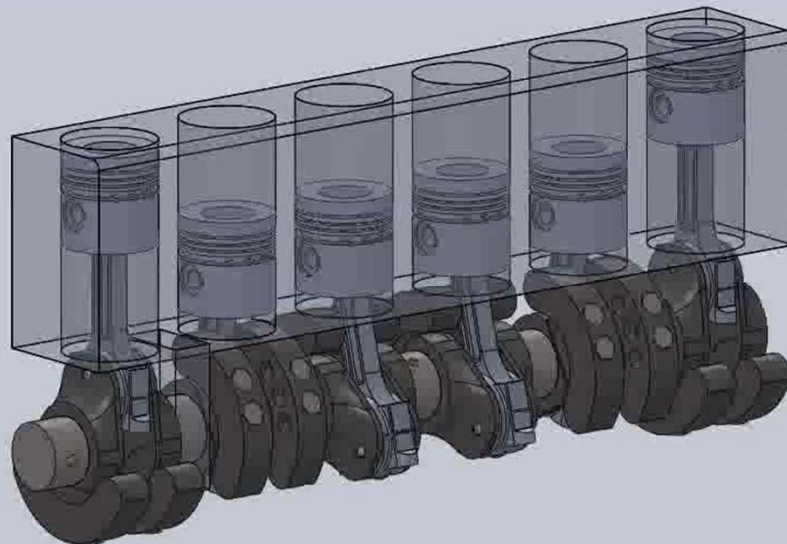
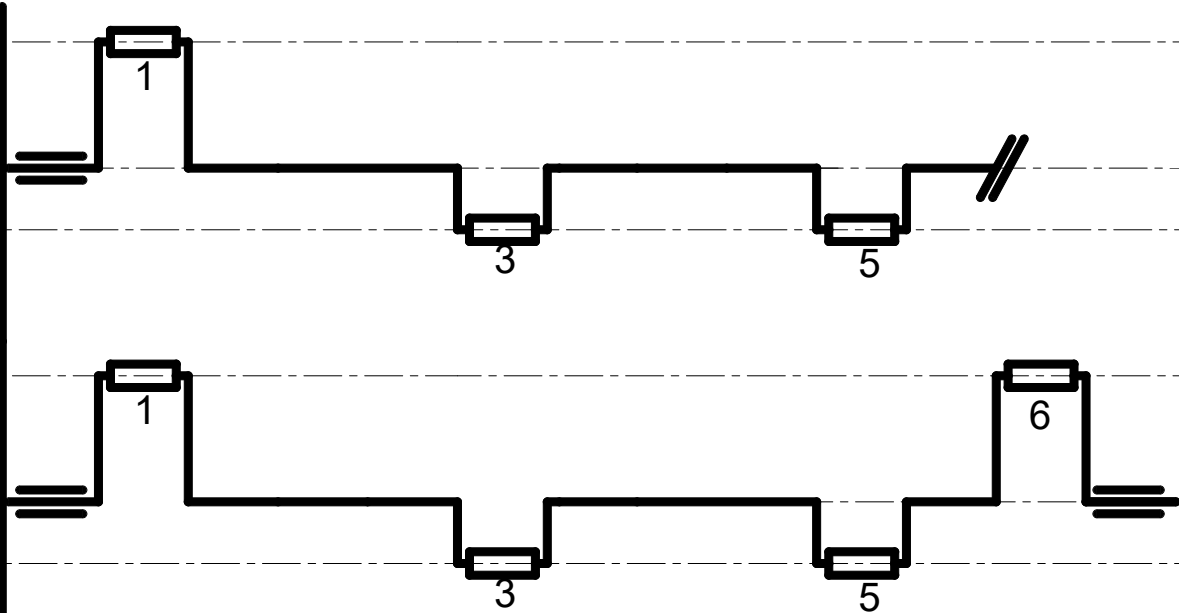
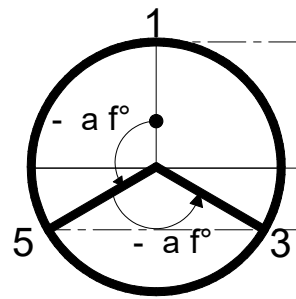
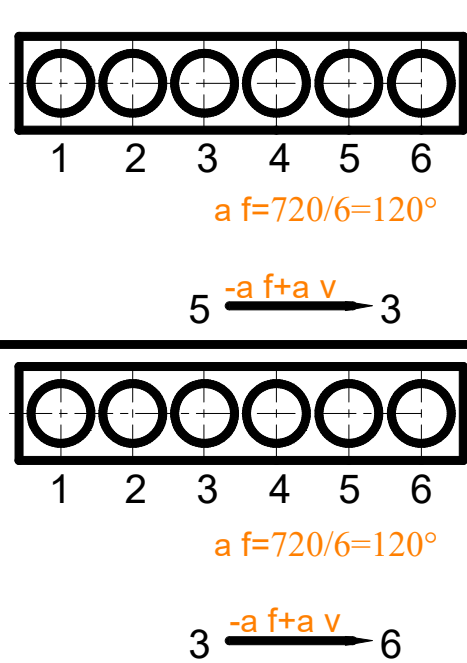
In-line engine example

- Initially an arbitrary direction of rotation should be considered as positive.
- Four stroke-I6 Engine
- Firing order 1-5-3-6-2-4
- $\alpha_f = 720/\text{number of cylinders}$
- $\alpha_f = \frac{720}{6} = 120^\circ$ *Crank angle*
- $\alpha_v = 0$

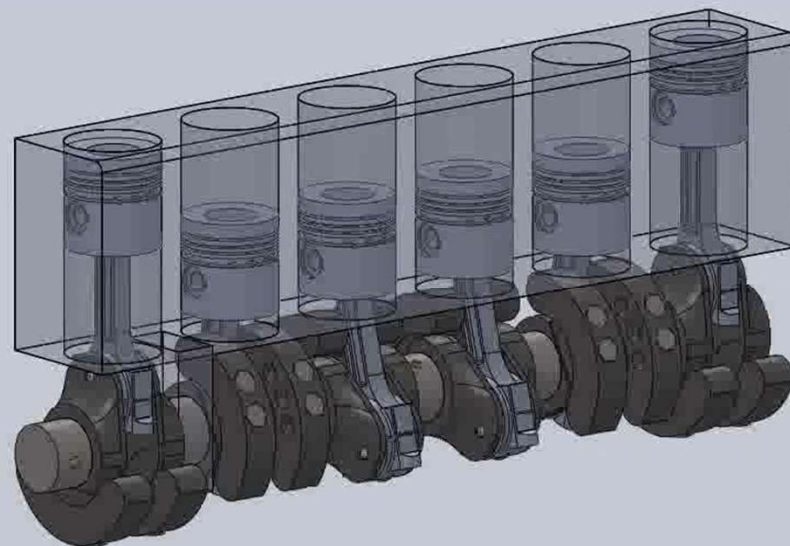
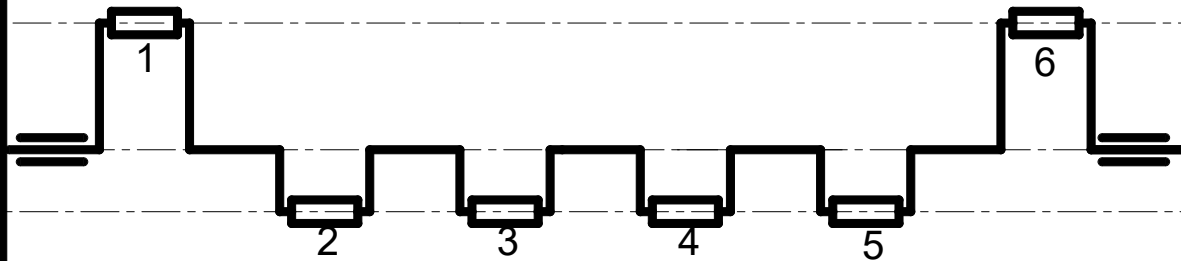
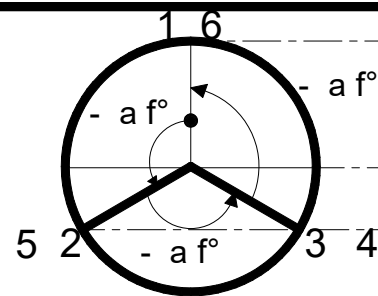
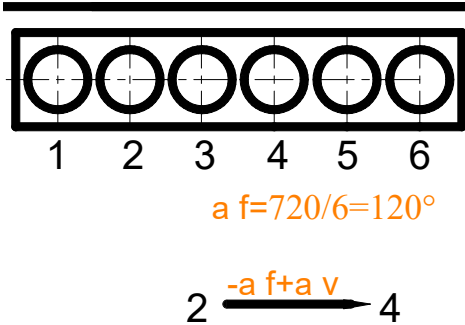
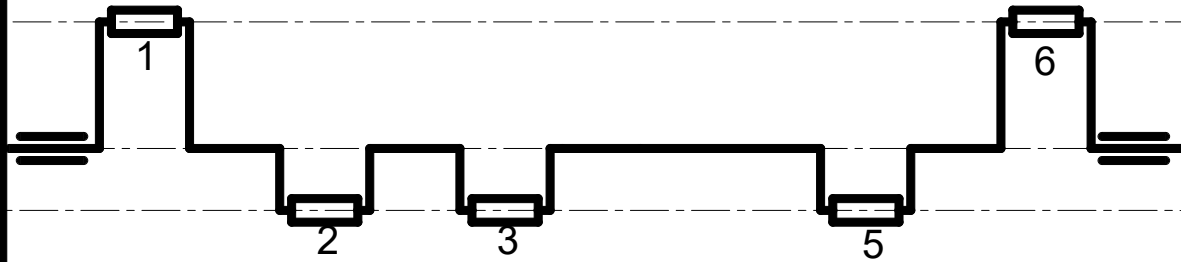
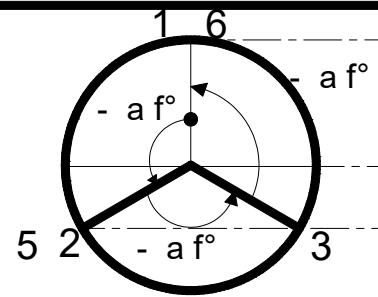
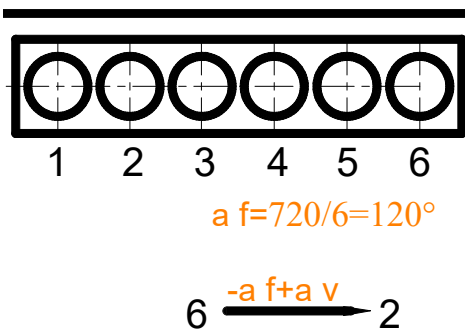
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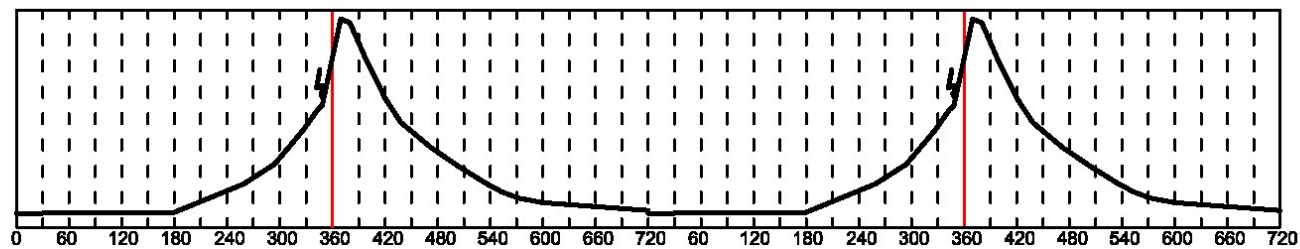
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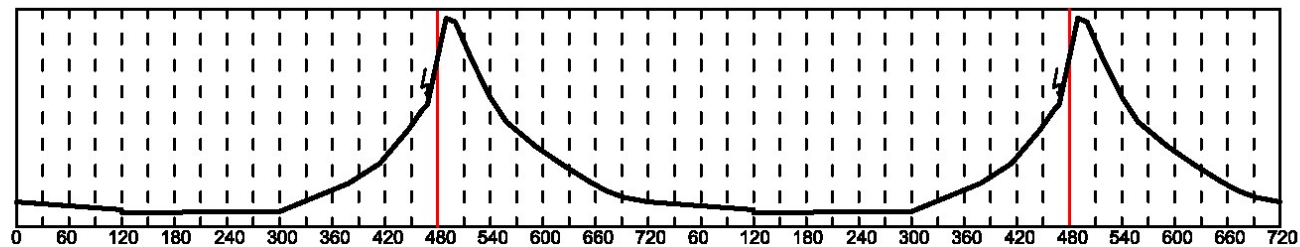
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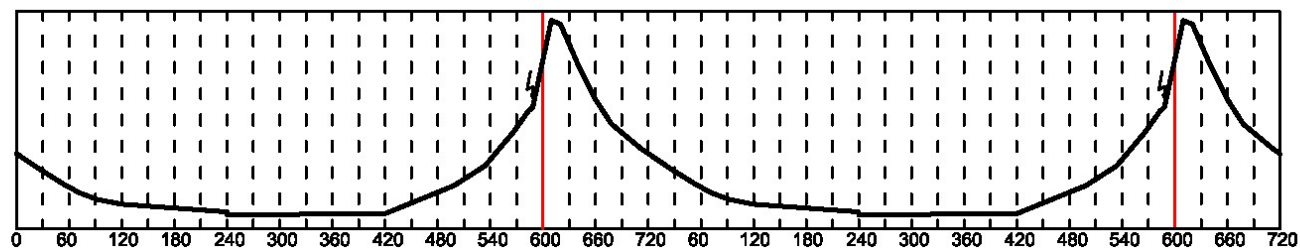
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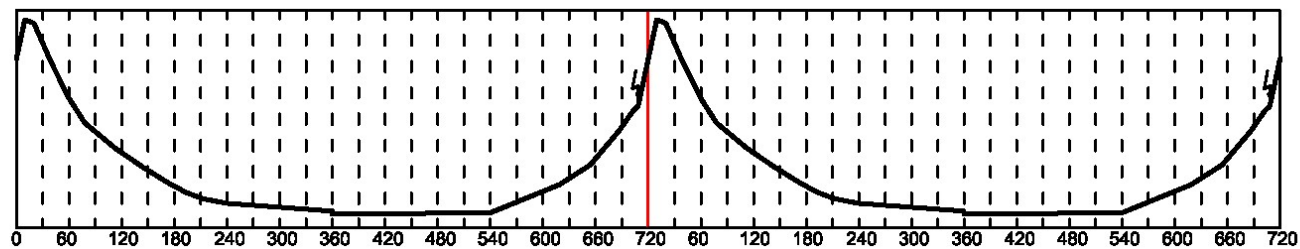
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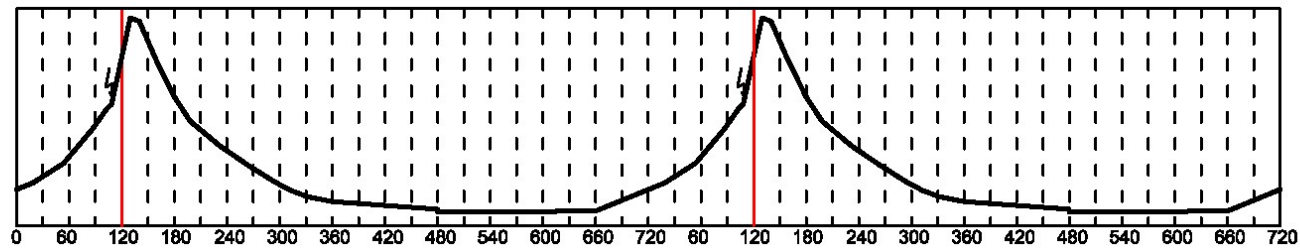
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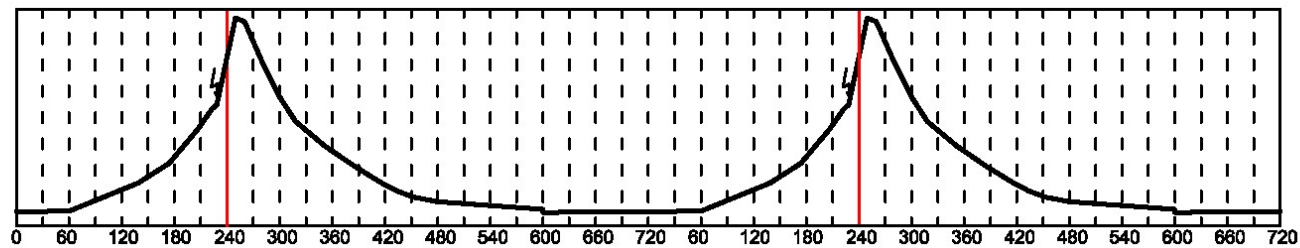
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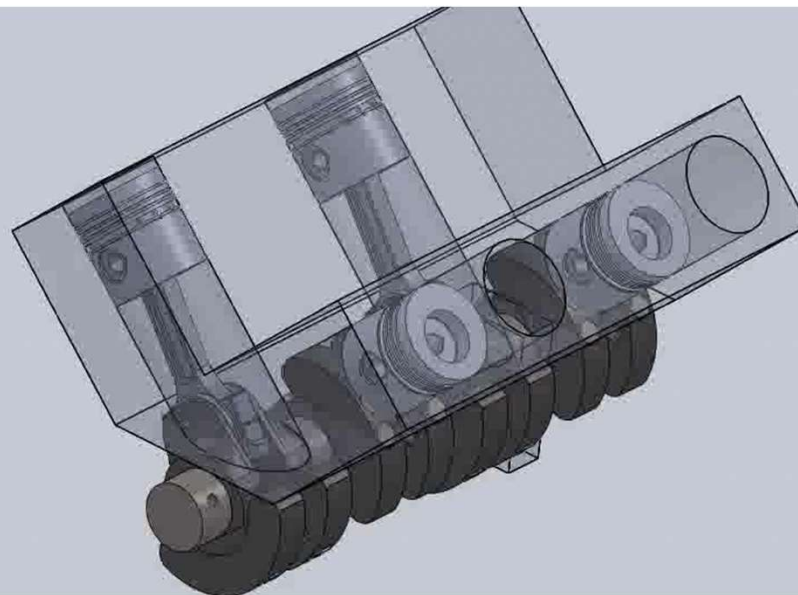
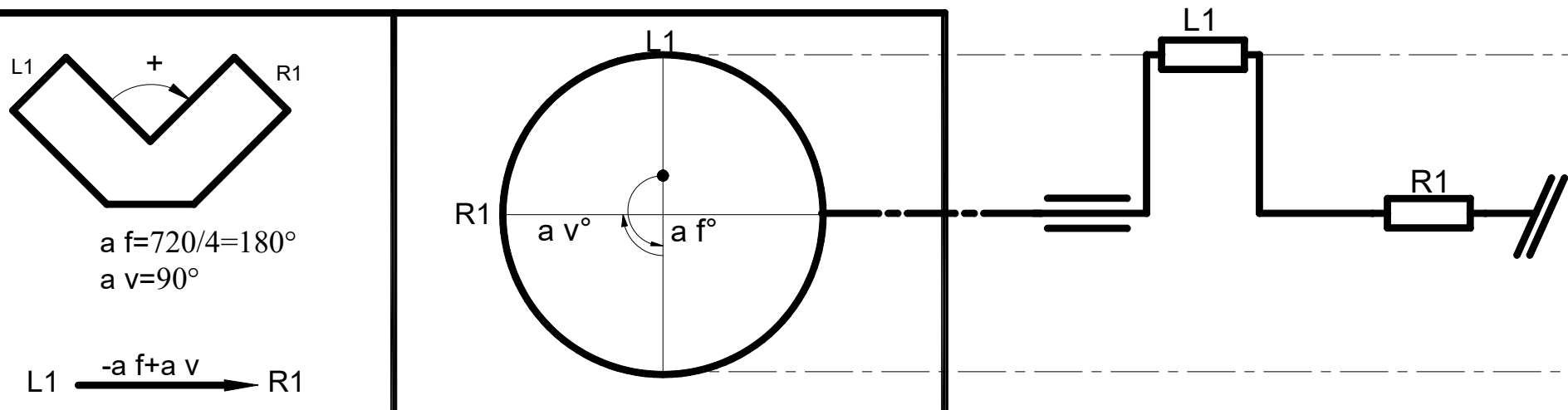
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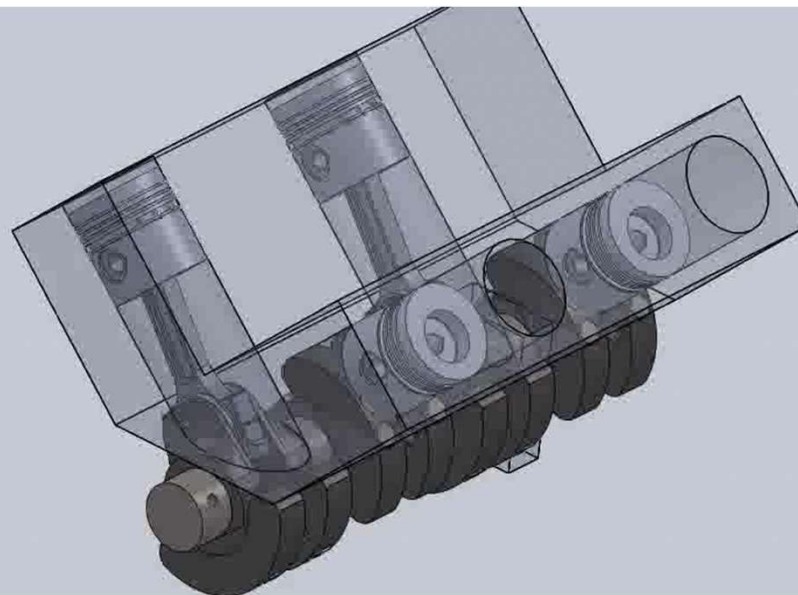
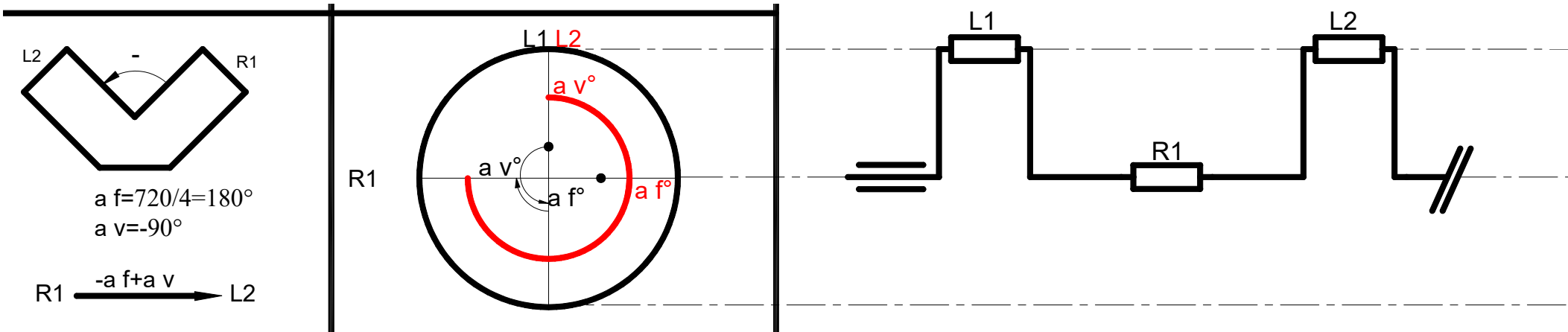
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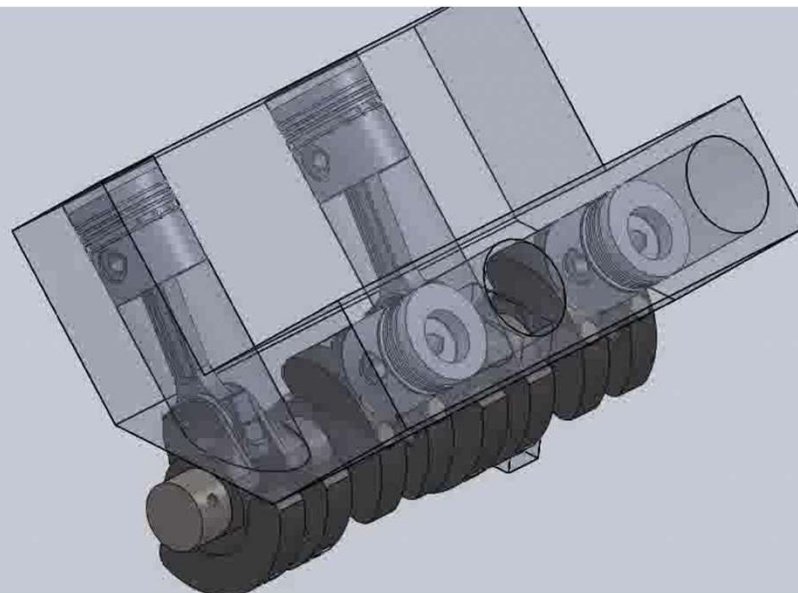
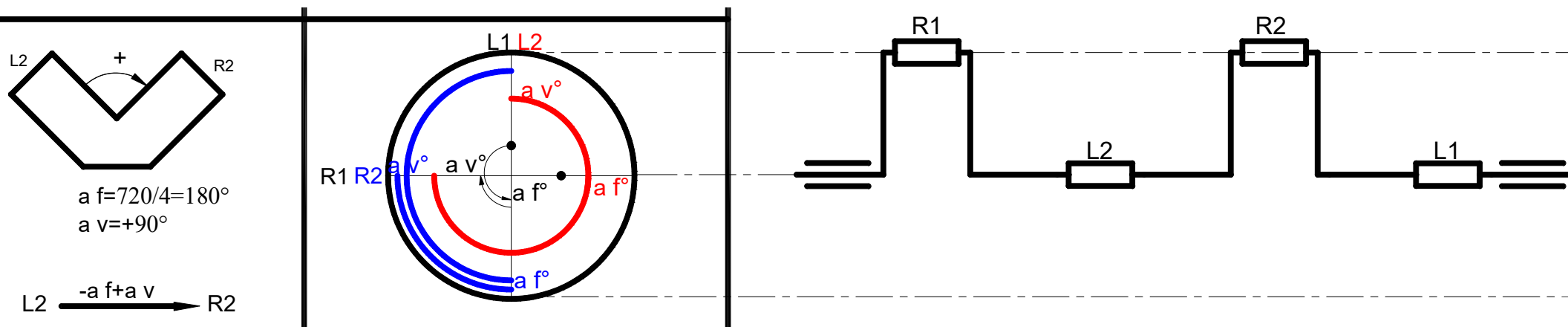
V4-V90 Individual journal design



V4-V90 Individual journal design



V4-V90 Individual journal design



V4-V90- $a_c=0^\circ$ Common journal

L1-R1-L2-R2

0-90-360-450

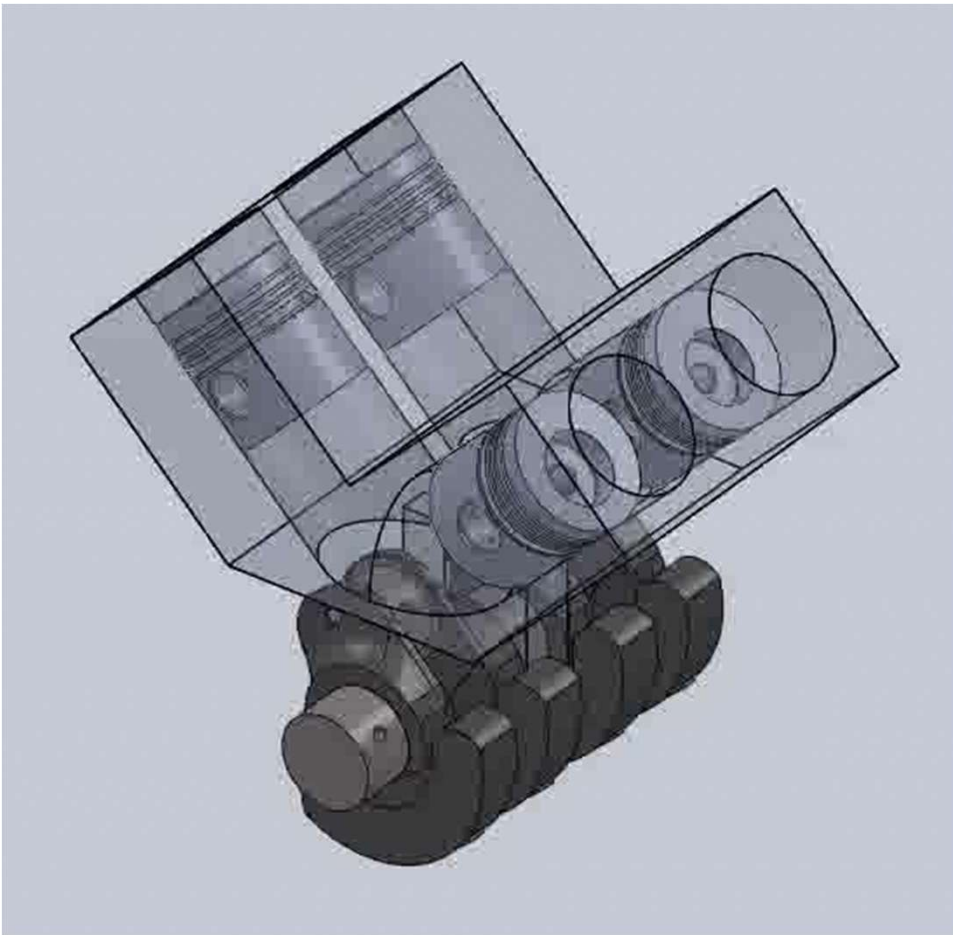
L1-R2-L2-R1

0-90-360-450

L1+L2-R1+R2

0-0 90-90

0-0 450-450

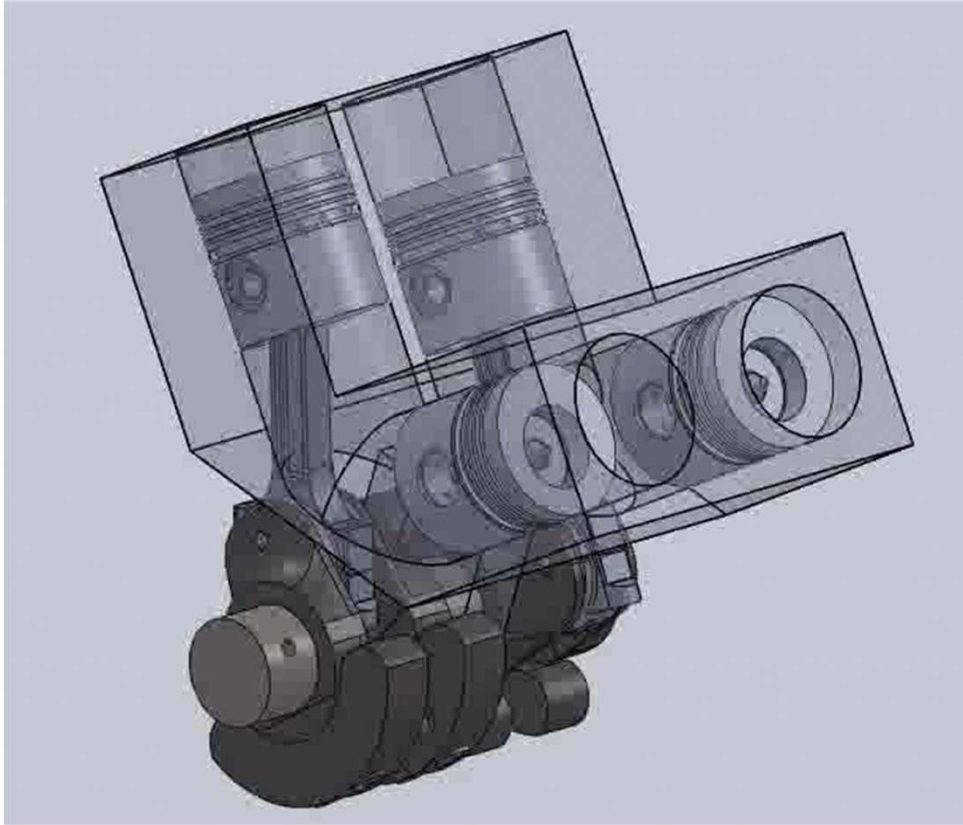


V4 V90 alpha_c=0

L1--90--R1--270--L2--90--R2--270--L1

L1--90—R2--270--L2--90—R1--270--L1

V4-V90- $a_c=90^\circ$ Common journal



L1-R1-L2-R2

0-90-270-360

L1-R2-R1-L2

0-360-450-630

L1-L2-R2-R1

0-270-360-450

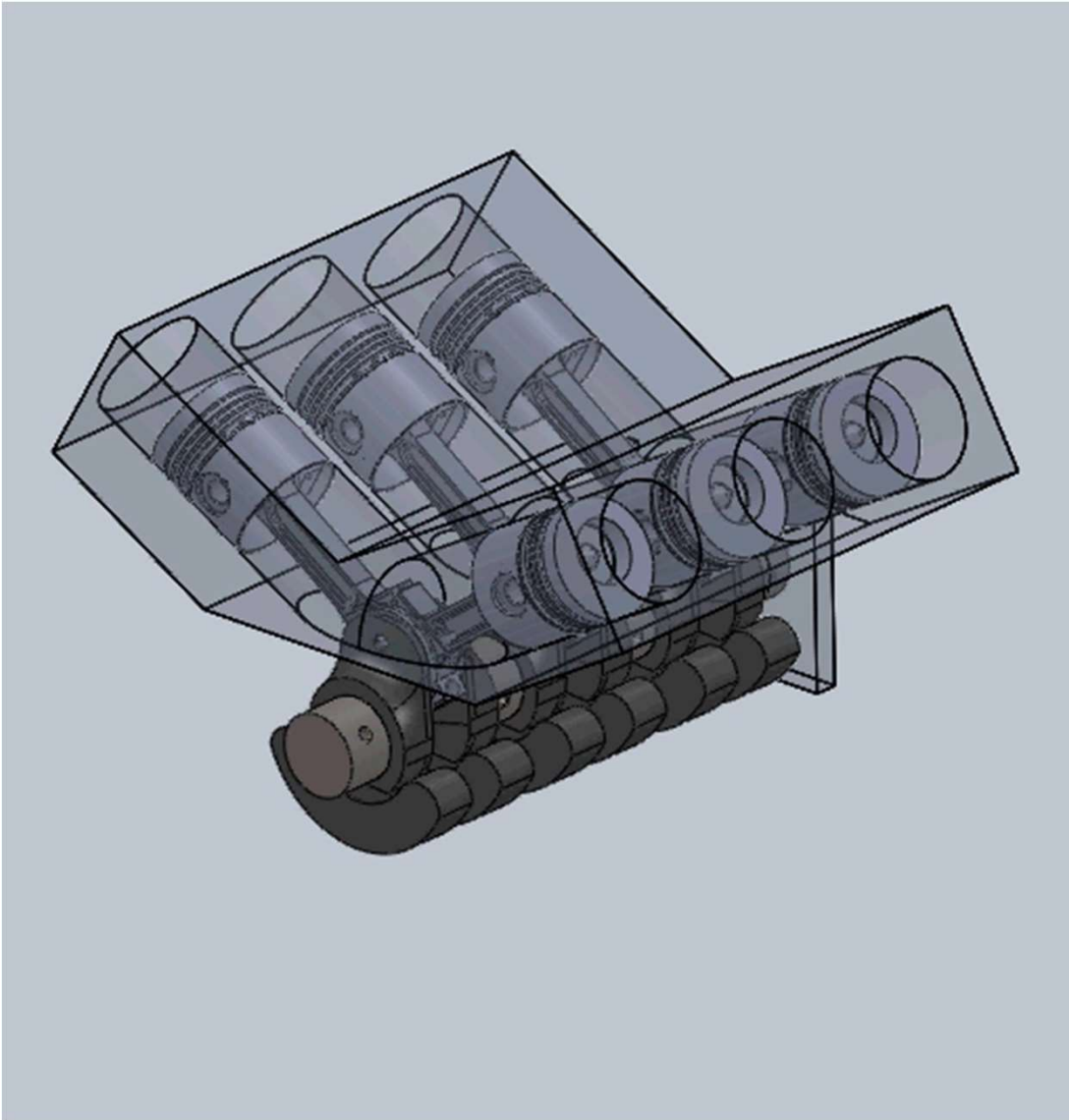
V4 V90 alpha_c=90

L1--90--R1--180--L2--90--R2--360--L1

L1--90--R1--270--R2--270--L2--90--L1

L1--270--L2--90--R2--90--R1--270--L1

V6-V120 $a_c=0$



V6-V120 $\alpha_c=90$

