

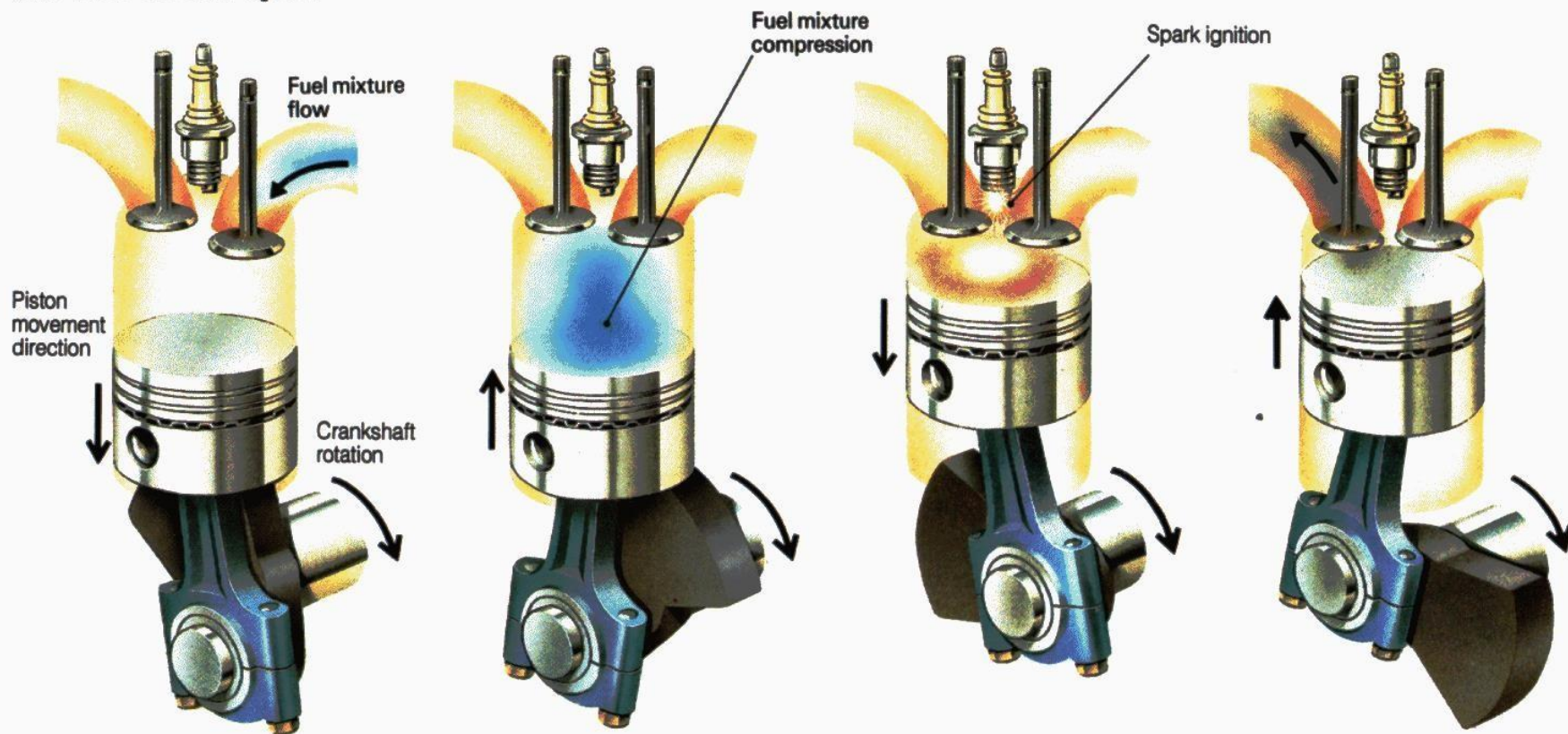


Politechnika Wrocławska

**Timing system**

# 4 stroke engine

## *The four-stroke cycle*

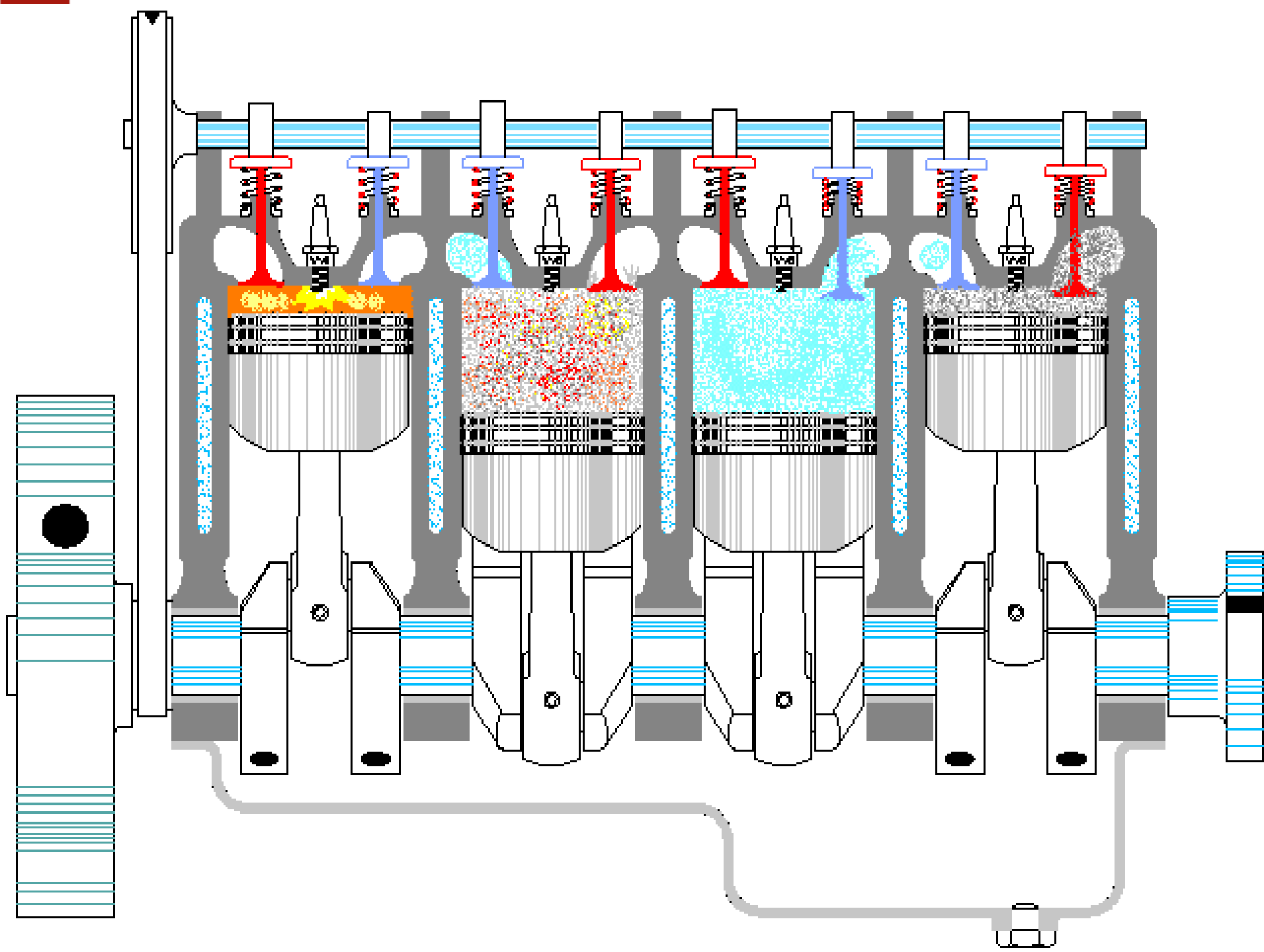


On the induction stroke the piston is descending, the inlet valve is fully open and the exhaust valve closed.

As the piston rises on its compression stroke the exhaust valve is still closed and the inlet valve is closing.

The power stroke drives the piston downwards as the ignited gases expand. Both the inlet and exhaust valves are closed.

The hot gases in the cylinder escape through the open exhaust valve as the piston rises again for the exhaust stroke.

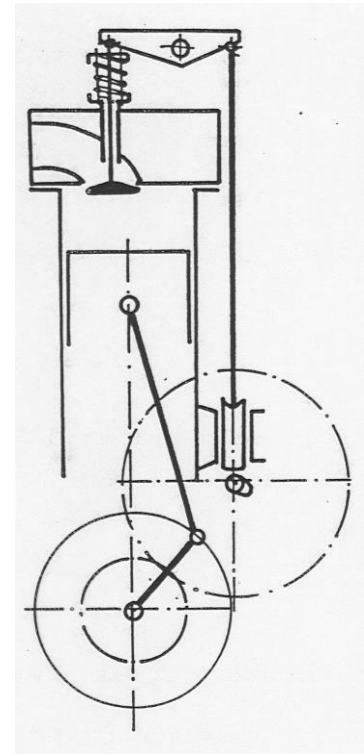


# Timing function

The timing system controls the start and end times as well as the duration of the fresh boost in the cylinder and exhaust gas expulsion.

The opening and closing moments are the points of opening and closing of the valves expressed in angles of rotation of the crankshaft.

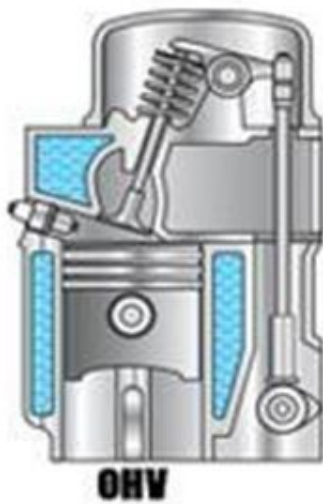
The synchronization of the timing phases with the position of the crankshaft is carried out by the mechanical connection of the crankshaft and the valve system.



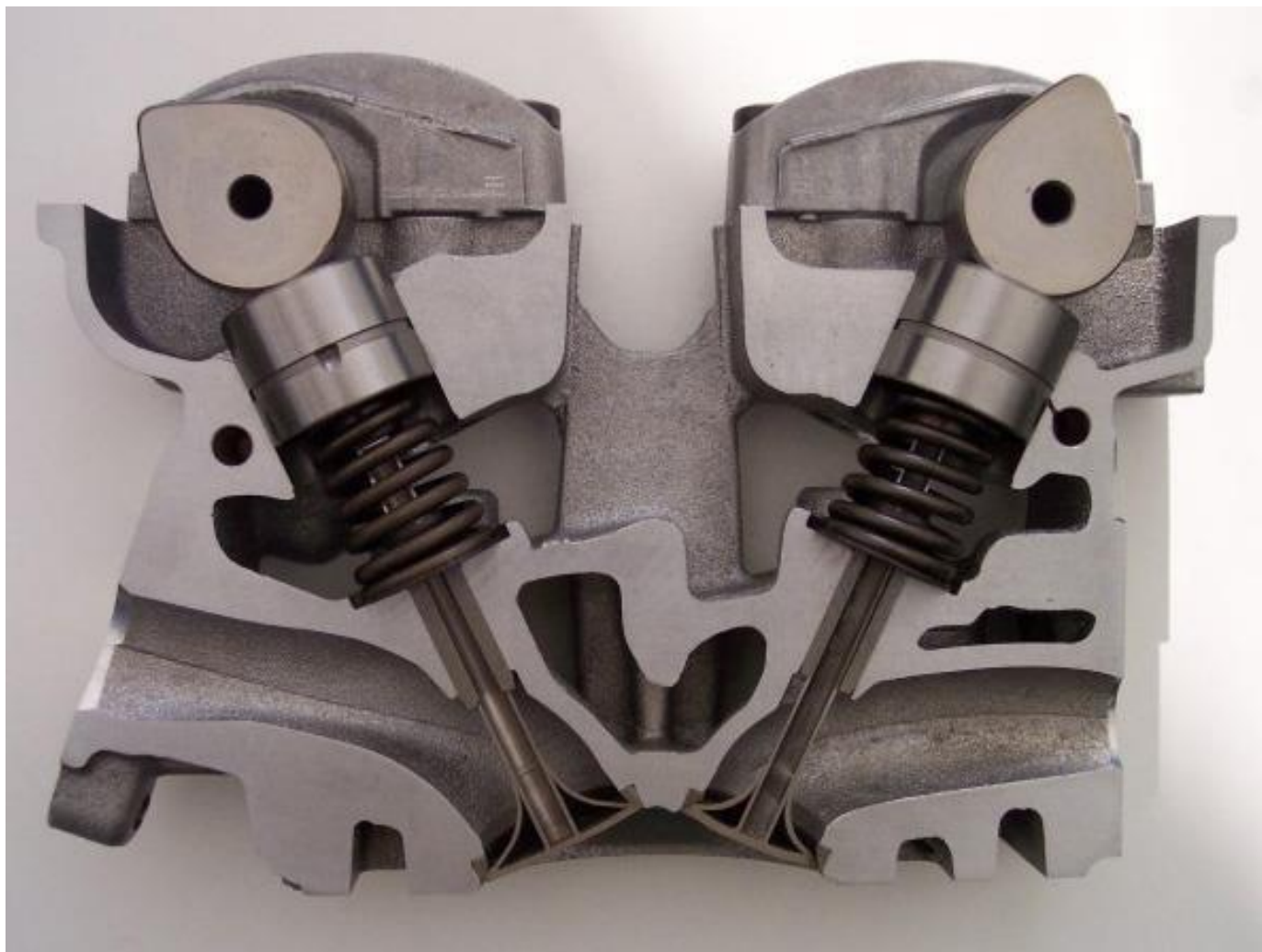
# Operation phases of a four-stroke engine

- 1) The intake valve is opened earlier than TDC:
  - the valve must open completely before the piston reaches TDC (valve opening distance)
  - the intake valve closure is later than TDC
- 2) The exhaust valve opens earlier than the BDC:
  - the pressure is lowered, making the exhaust gas more easily pushed out of the cylinder
- 3) Exhaust valve closure is later than BDC
  - Overlap- (co-opening angle):
  - additional cooling - regulation of the thermal load of the system
  - better flushing of the cylinder from exhaust gases

# Timing system architecture



# DOHC





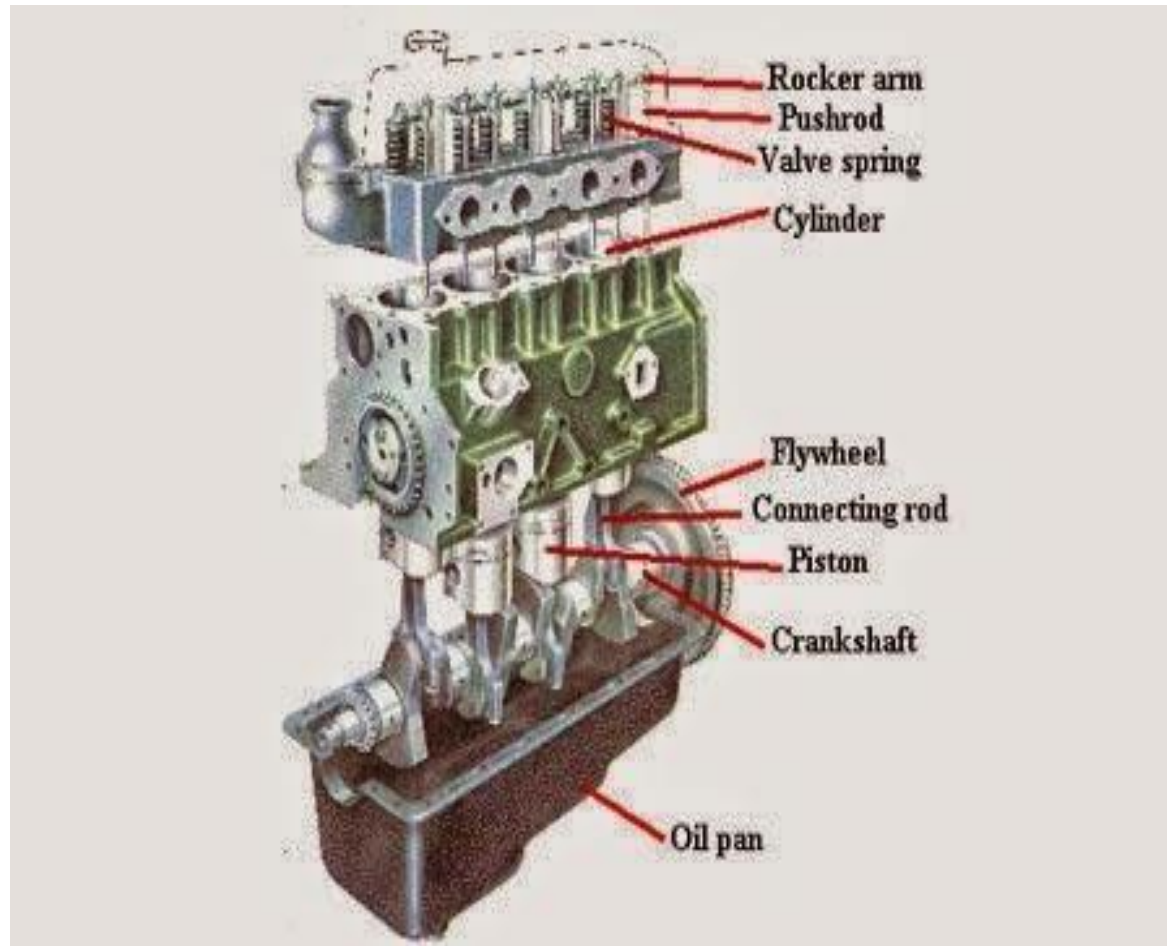
# Location of the overhead camshaft

- 1) OHV (overhead valves): overhead valves located in the cylinder head and the camshaft in the engine block
- 2) OHC (overhead camshaft): the valves are hanging in the head and the shaft is located above the head
- 3) DOHC (double overhead camshaft): two overhead camshafts
- 4) SOHC (single overhead camshaft)

Passenger cars and vans (high-speed engines) - SOHC or DOHC systems

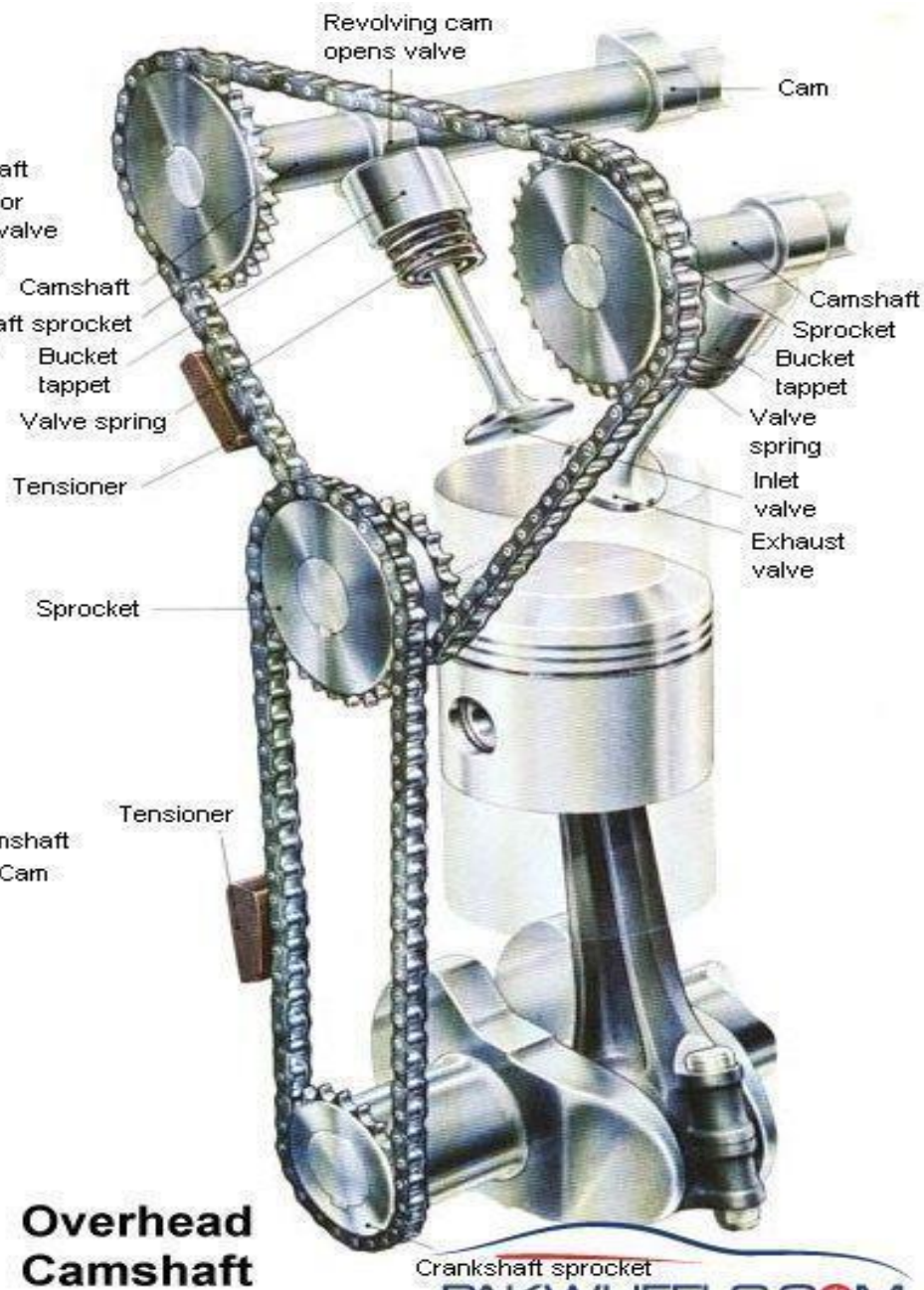
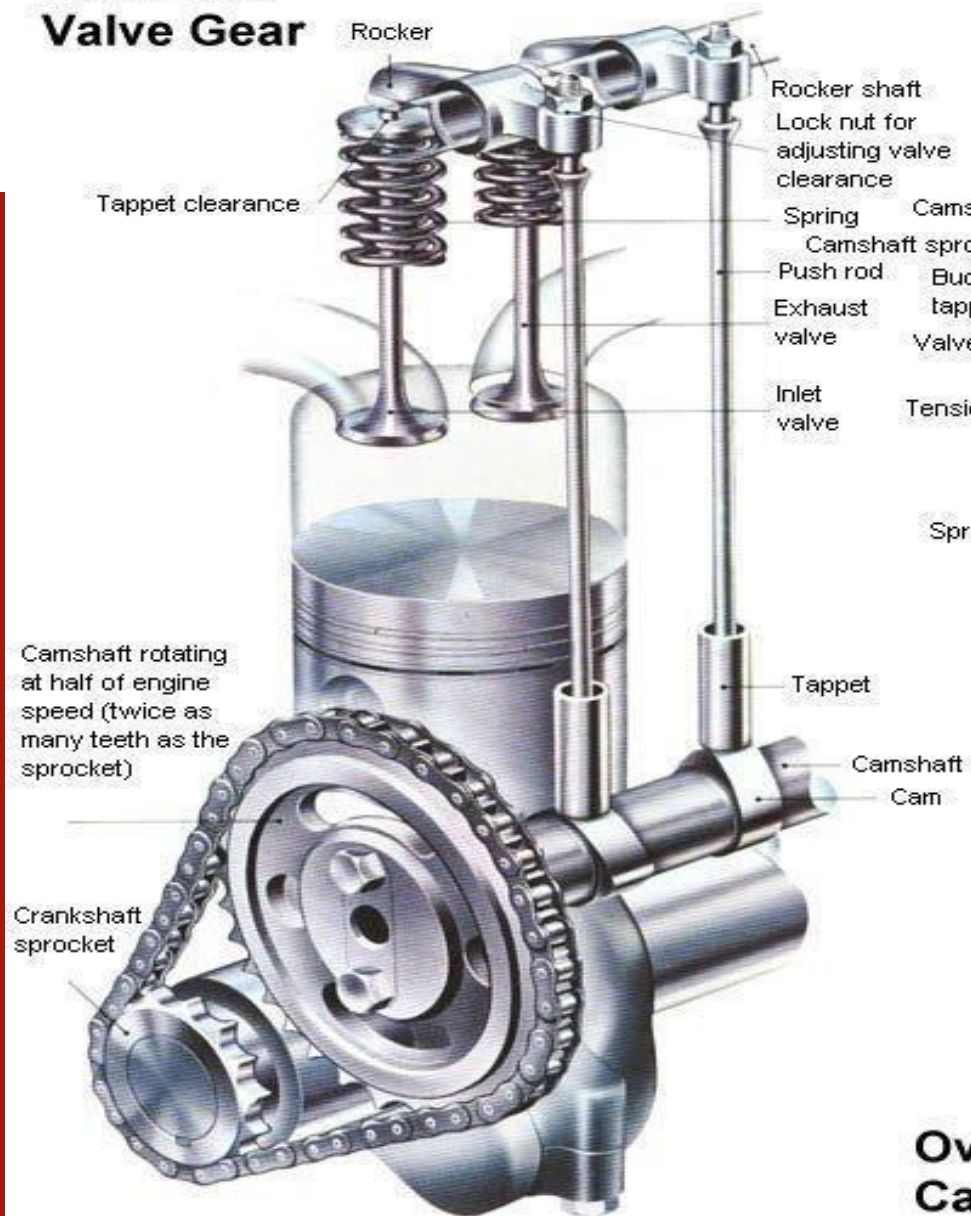
# Basic elements

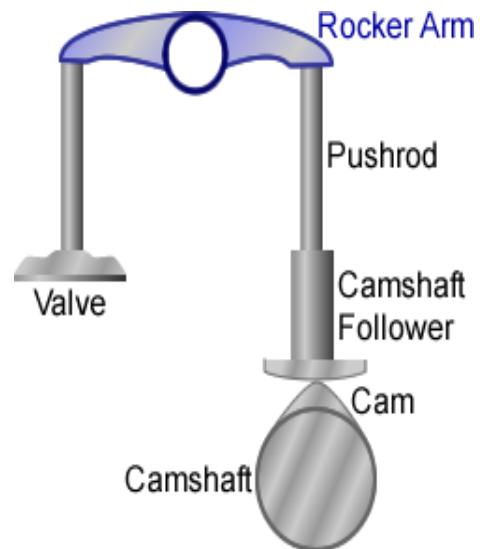
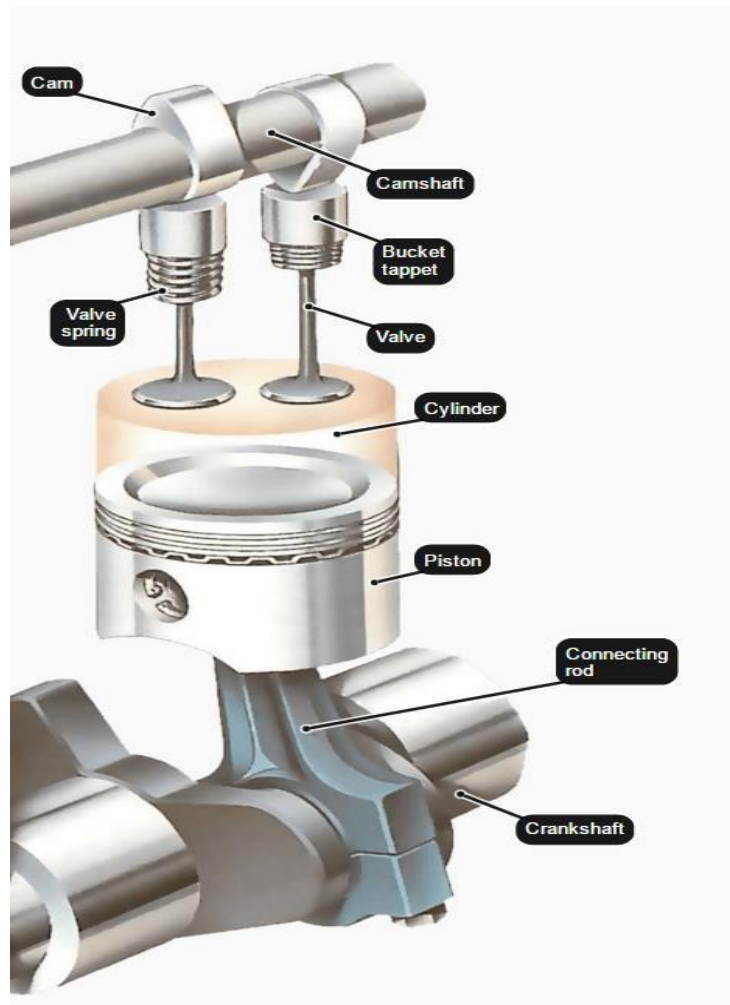
Layout element:  
valves (suction and discharge)  
valve guide  
valve seat  
valve springs  
pusher  
camshaft  
camshaft drive (gears, chain)



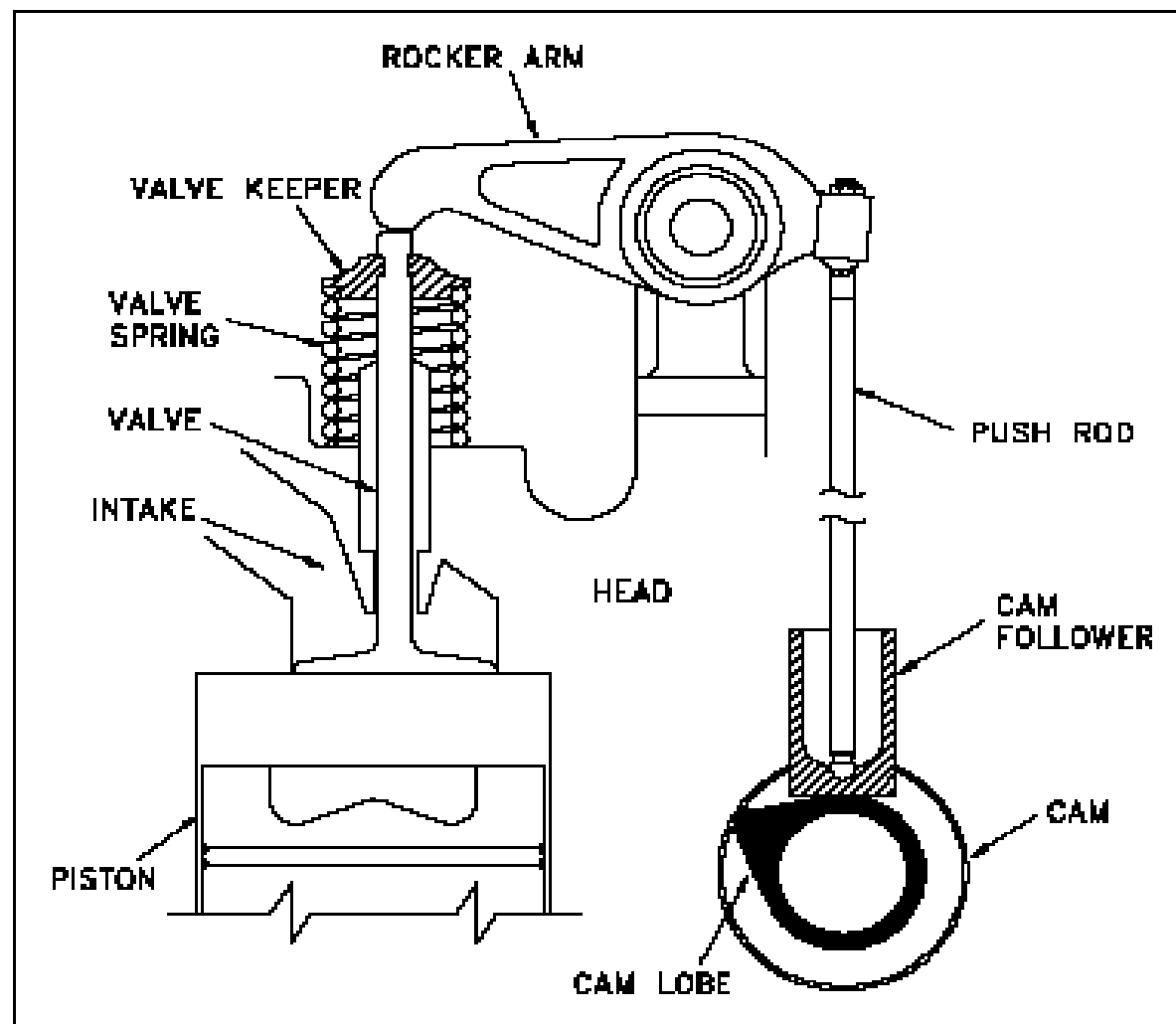


## Push Rod Valve Gear





The ratio of  
the rotational  
speed of the  
crankshaft to  
the camshaft is  
2: 1

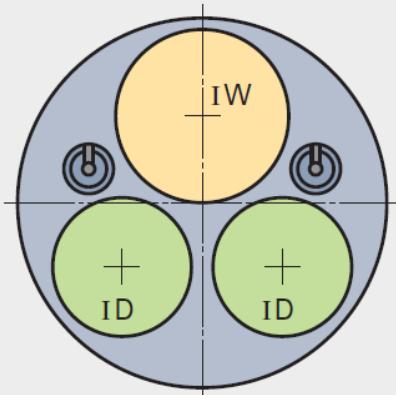


# Valves

- a distinction is made between intake and exhaust valves.
- the diameter of the valve plug and the valve stroke must be of such size that gas exchange occurs as smoothly as possible and the flow resistance is as low as possible
- the diameter of the exhaust valve head is usually smaller than that of the intake valve, because due to the still high pressure of exhaust gases after opening the valve, the combustion chamber is emptied very quickly

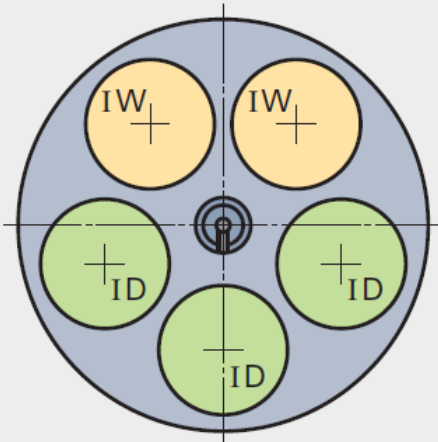
# Multi-valve layouts

W – zawór wylotowy

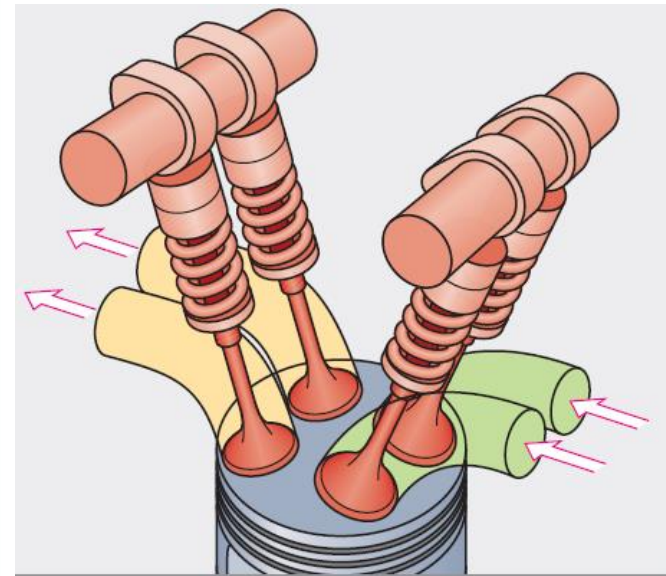
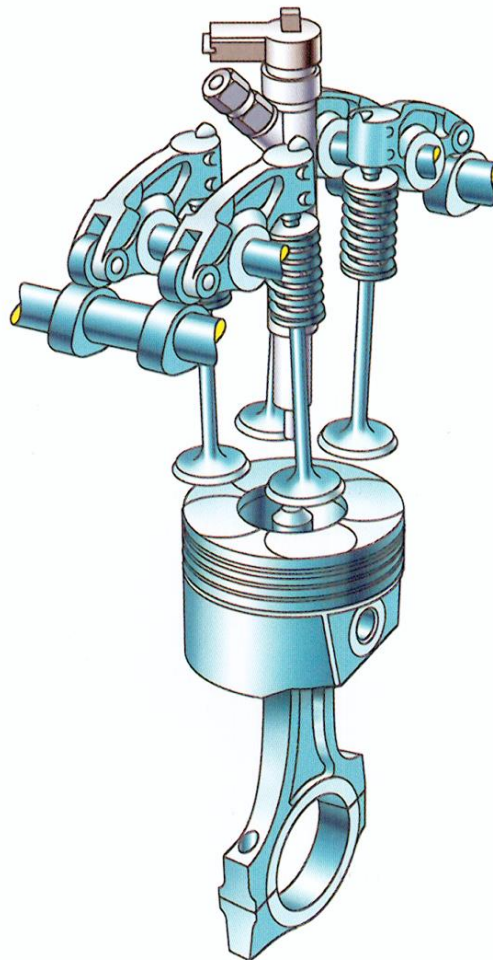


D – zawór dolotowy

W – zawór wylotowy



D – zawór dolotowy



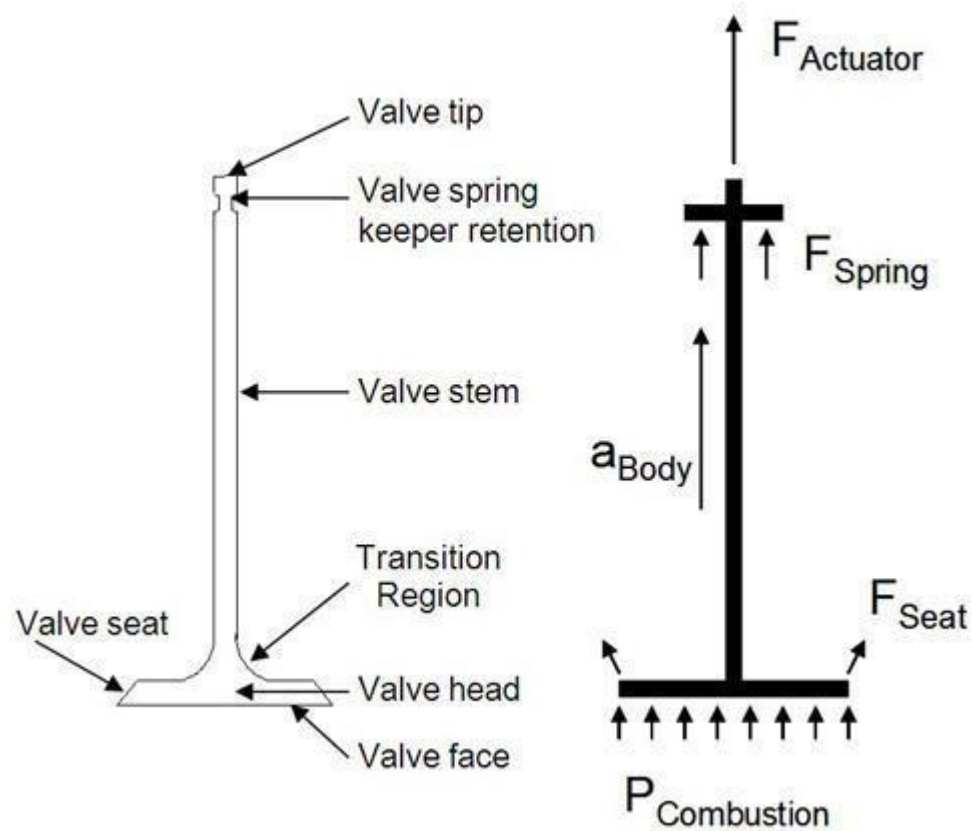
# Valves

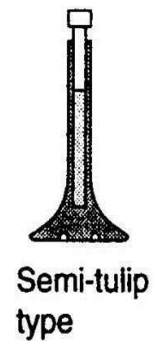
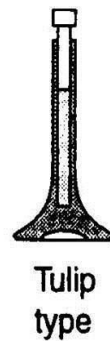
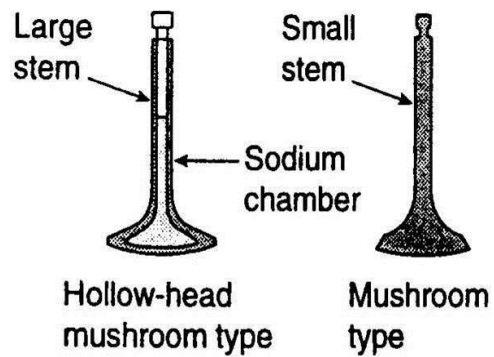
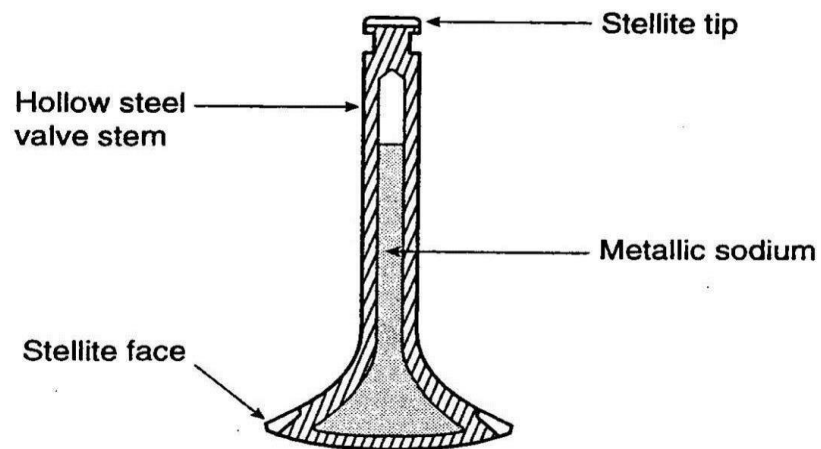
## Loads

- the valves are subjected to very high loads at a speed of 4000 rpm, 2000 times per minute, lifted by a valve cam and the same number of times as a result of the action of a valve spring, they hit the valve seat  
valve stem and stem tip are subject to abrasive wear

The intake valves, which are continuously cooled by the intake gases, nevertheless reach an average temperature of around 500 °C

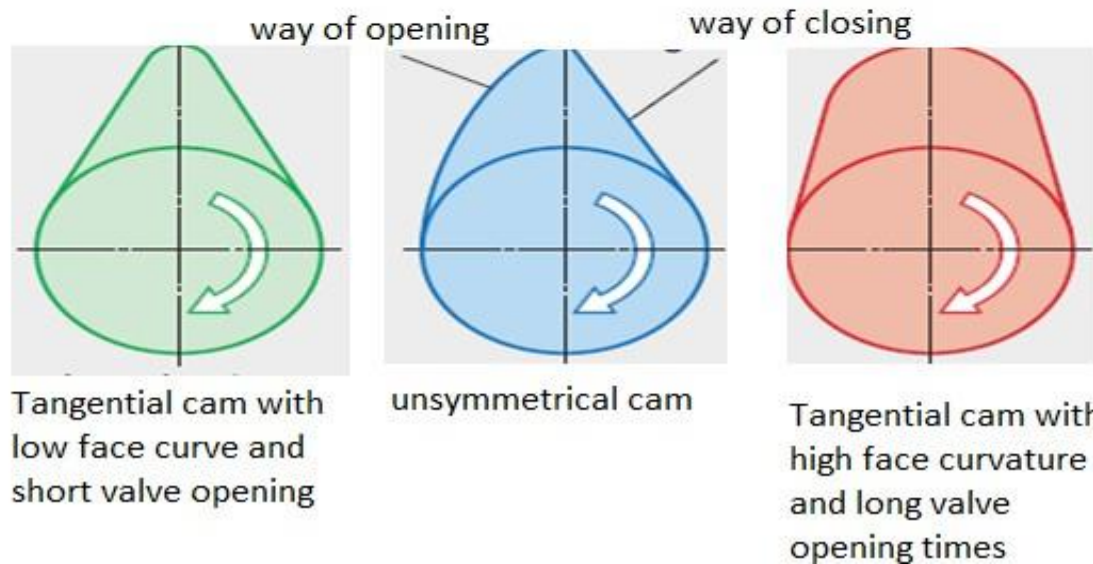
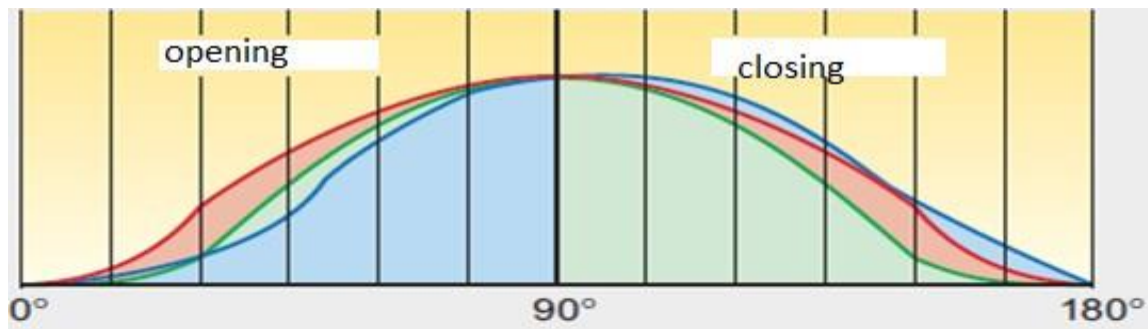
# Valves





# Cams, types of timing cams.

They affect the valve opening and closing sequence.





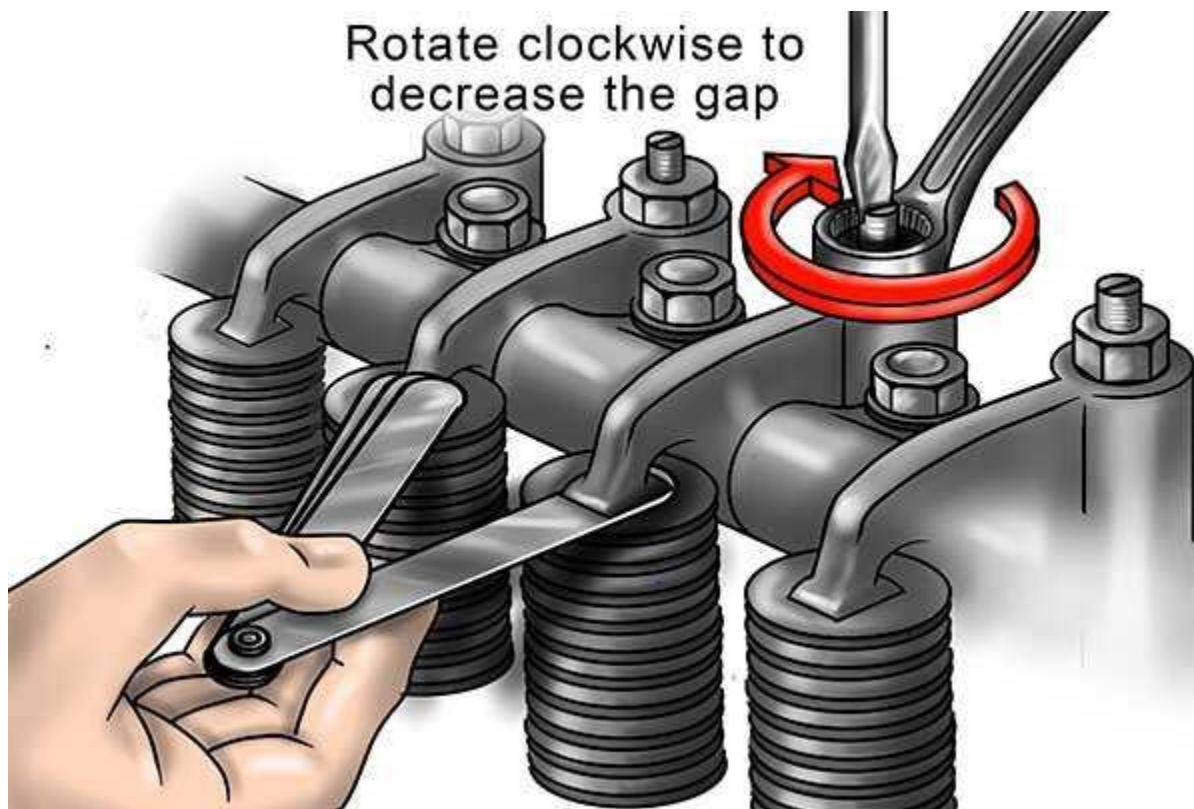
# Valve clearance

- Inlet and exhaust valves deform during operation depending on the temperature and the material from which they are made
- after an extended period of time, the valve clearance between the timing drive components changes due to wear
- in a cold engine, the clearance is always greater than in a warm engine
- The clearance of the exhaust valve is usually greater than the clearance of the intake valve because its temperature is greater.

• Valve clearance too small:  
valve opens earlier and closes later,  
the exhaust valve temperature is too high,  
if the engine is hot, there is a risk of  
the intake or exhaust valve not closing  
completely

Valve clearance too big:  
the valve opens too late and closes too  
early (shortening the valve opening and  
co-opening times, and as a result,  
deterioration of cylinder filling and engine  
power),  
the mechanical load and noise of the  
timing system components increases

# Valve clearance

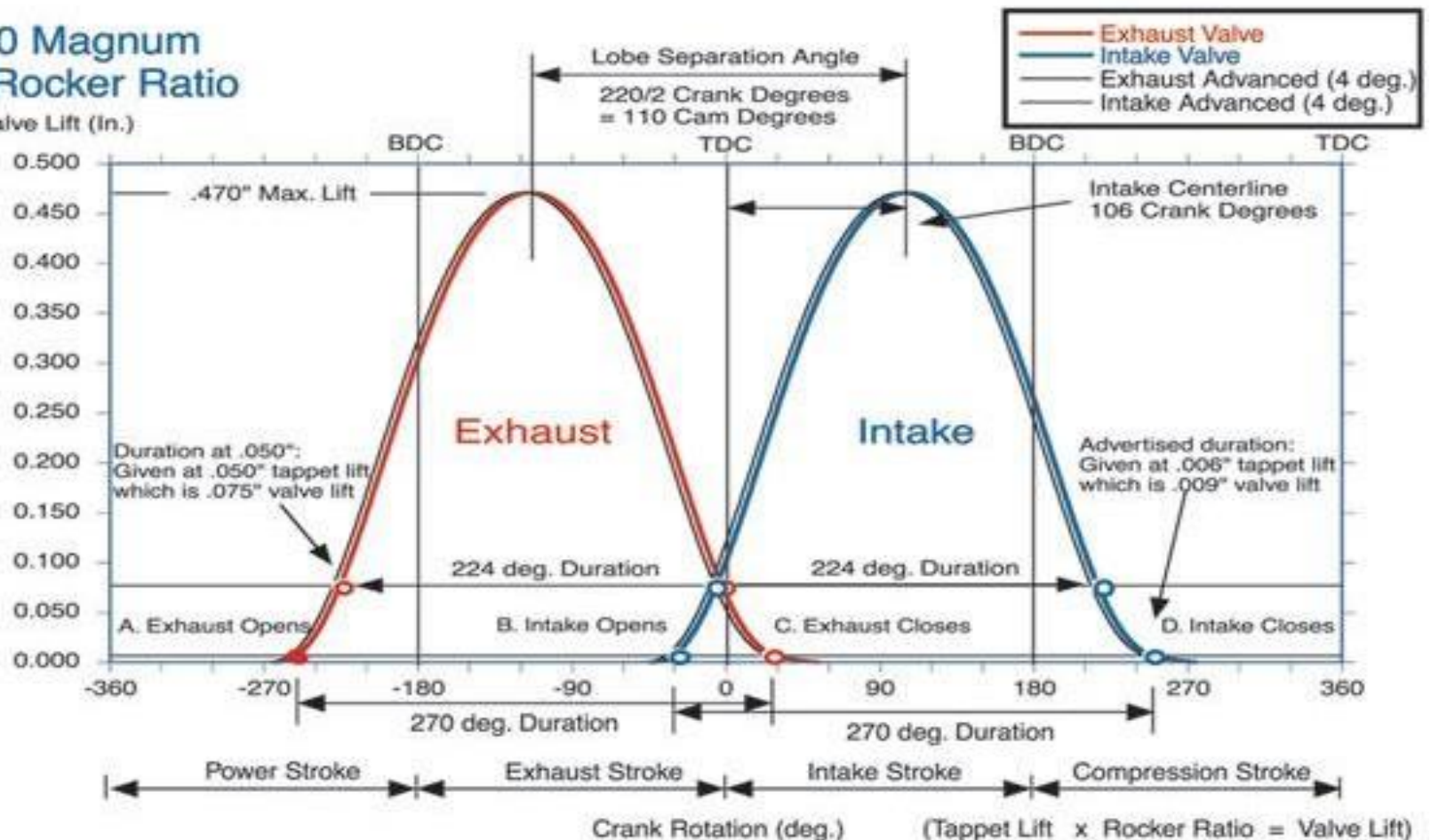




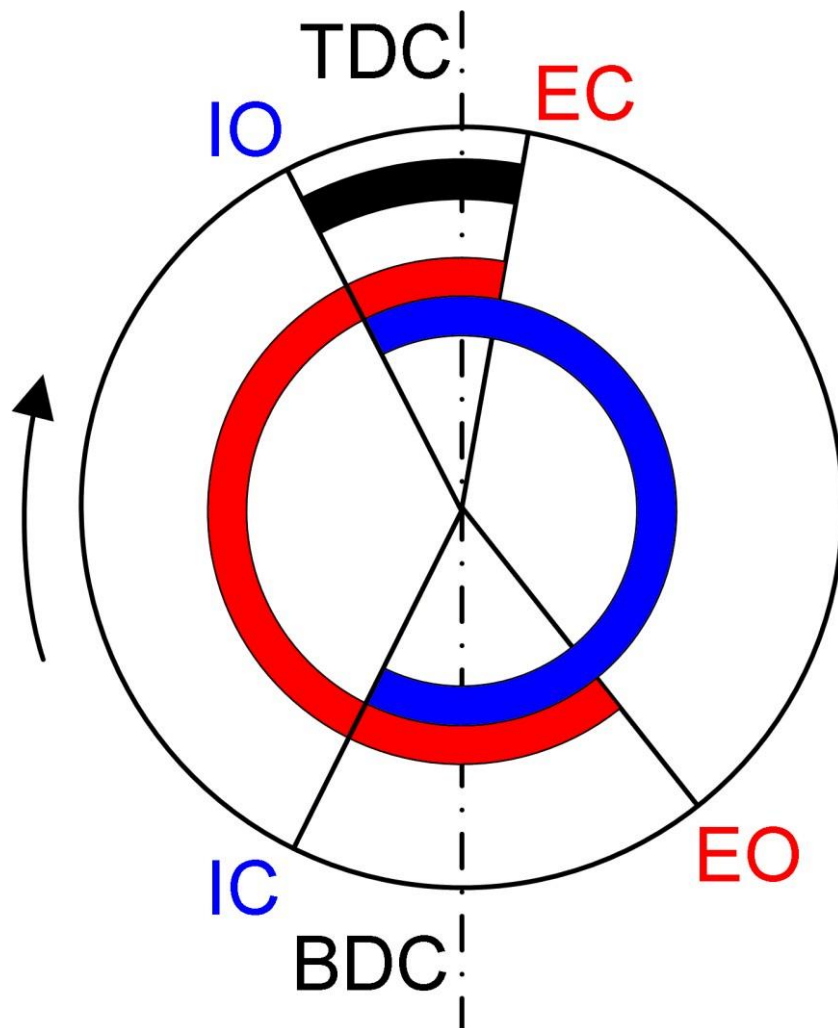
# Open timing chart

## 270 Magnum 1.5 Rocker Ratio

Valve Lift (In.)



# Closed timing chart



## Example Cam Card

