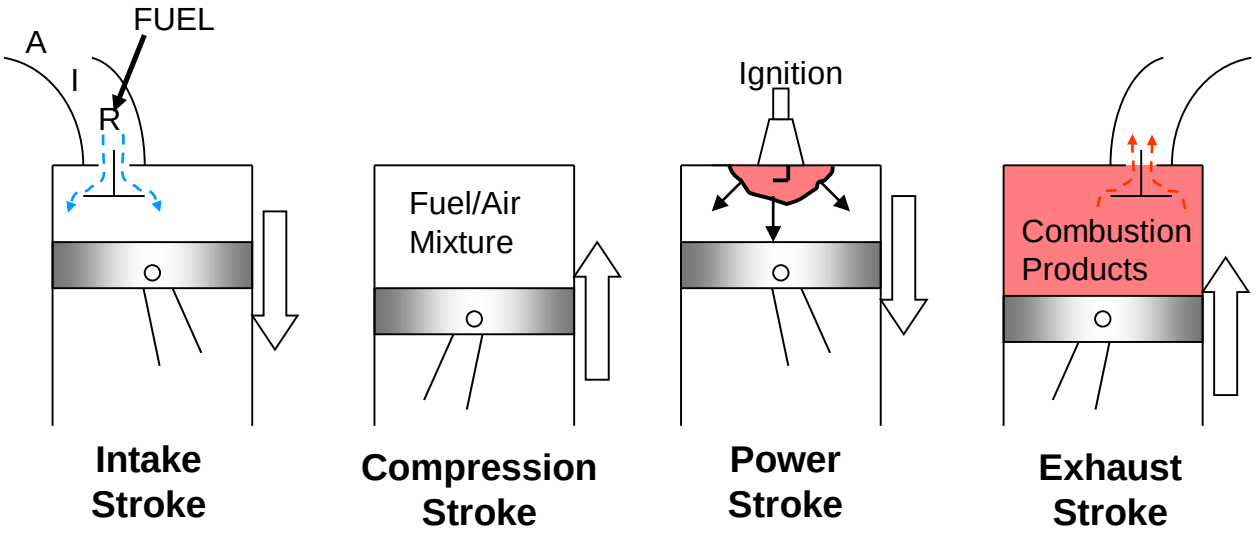
Four Stroke SI Engine

Stroke 1: Fuel-air mixture introduced into cylinder through intake valve

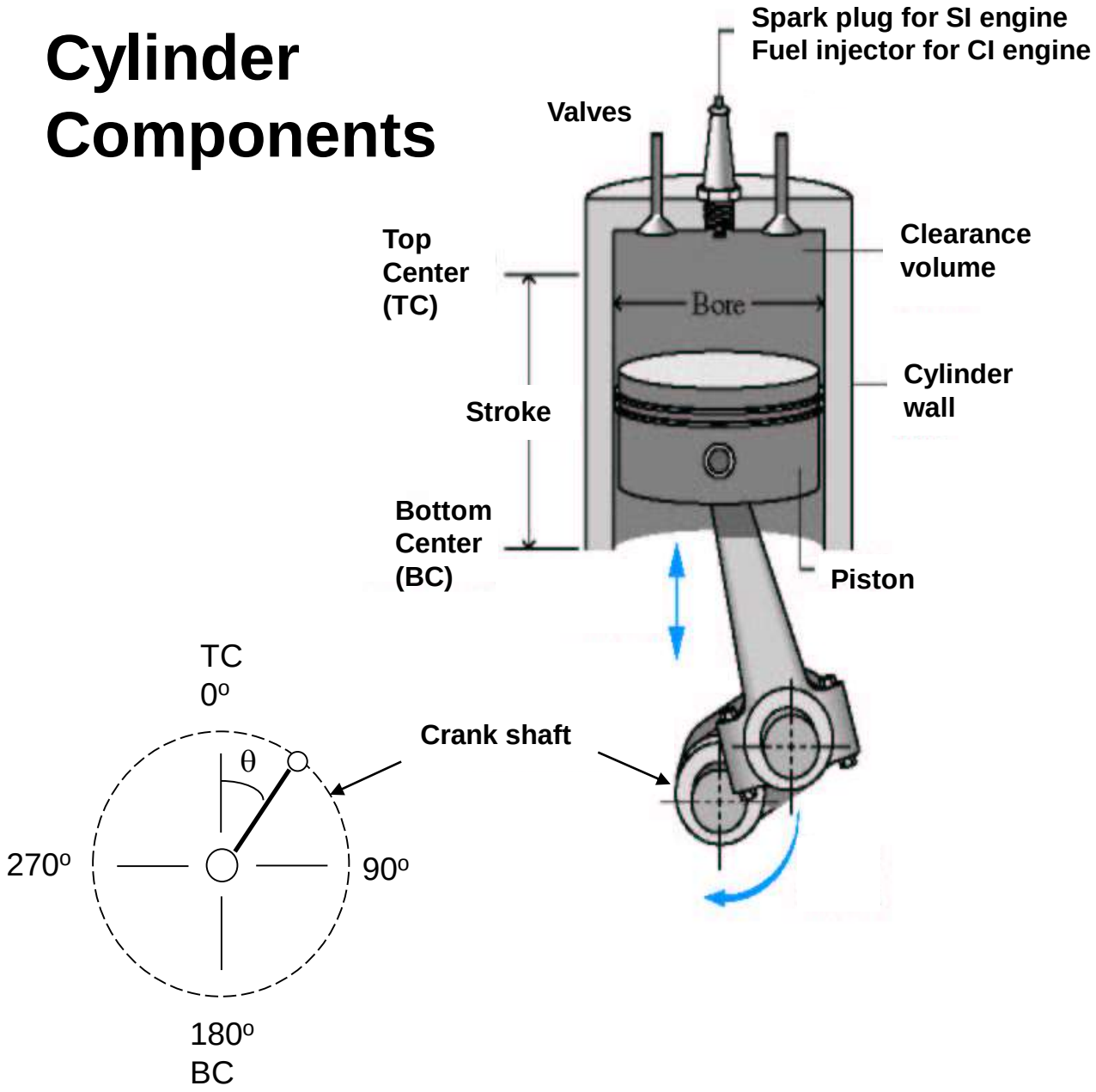
Stroke 2: Fuel-air mixture compressed

Stroke 3: Combustion (~constant volume) occurs and product gases expand doing work

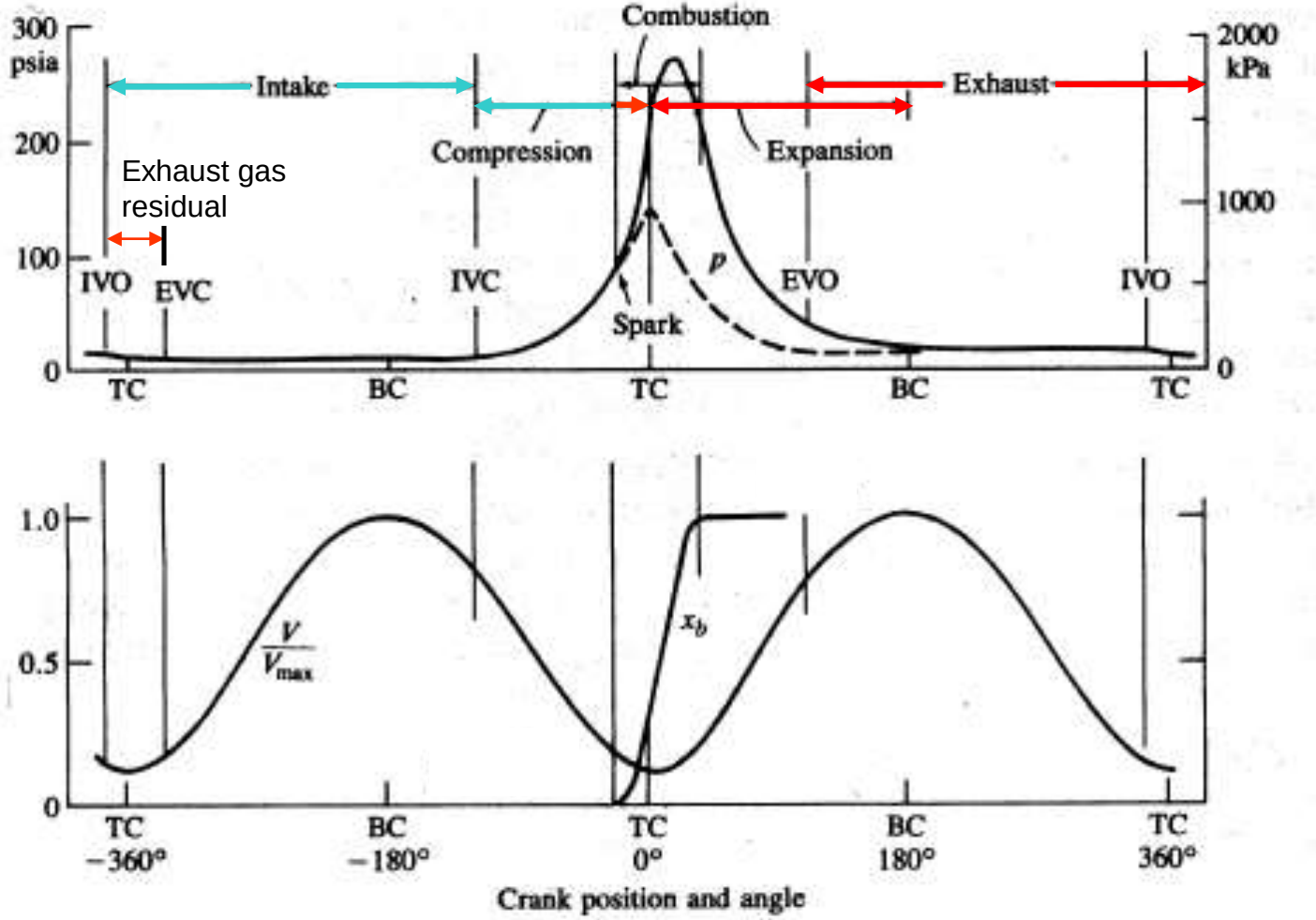
Stroke 4: Product gases pushed out of the cylinder through the exhaust valve



Cylinder Components

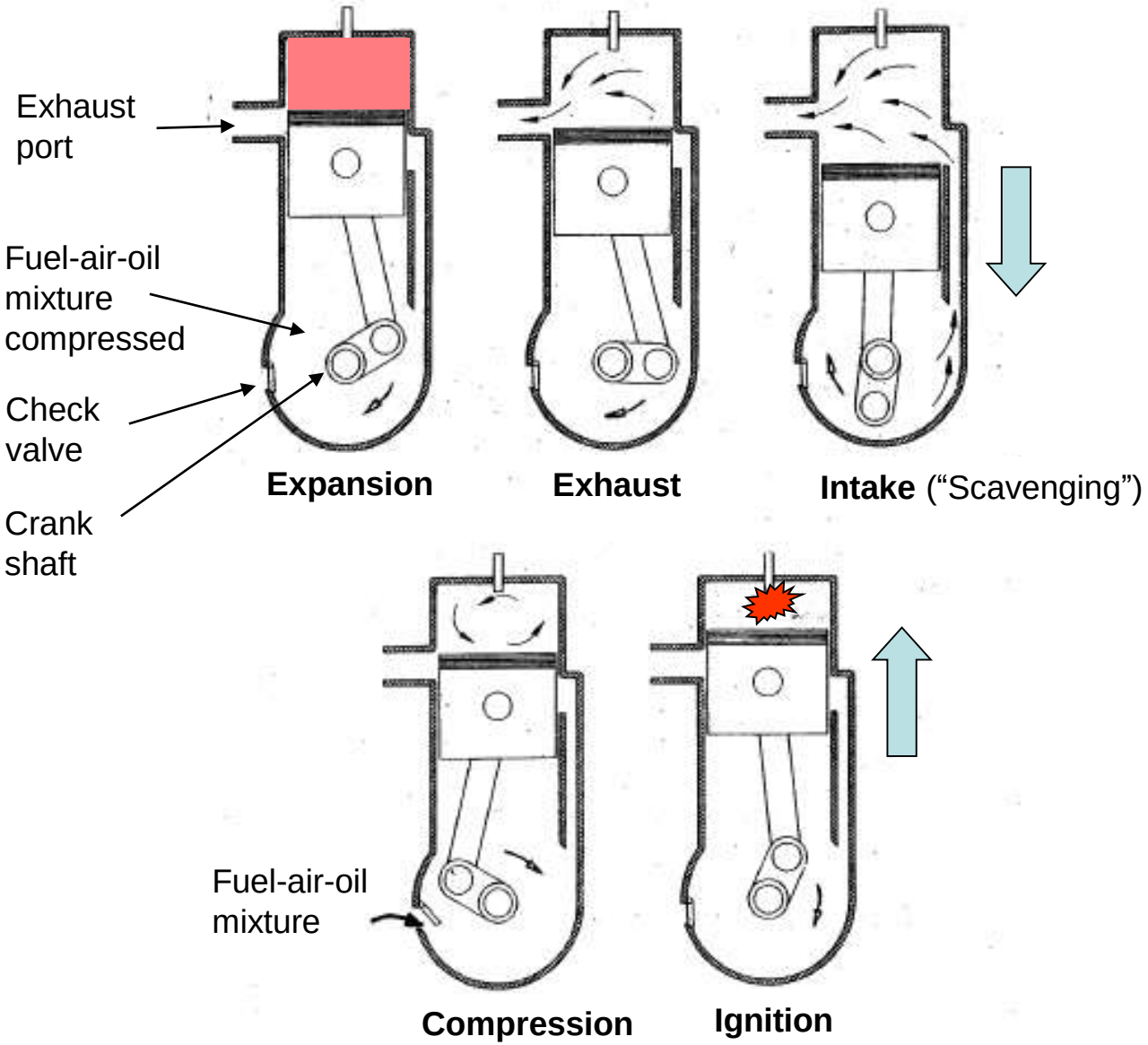


Four-Stroke SI Engine

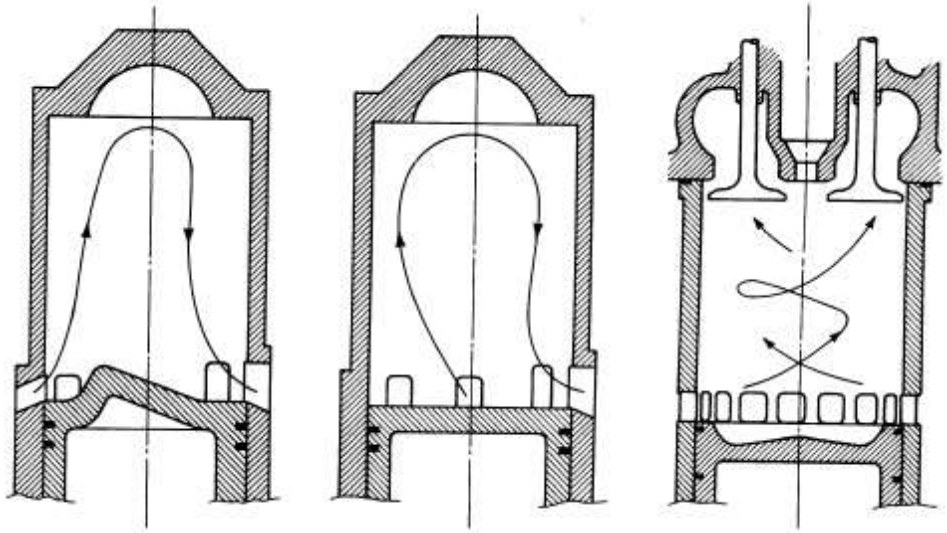


IVO - intake valve opens, IVC – intake valve closes
EVO – exhaust valve opens, EVC – exhaust valve opens
X_b – burned gas mole fraction

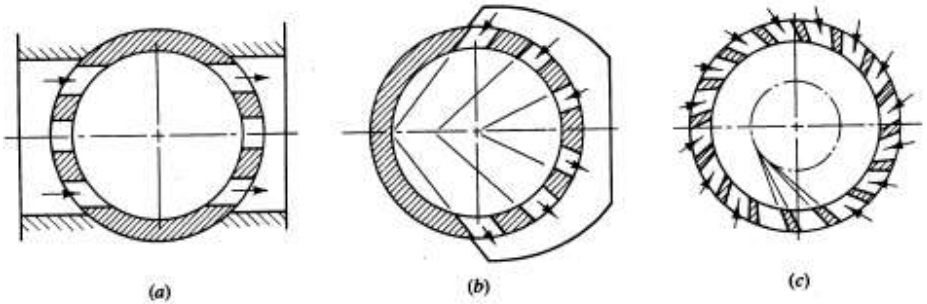
Two Stroke SI Engine

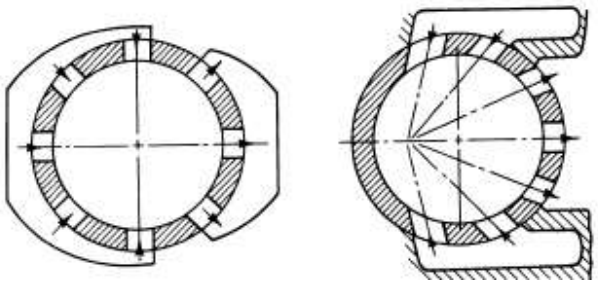


Two-Stroke Scavenging

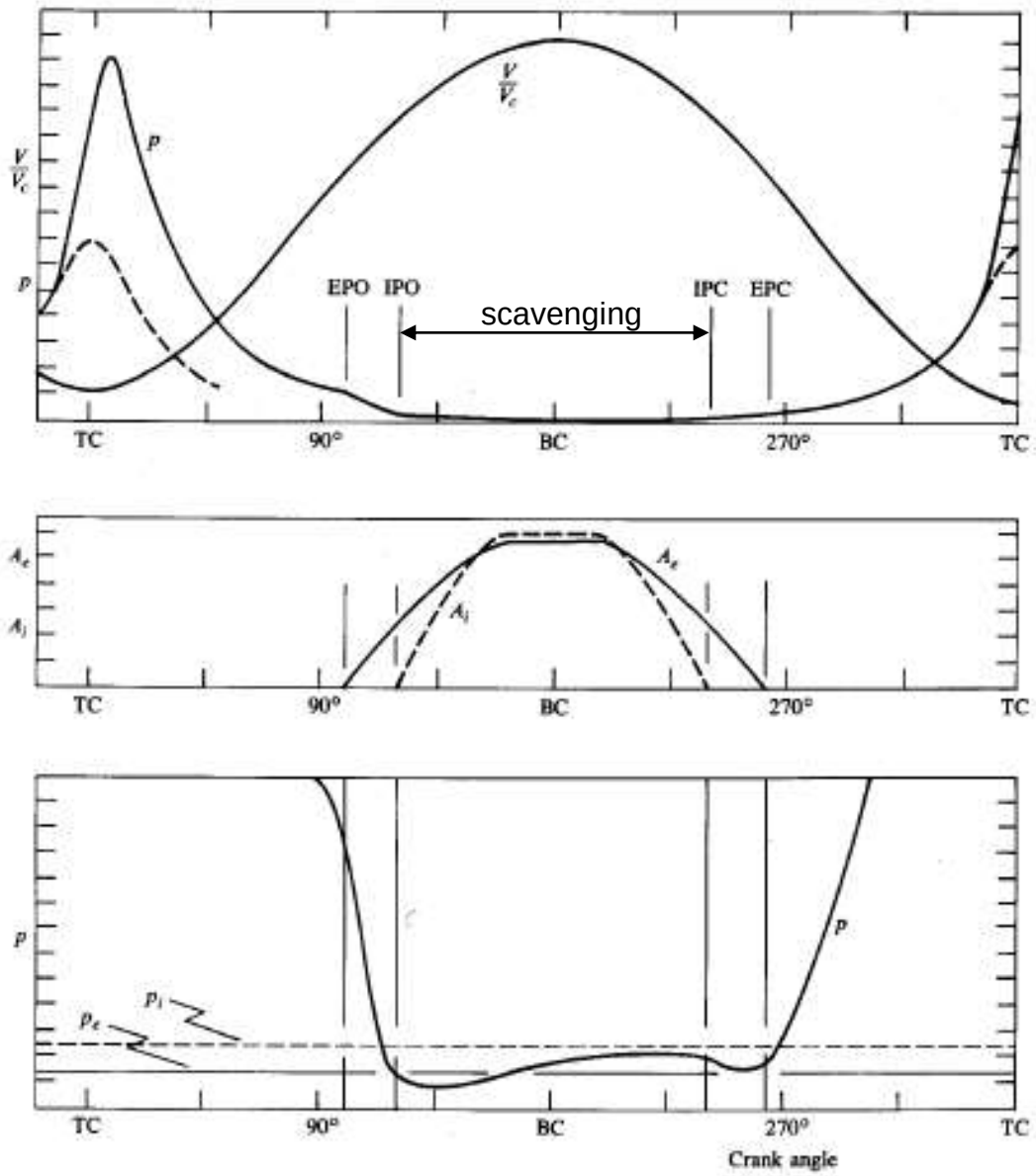


Cross **Loop** **Uniflow**





Two-Stroke SI Engine



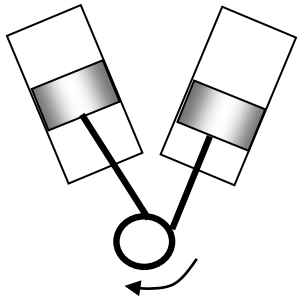
EPO – exhaust port open
EPC – exhaust port closed
IPO – intake port open
IPC – intake port closed

Cylinder Arrangement

Single-cylinder engine gives one power stroke per crank revolution (2 stroke) or two revolutions (4 stroke). The torque pulses are widely spaced, and engine vibration and smoothness are significant problems. Used in small engine applications where engine size is more important

Multi-cylinder engines spread out the displacement volume amongst multiple smaller cylinders. Increased frequency of power strokes produces smoother torque characteristics. Engine balance (inertia forces associated with accelerating and decelerating piston) better than single cylinder.

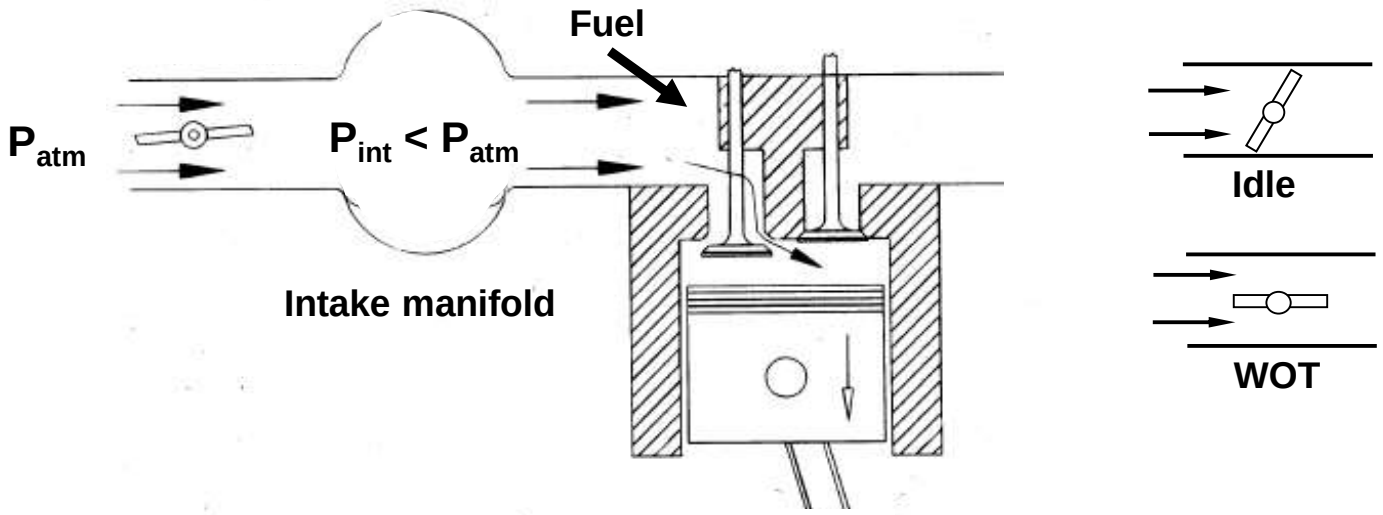
Most common cylinder arrangements:
- In-line 4-cylinder
- In-line 6-cylinder
- V-6 and V-8



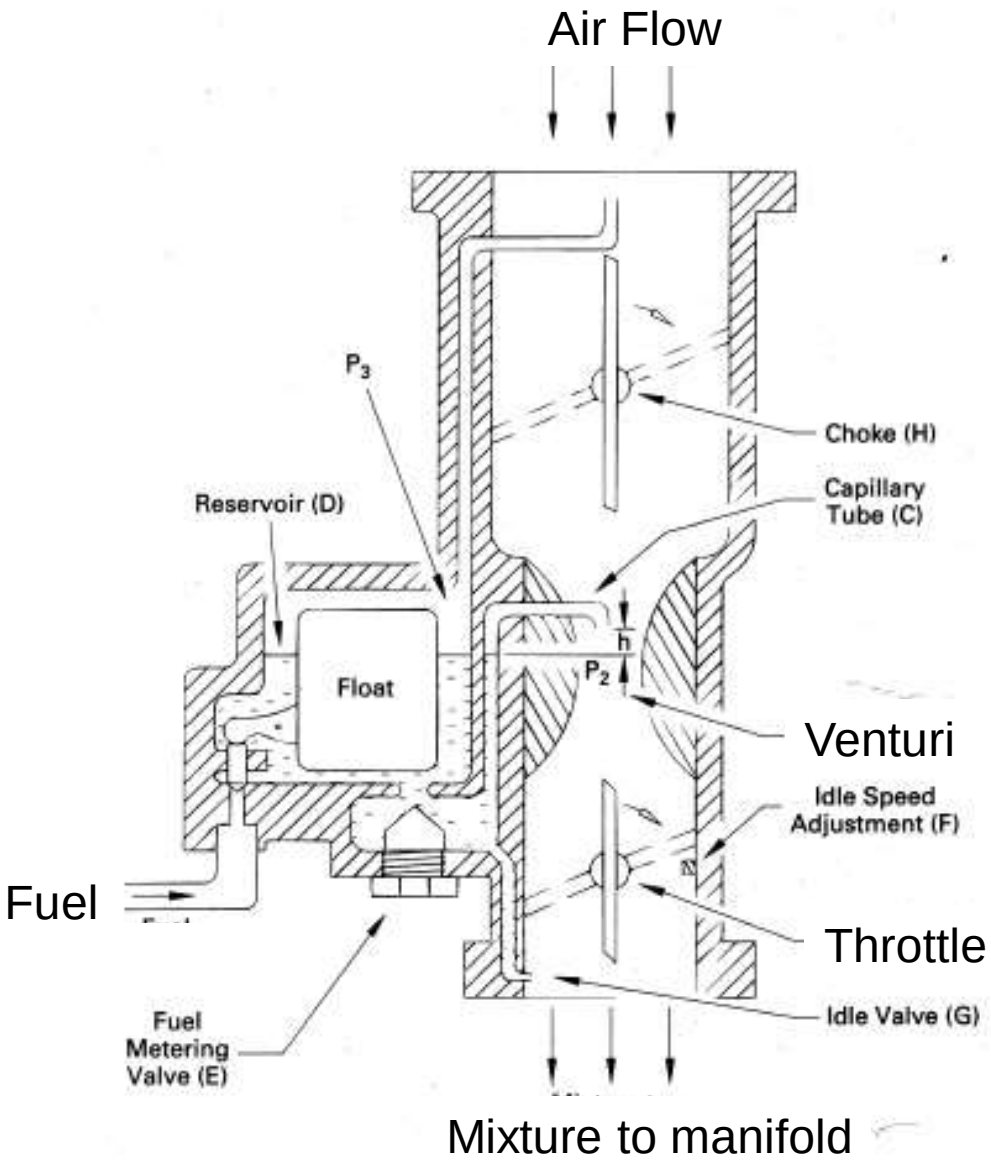
Power Regulation (Throttling)

An IC engine is basically an air engine, the more air you get into the cylinder, the more fuel you can burn, the more power you get out. The initial pressure in the cylinder is roughly equal to the pressure in the intake manifold.

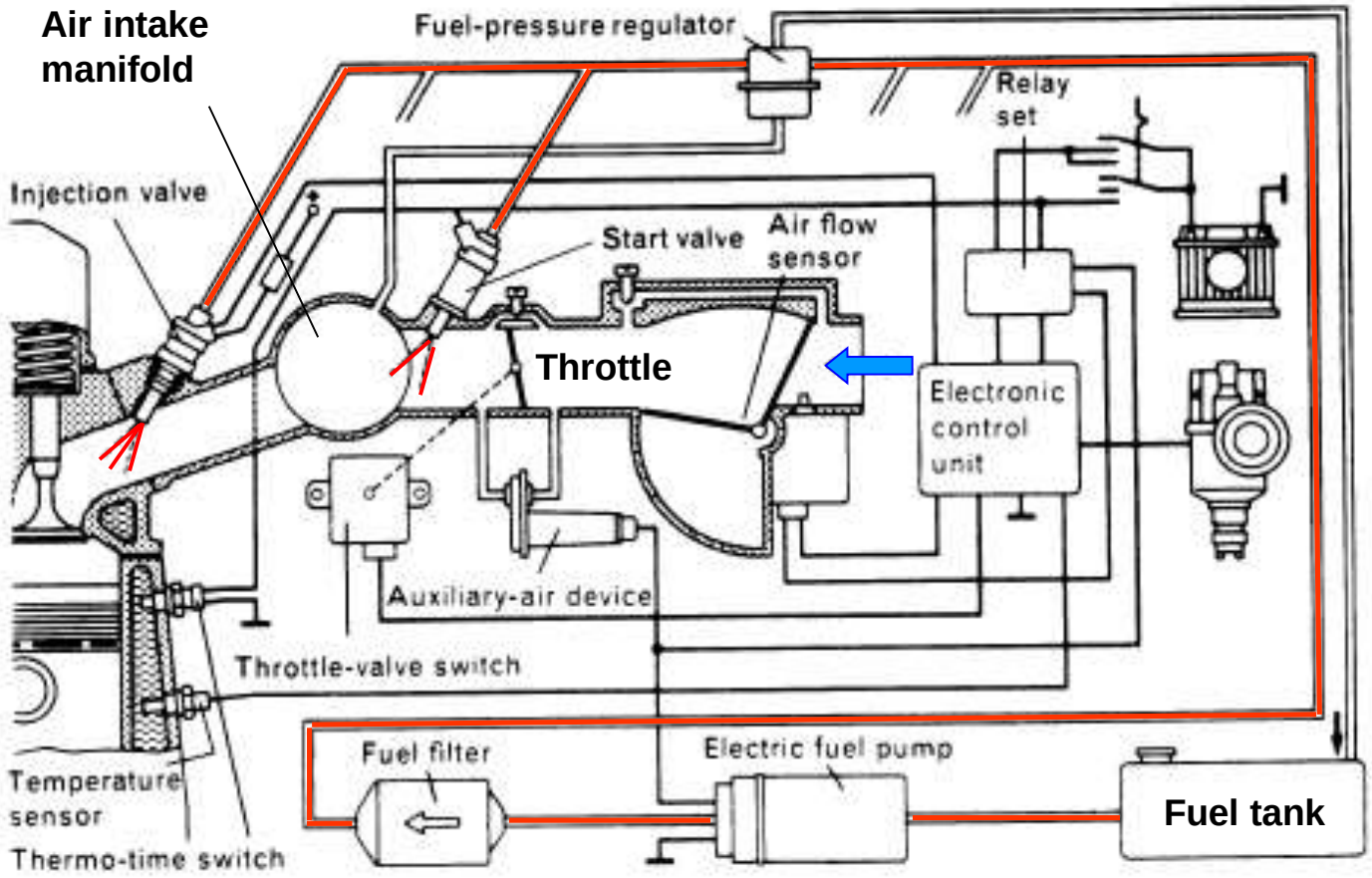
Pressure in the intake manifold is varied by opening and closing the throttle plate to change the pressure drop. Maximum air flow (and power) achieved at wide-open-throttle (WOT). Minimum air flow at idle



Basic Carburetor Design

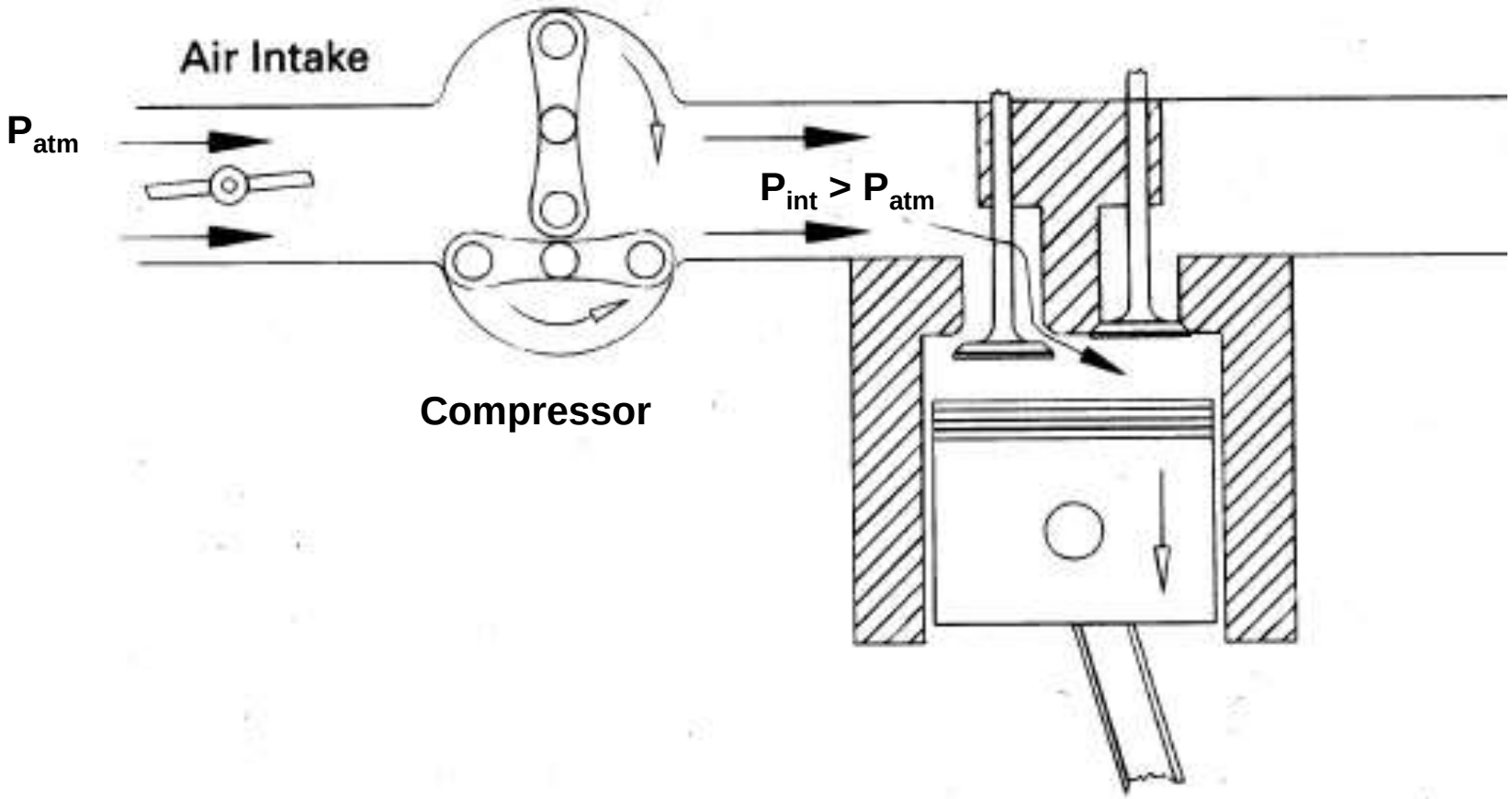


Fuel Injection System

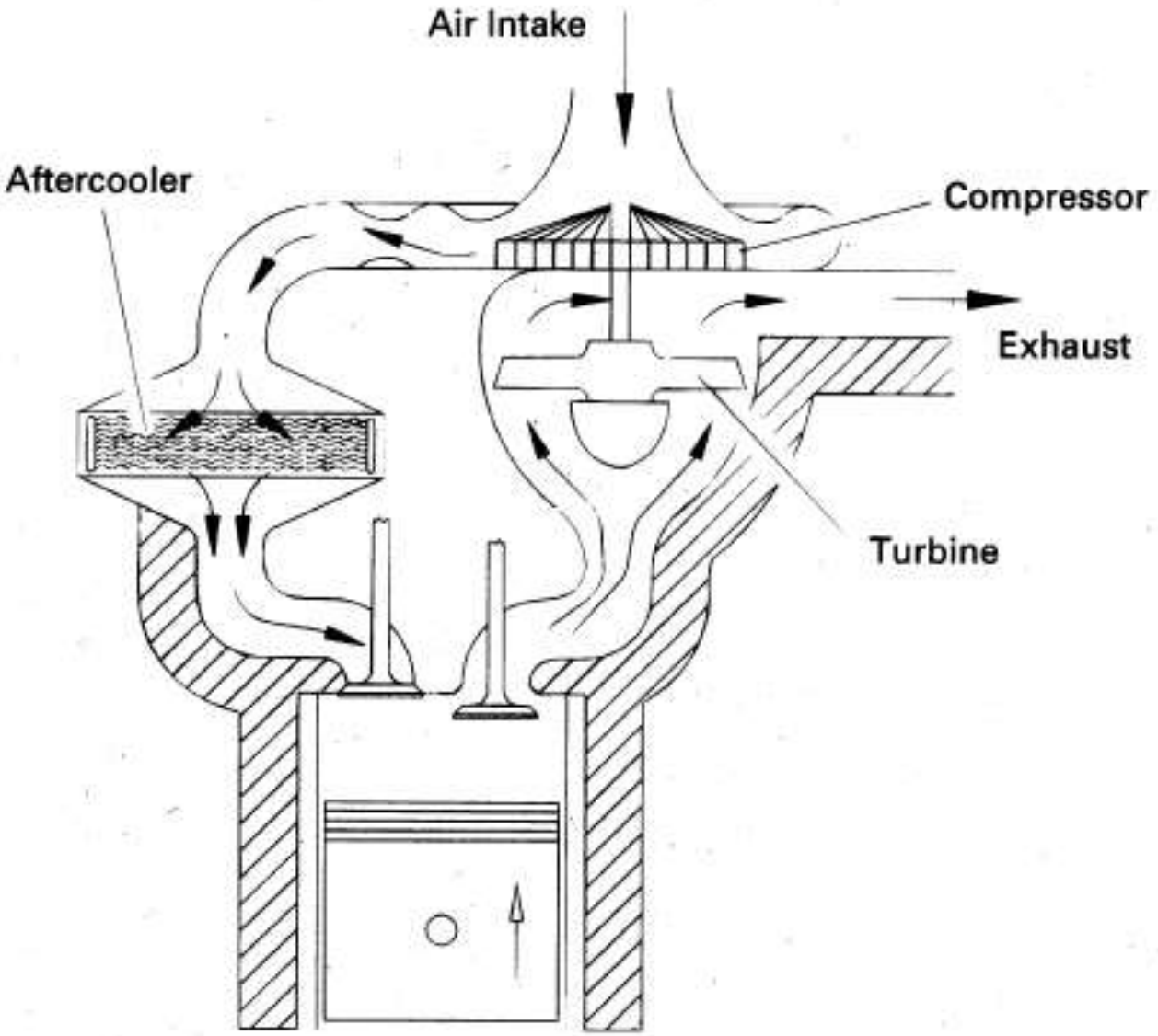


During start-up the components are cold so fuel evaporation is very slow, as a result additional fuel is added through a second injecting valve

Superchargers are compressors that are mechanically driven by the engine crankshaft and thus represent a parasitic load.



Turbochargers couple a compressor with a turbine driven by the exhaust gas. The compressor pressure is proportional to the engine speed



The peak pressure in the exhaust system is only slightly greater than atmospheric – small ΔP across turbine.

In order to produce enough power to run compressor the turbine speed must be very fast (100k-200k rev/min). It takes time for the turbine to get up to speed so when the throttle is opened suddenly there is a delay in achieving peak power - **Turbo lag.**

Waste gate valve controls the exhaust gas flow rate to the turbine.
It is controlled by the intake manifold pressure