

MA0013 Fall 2018

Applied Laboratory for Mechanical Engineering 1

Introduction to Internal Combustion Engines

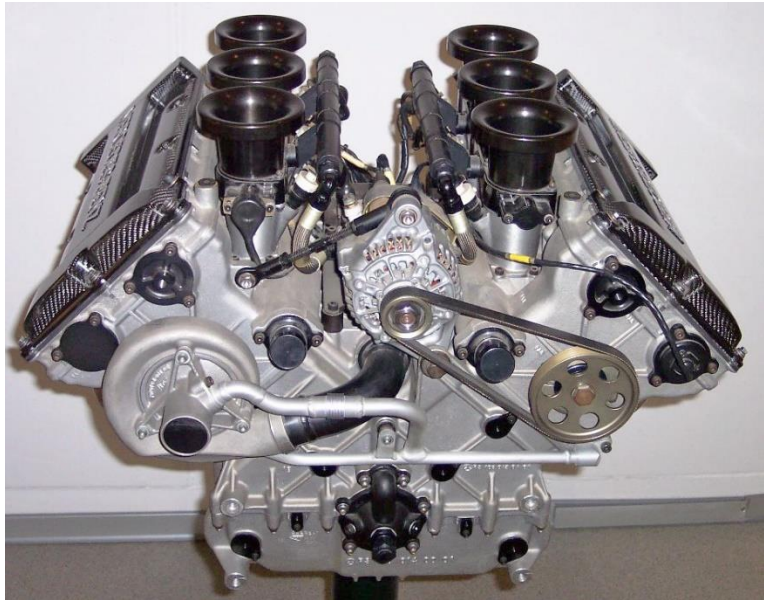
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Introduction

- External combustion engines
 - Steam engines
 - Some gas turbine engines
- Internal combustion engines
 - Reciprocating engines
 - Rotary engines
 - Rocket engines
 - Jet engines
 - Firearms
- Fuel cells
- Hybrid vehicles

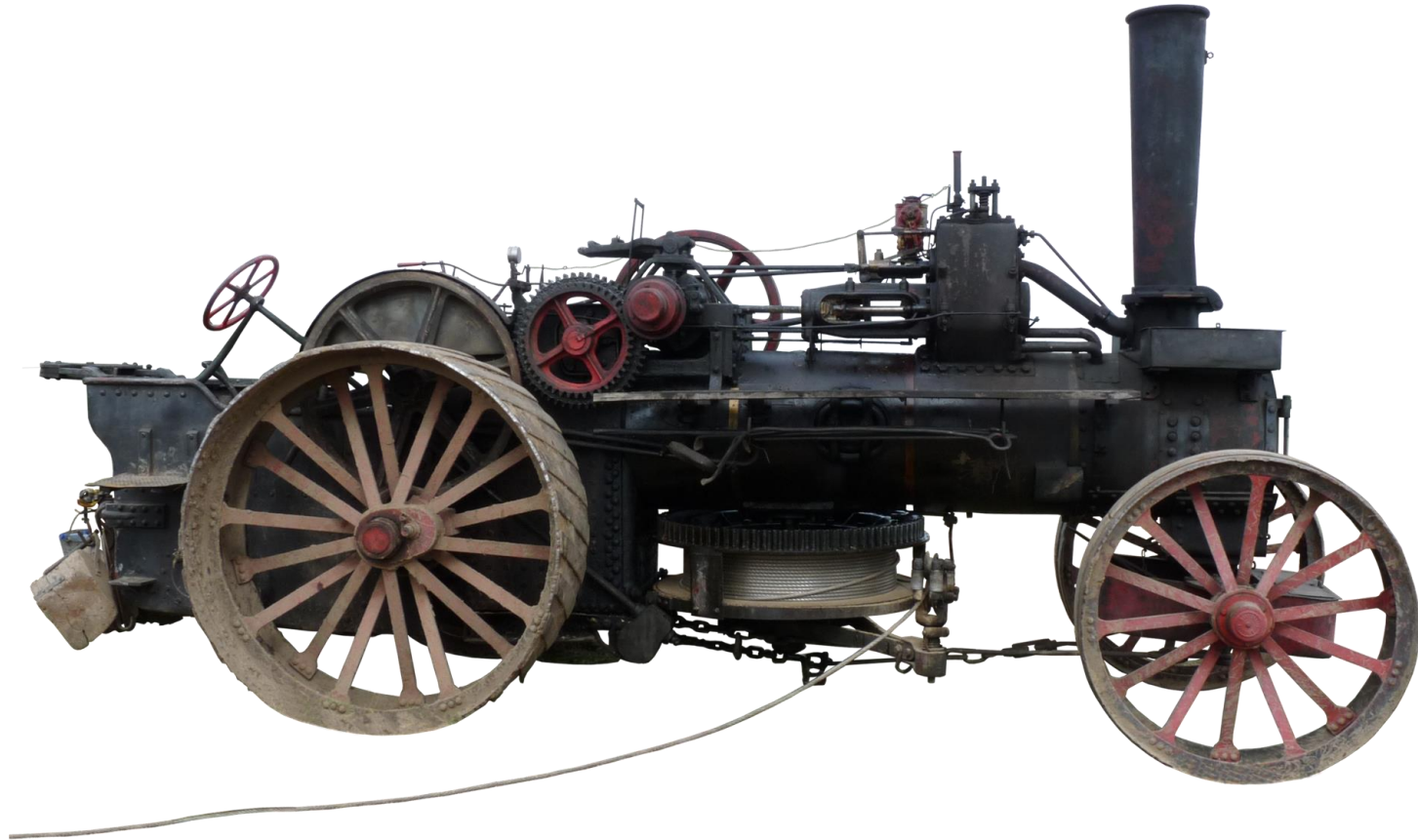


A V6 internal combustion engine from a Mercedes-Benz
<https://en.wikipedia.org/wiki/Engine>

Internal Combustion Engines

- A heat engine that converts **chemical energy** in a fuel into **mechanical energy**
 - Chemical energy -> Thermal energy (Combustion)
 - Thermal energy -> Mechanical energy through temperature and pressure rise
 - Thermal expansion -> Rotating crankshaft by mechanical linkages
 - Crankshaft -> Transmission or power train
(Mechanical energy -> final use)
 - Final use
- Cf) Heat engine: A device that operates in a thermodynamic cycle and does a net positive work through heat transfer from a high-temperature body to a low-temperature body

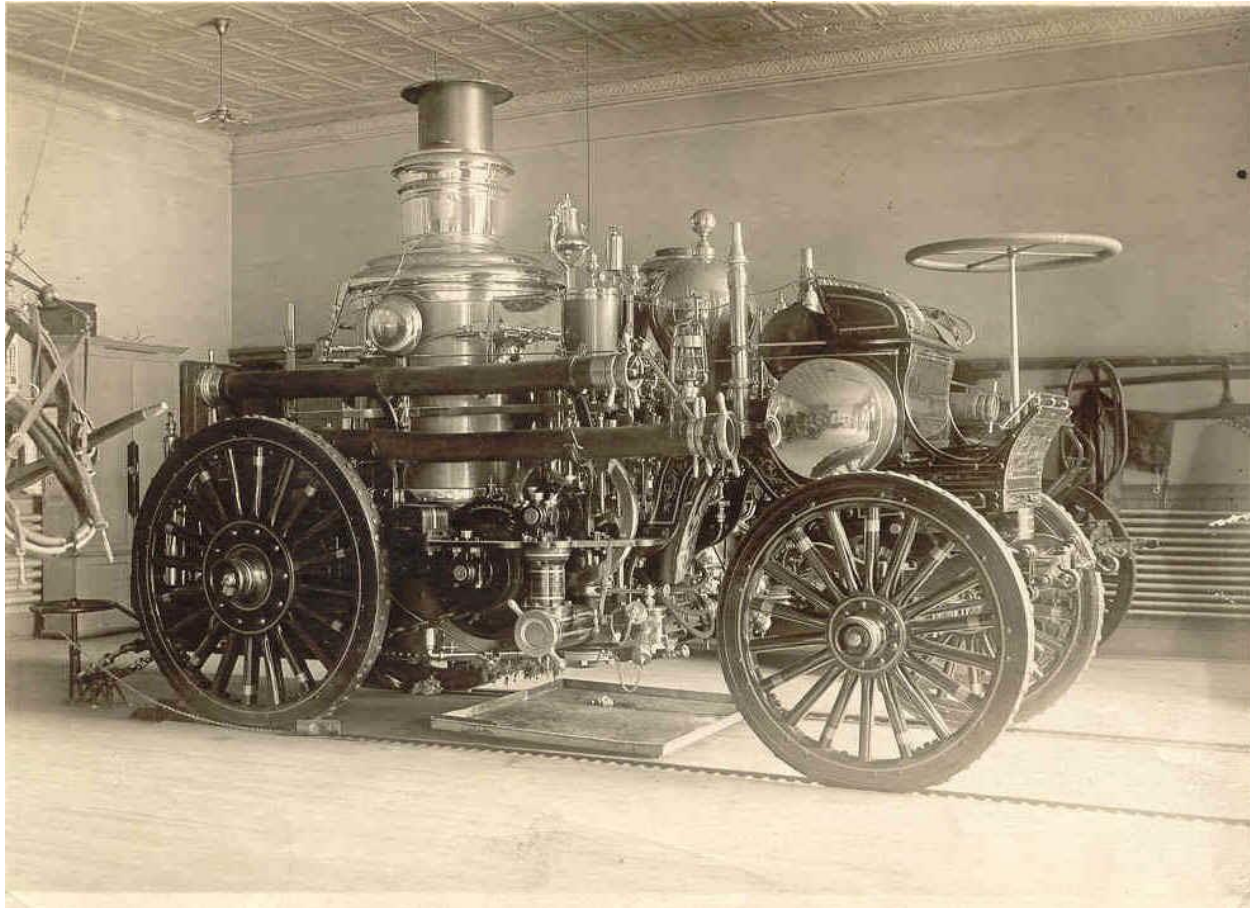
Steam Engines



Steam powered agricultural ploughing device

https://en.wikipedia.org/wiki/Steam_engine

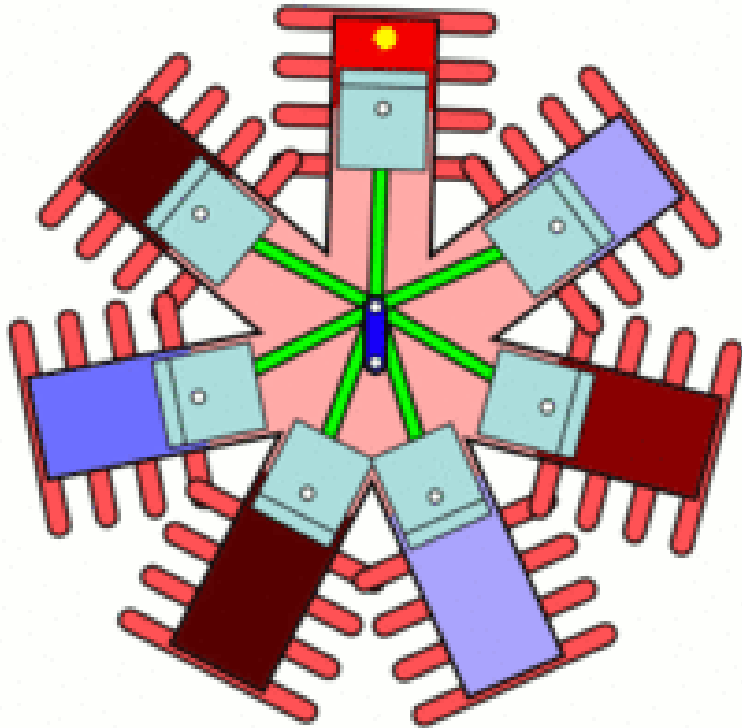
Steam Engines



Engine 5 in use from 1903 to 1924

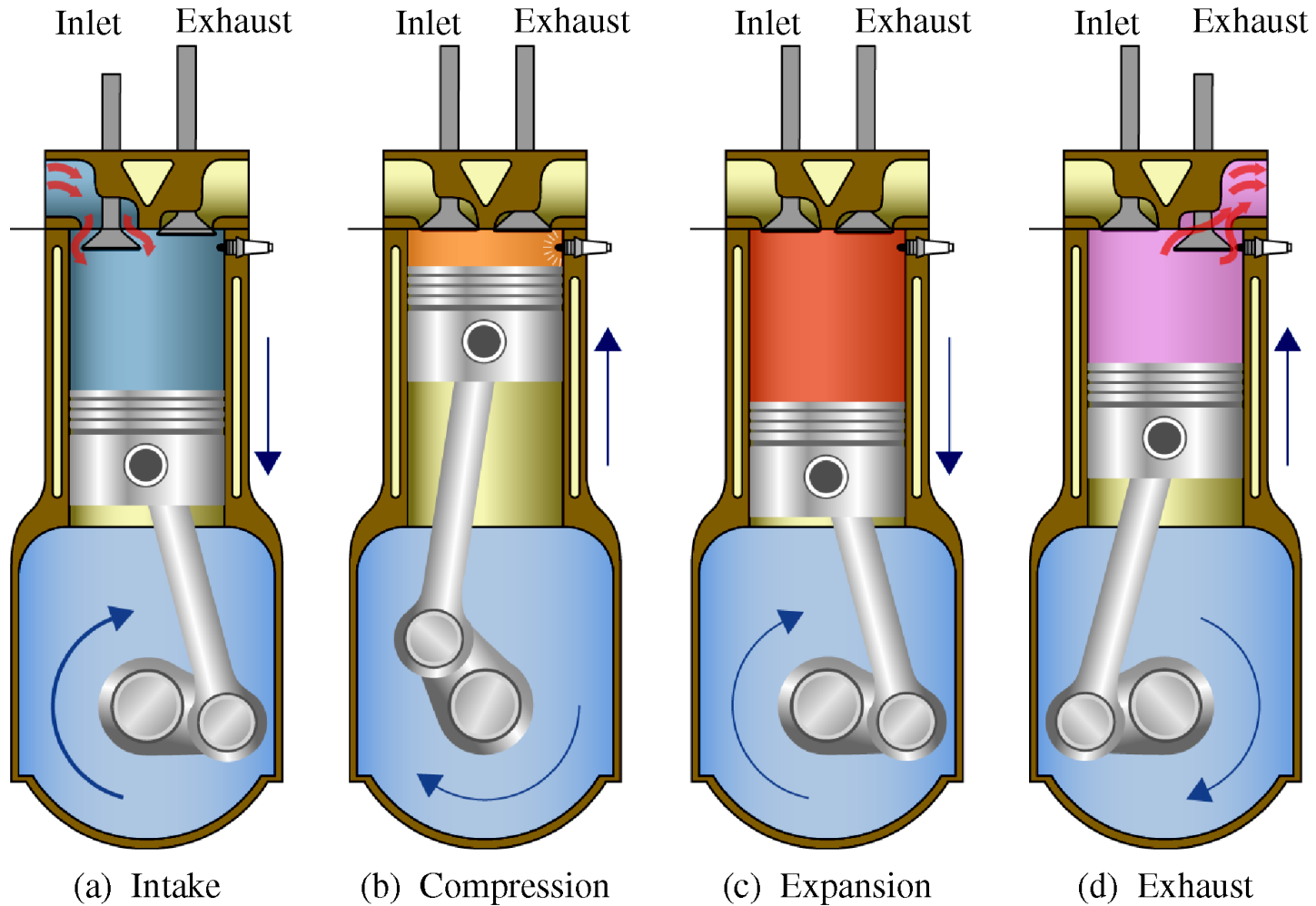
Source: portlandfiremuseum

Rotary Engines

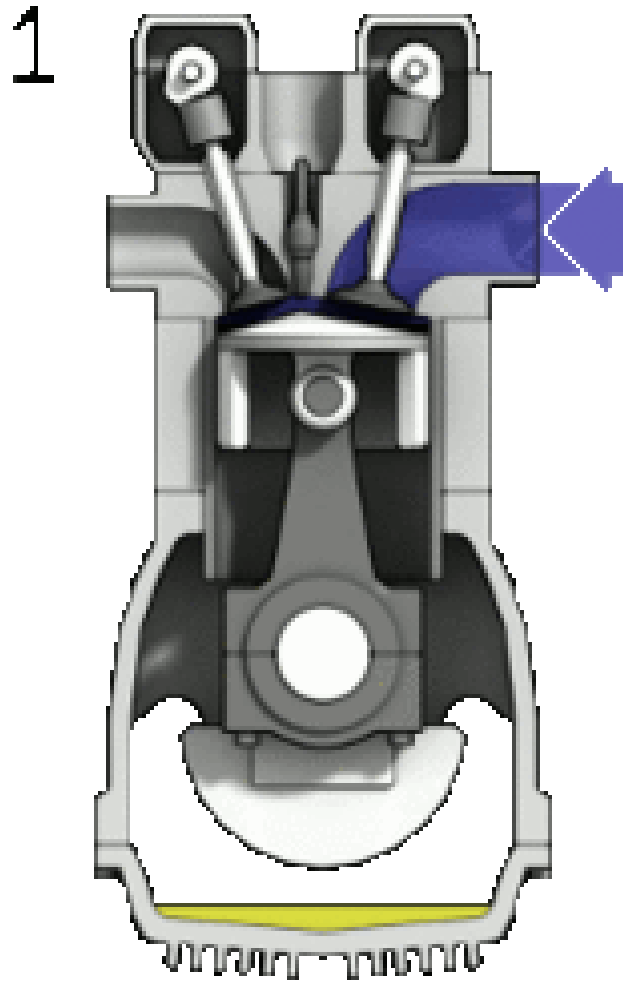


Megola motorcycle with rotary engine mounted in the front wheel

Reciprocating Engines



Reciprocating Engines



Reciprocating Engines

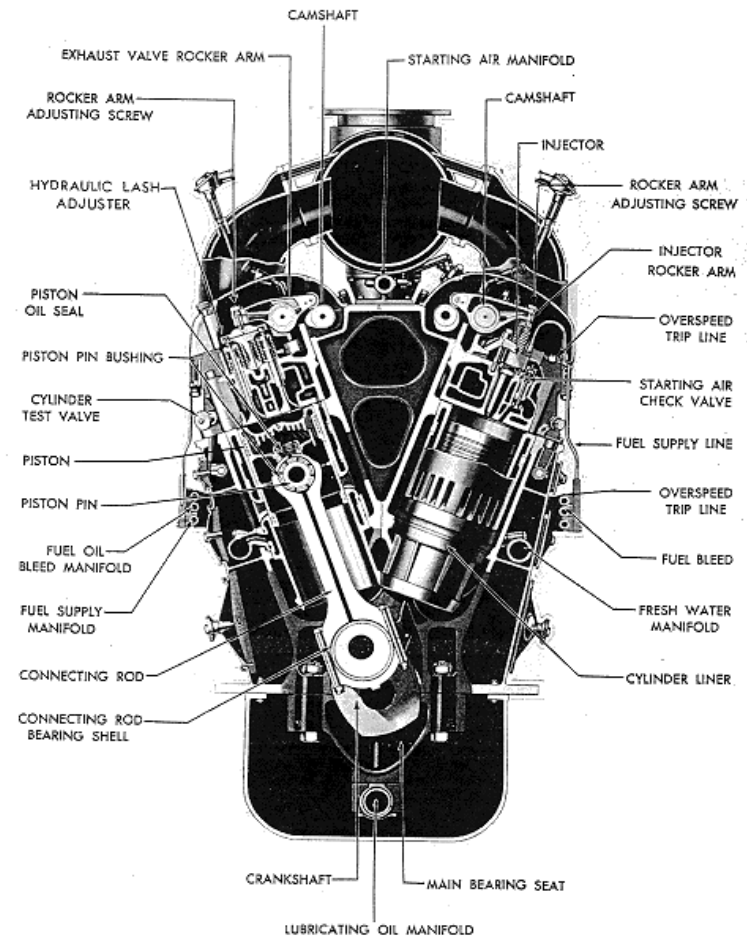
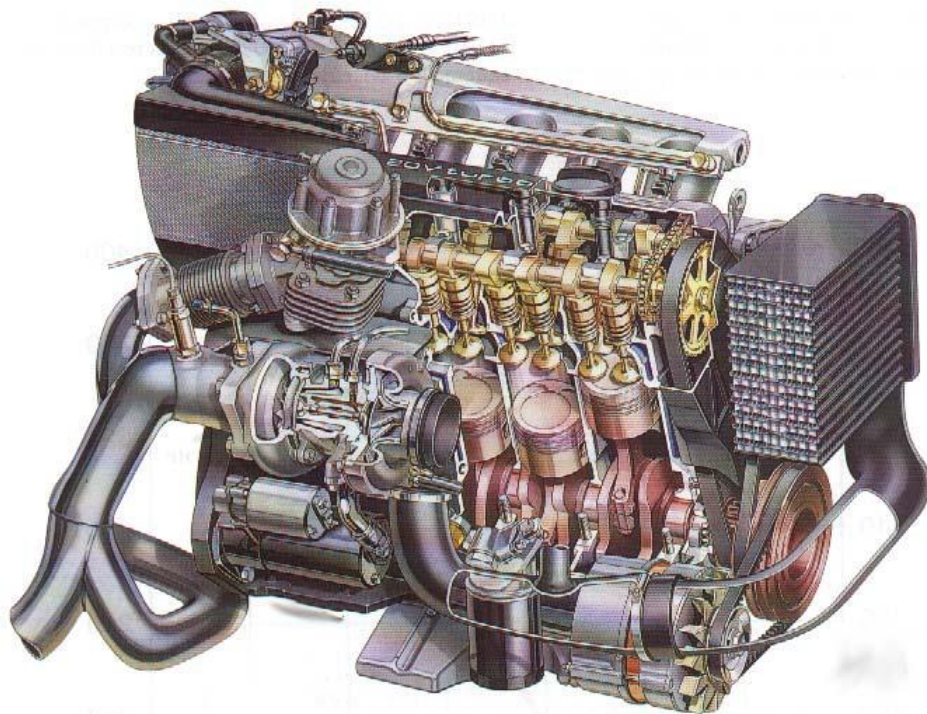
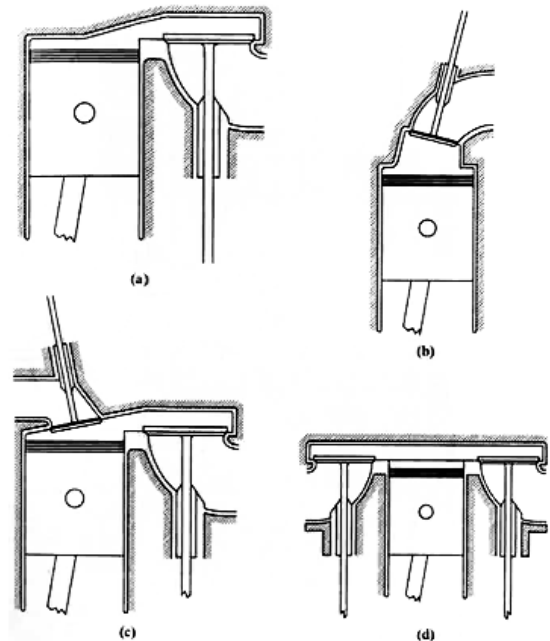


Figure 3-7. Cross section of GM 16-278A engine.

Harold Schock, Michigan State University

Engine Classifications

- Type of ignition
 - Spark ignition (SI)
 - Compression ignition (CI)
- Engine cycle
 - Four-stroke cycle
 - Two-stroke cycle
 - Cf) Three- or six-stroke cycles were attempted in the past
- Valve location
 - I head: Valve in head or overhead valve
 - L, T heads: Valve in block or flat head
 - F head



Engine Classifications

- Basic design
 - Reciprocating
 - Rotary
- Position, number of cylinders (See figure)

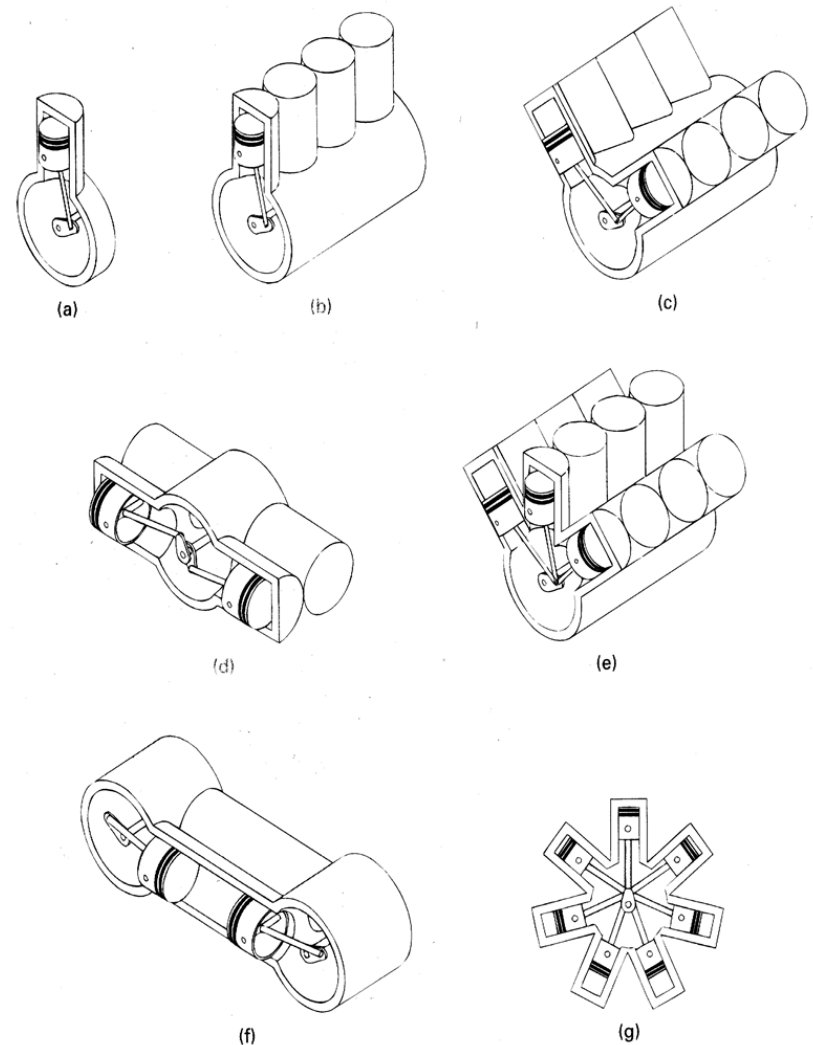


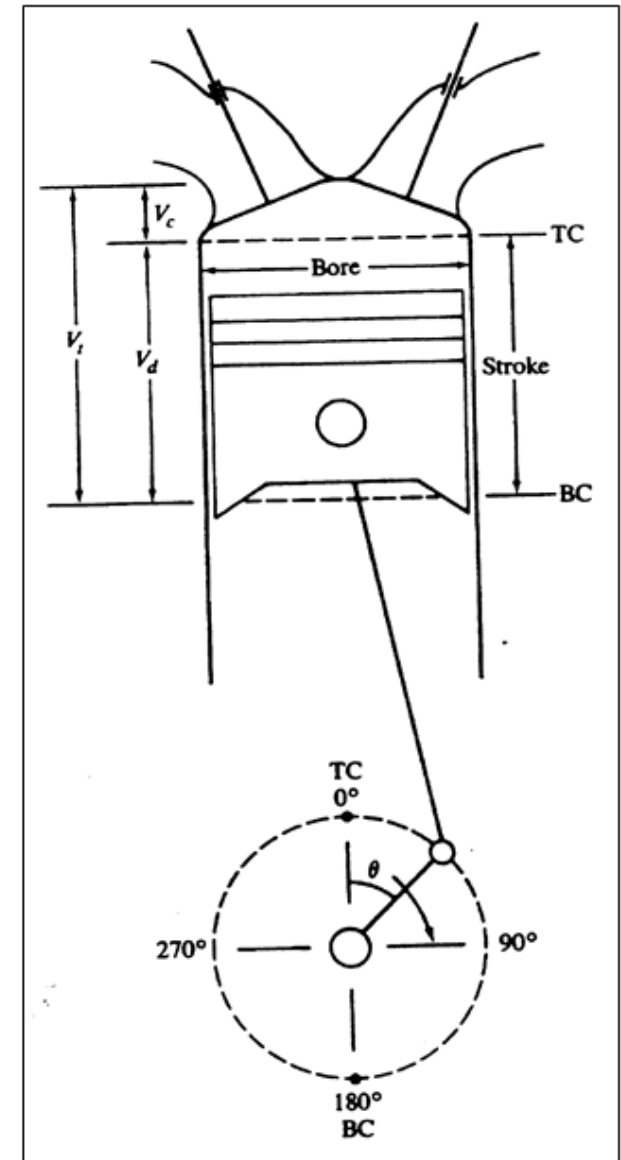
Figure 1-7 Engine Classification by Cylinder Arrangement. (a) Single cylinder. (b) In-line, or straight. (c) V engine. (d) Opposed cylinder. (e) W engine. (f) Opposed piston. (g) Radial.

Terminology and abbreviation

- 상사점 (Top-dead-center (TDC),
a.k.a. Top-center (TC),
Head-end-dead-center (HEDC))
- 하사점 (Bottom-dead-center (BDC),
a.k.a. Bottom-center (BC),
Crank-end-dead-center (CEDC))
- 행정 (Stroke): l
- 보어 (Bore): d
- 연소실체적 (Clearance Volume) : V_c
- 행정체적 (Stroke or Displaced Volume): V_d

$$\text{압축비} (r_c) = \frac{V_d + V_c}{V_c}$$

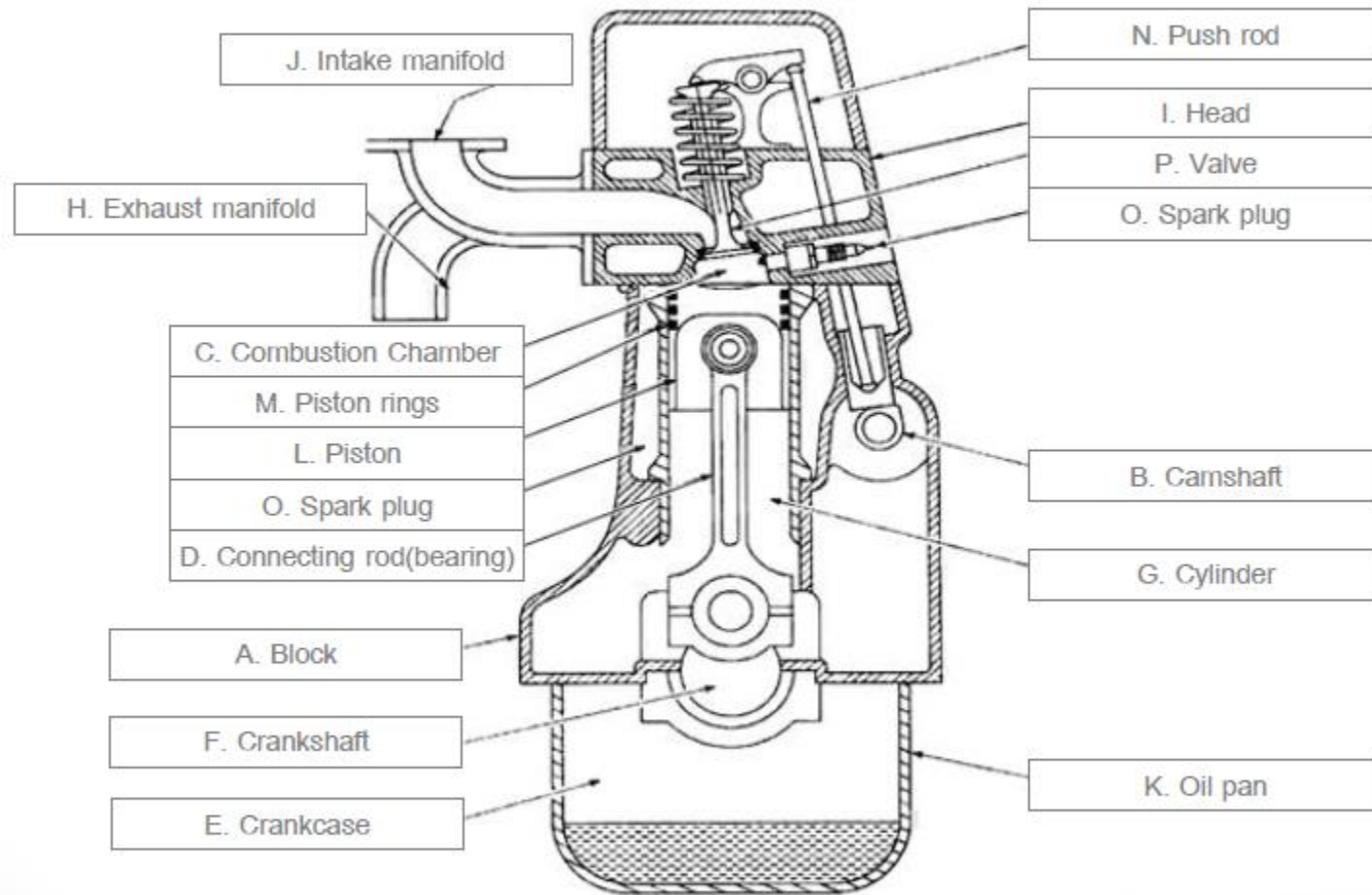
$$\text{총배기량}(V) = \frac{\pi}{4} d^2 l \times z$$



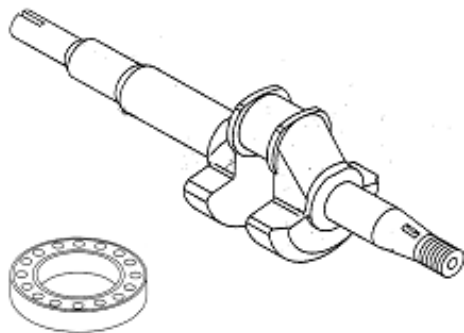
Engine Components

- An engine at least needs to include the following systems to be operated:
 - Air supply and exhaust system
 - Fuel supply system
 - Combustion system
 - Ignition system (for SI engines)
 - Cooling system
 - Lubrication system
 - Starting system
 - Electrical power supply system (battery and generator)

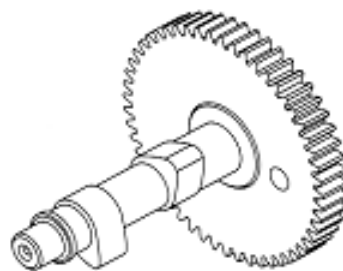
Engine Components



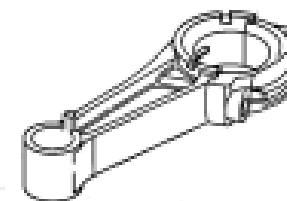
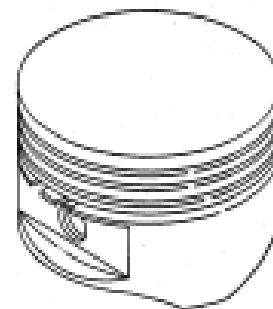
Engine Components



Crankshaft

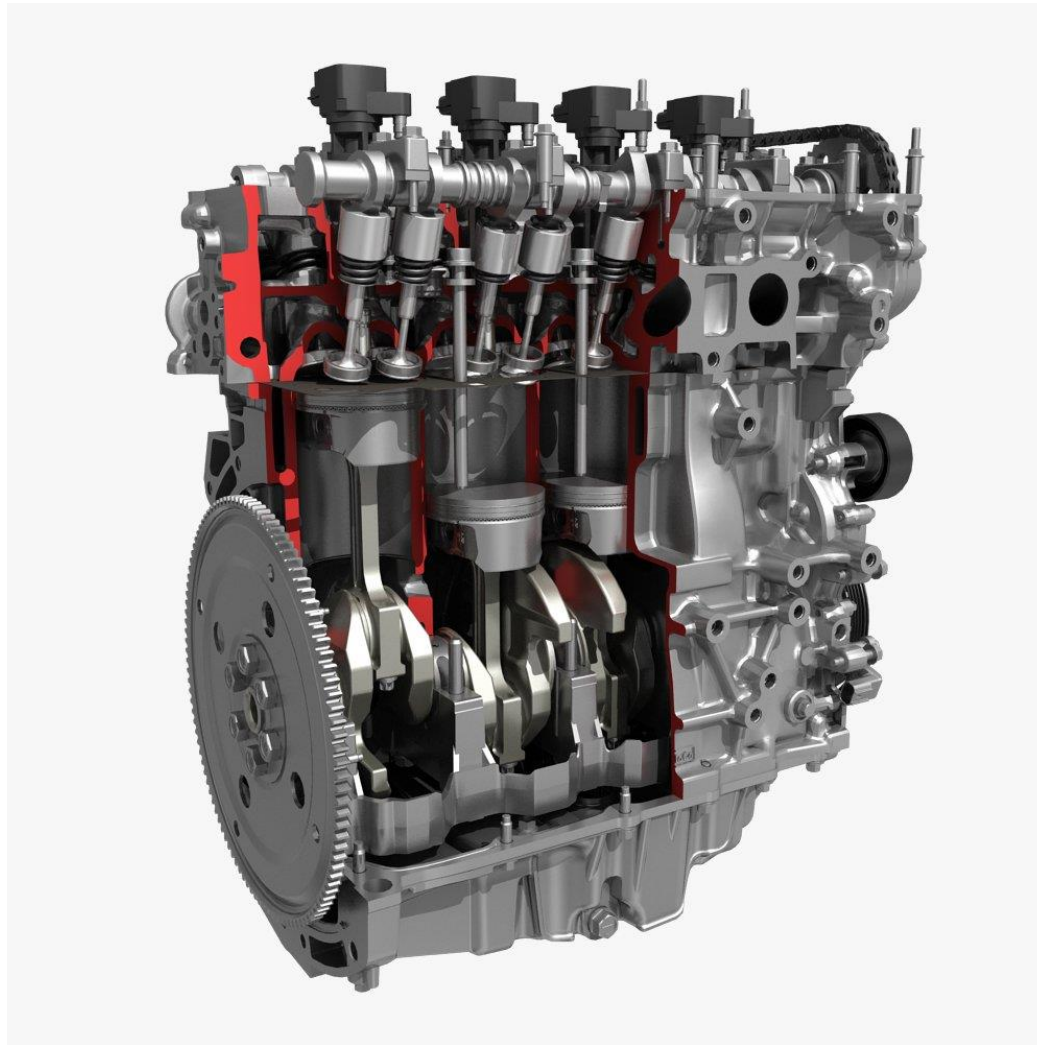


Camshaft



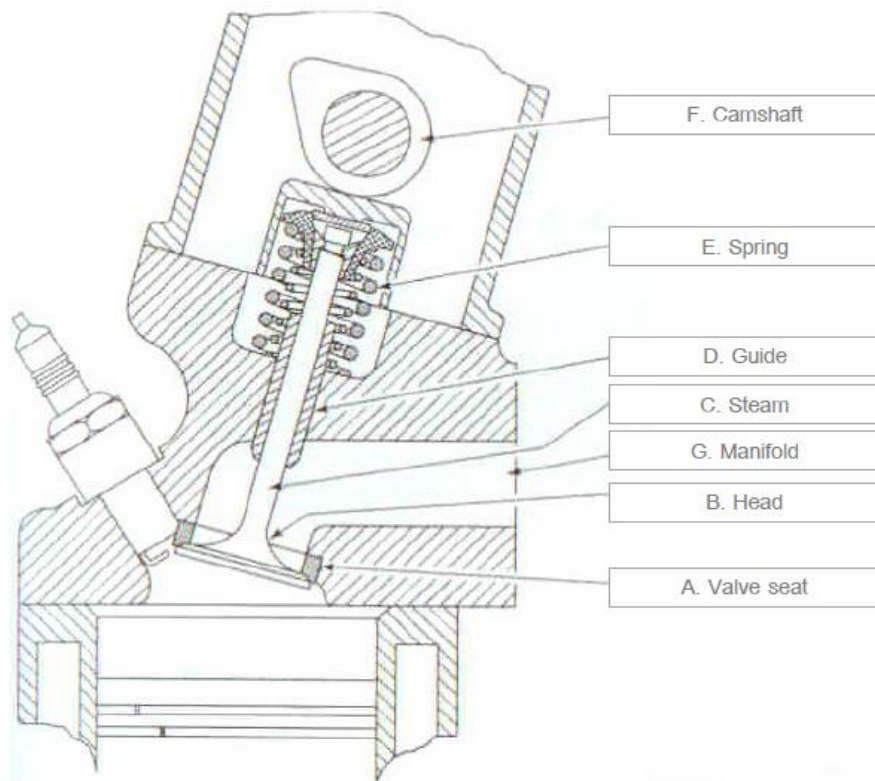
Piston assembly

Engine Cutaway

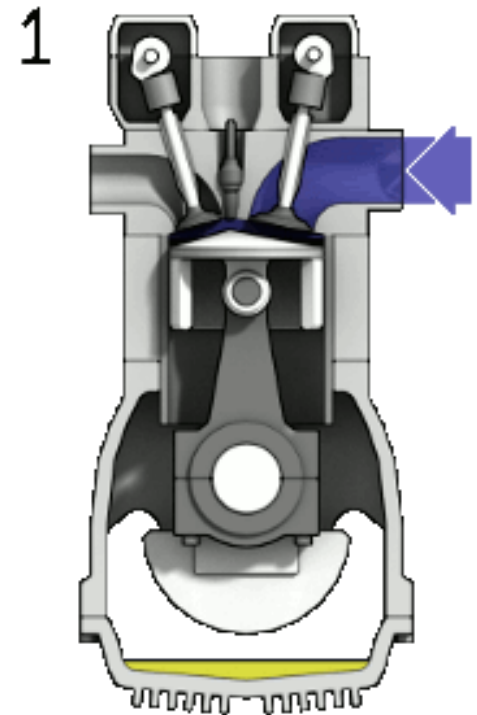


4 Cylinder Engine Block Cutaway

Valve Components

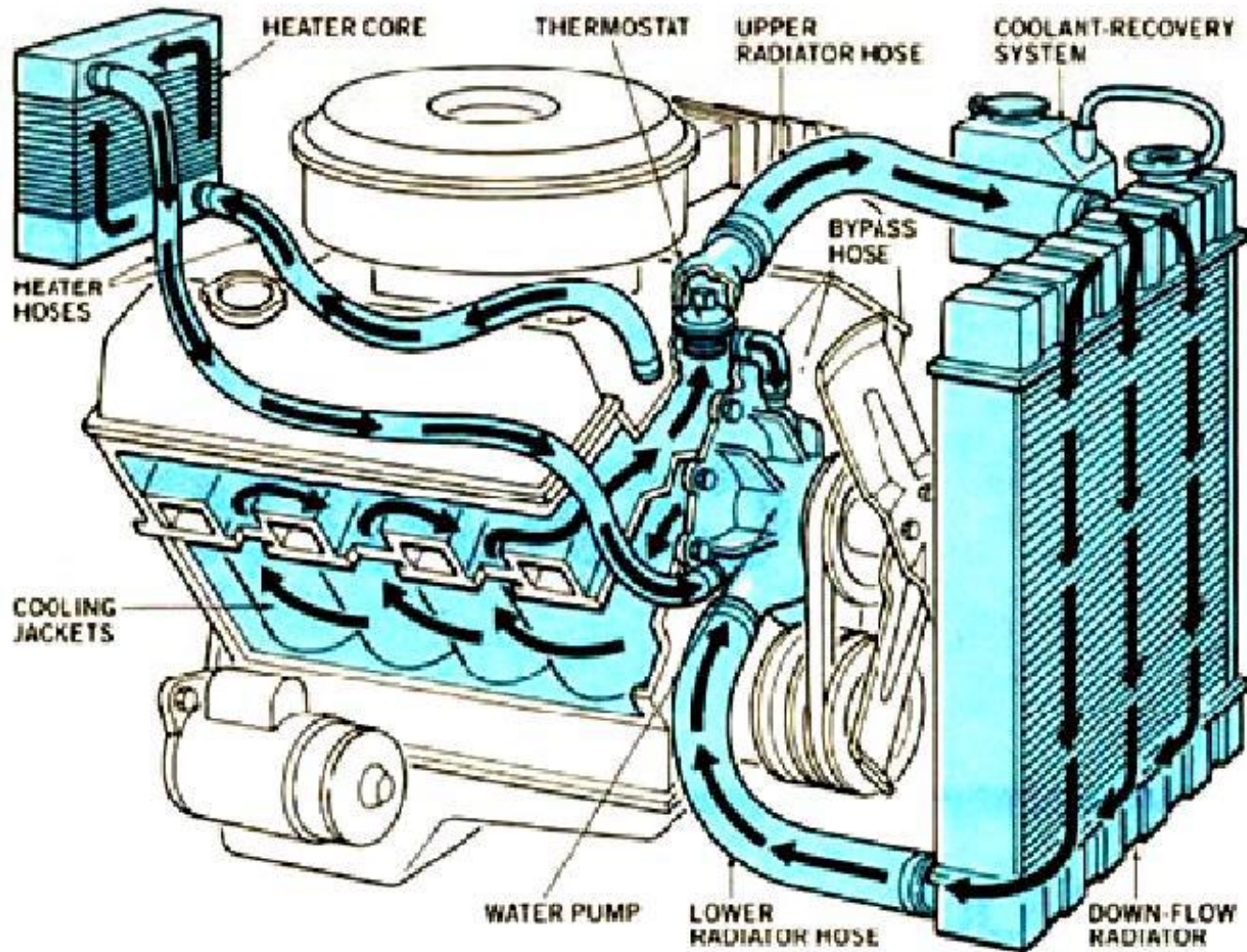


Poppet valve



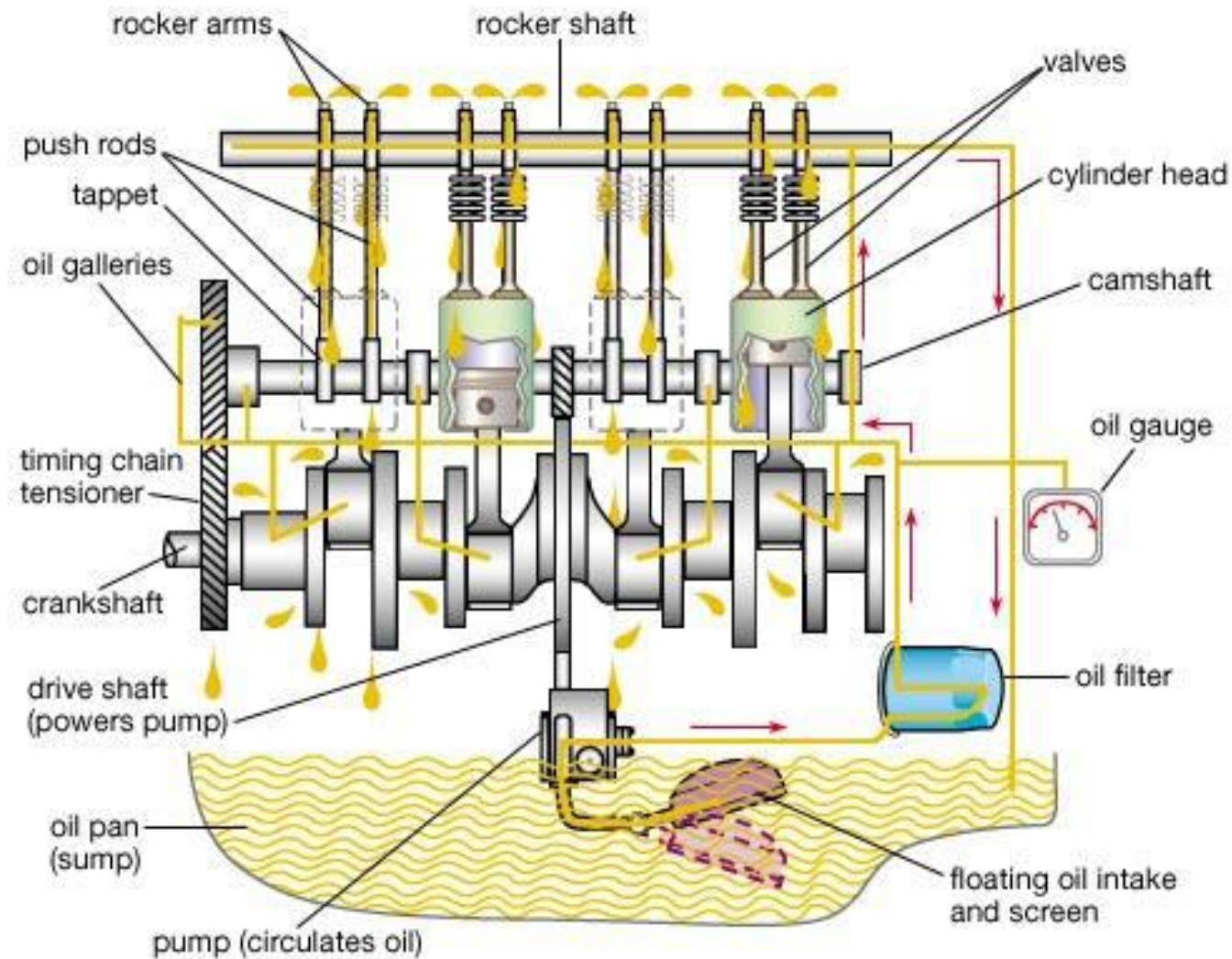
Poppet valves in action at the top of the cylinder

Engine Cooling System



Cooling fins, radiator, fan, water pump

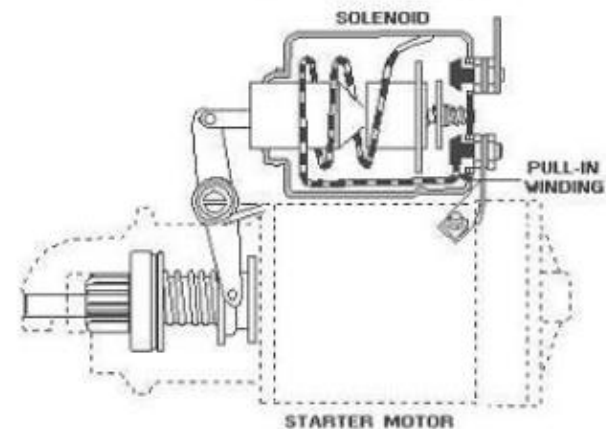
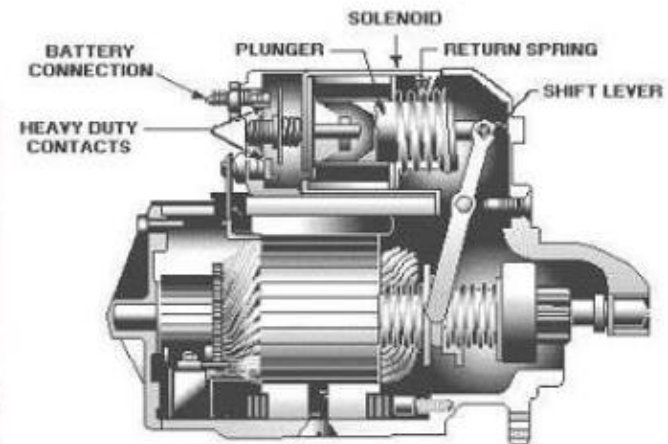
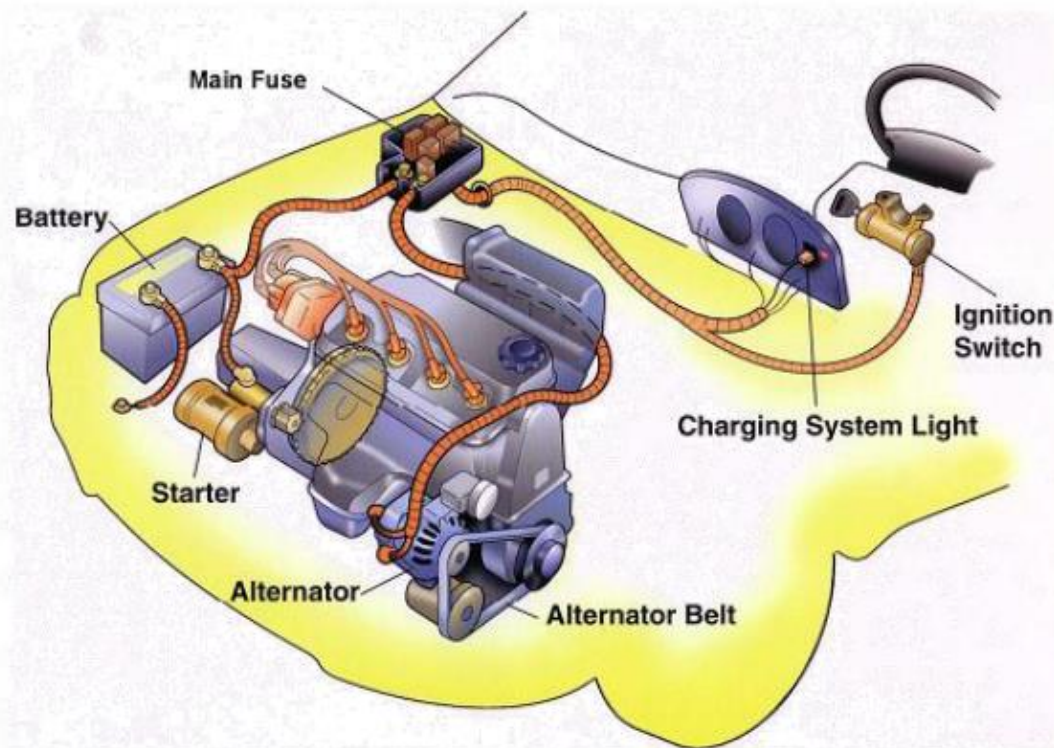
Lubrication System



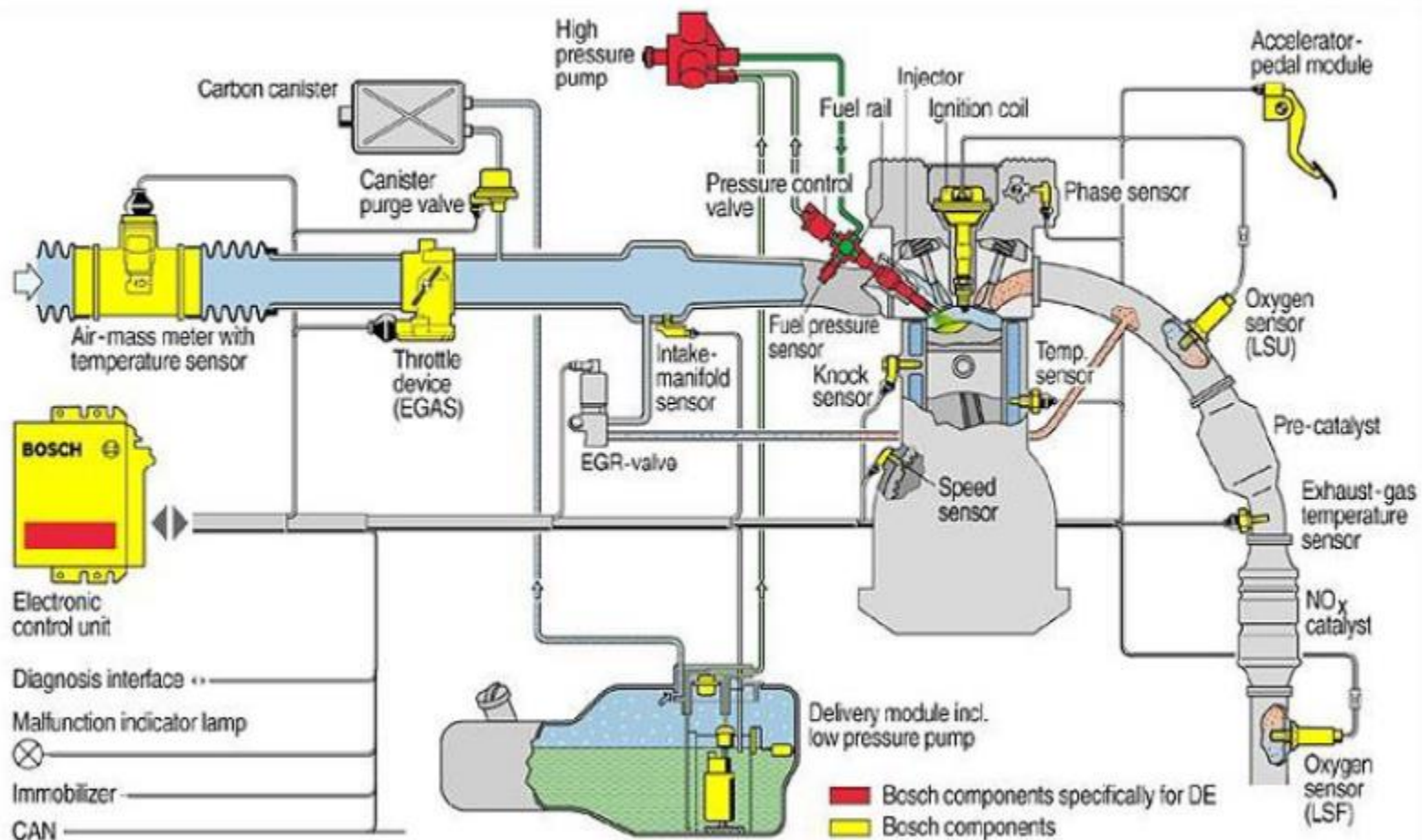
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Oil pump, oil sump

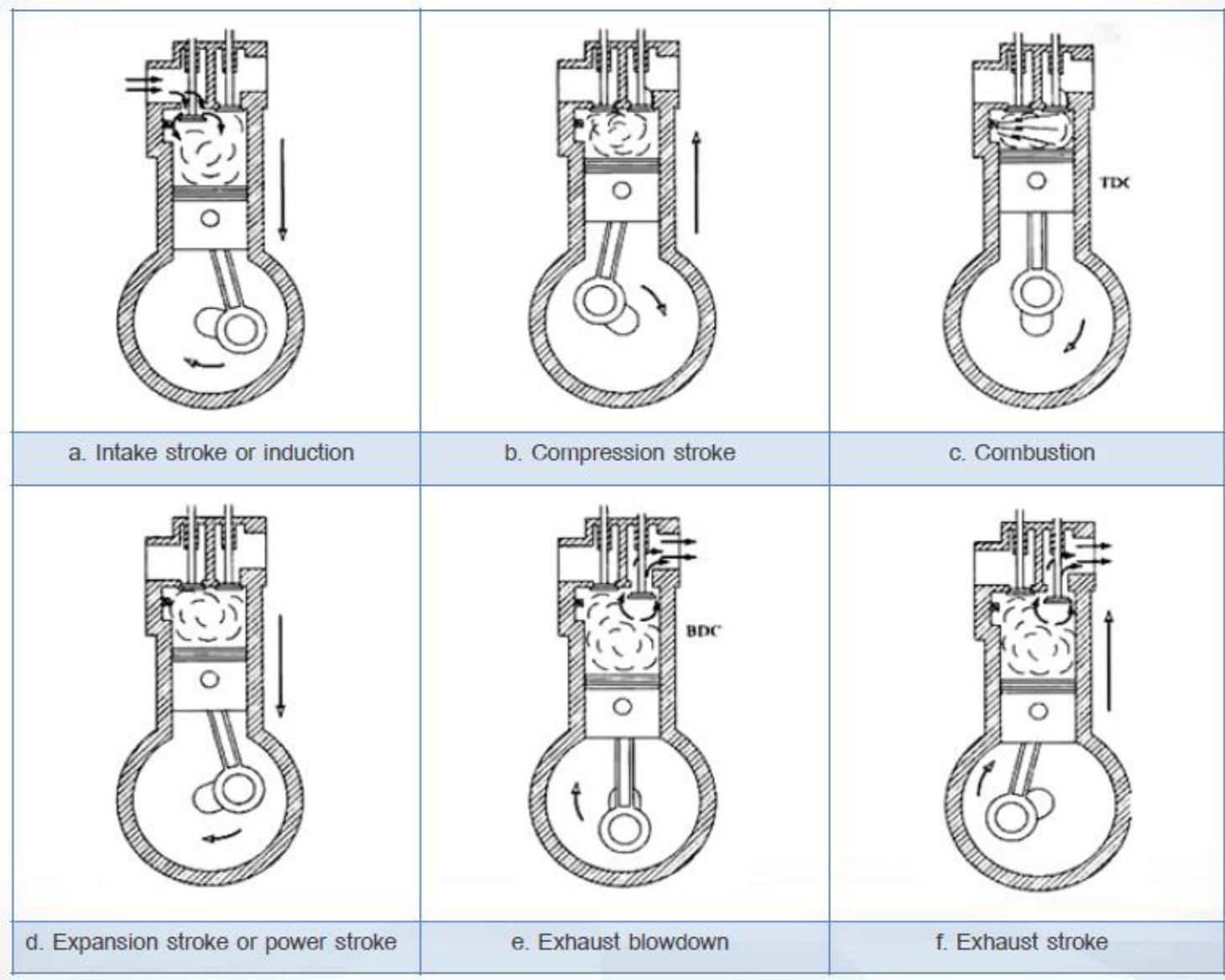
Engine Starting and Charging System



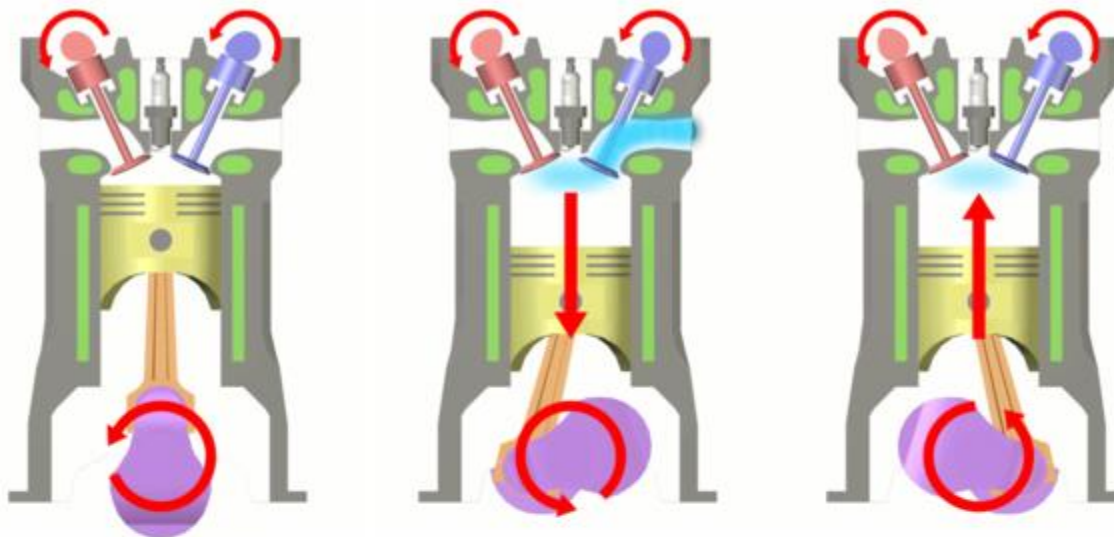
Engine Management System



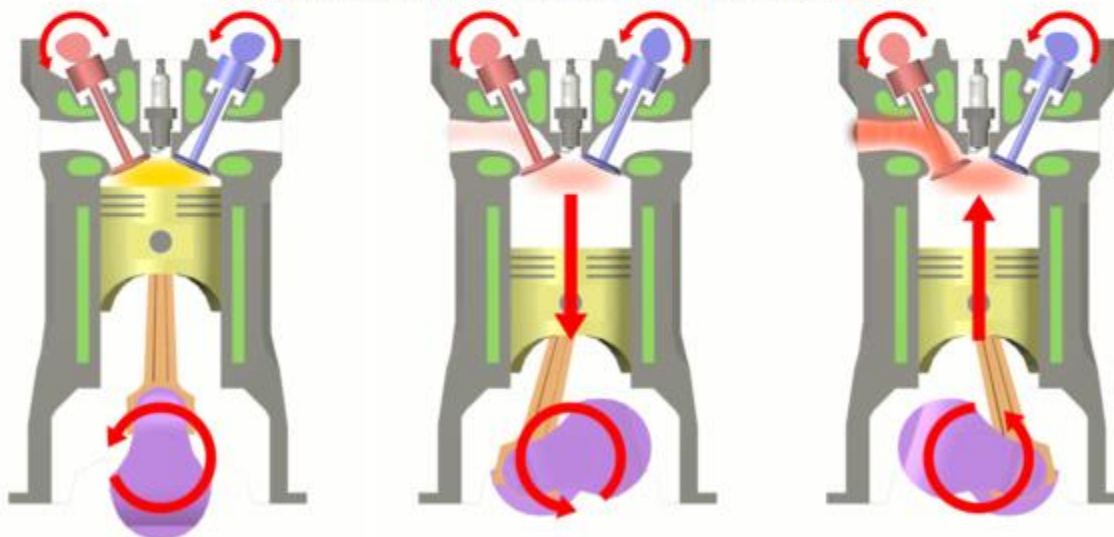
Four-Stroke SI Engine Cycle



Four-Stroke SI Engine Cycle

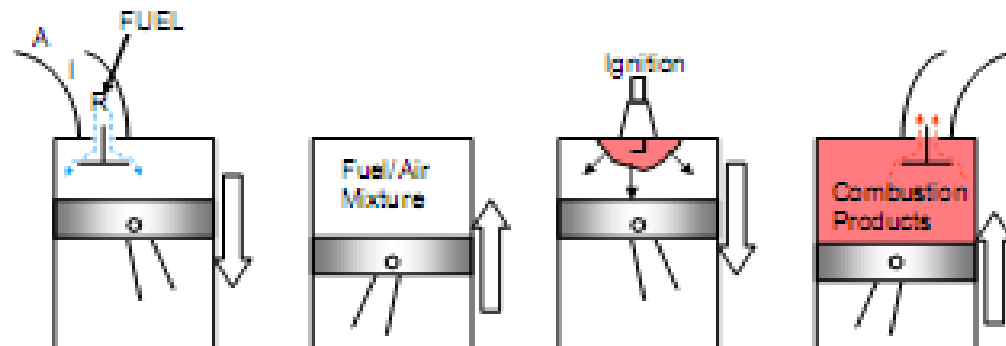


Starting position, intake stroke, and compression stroke.

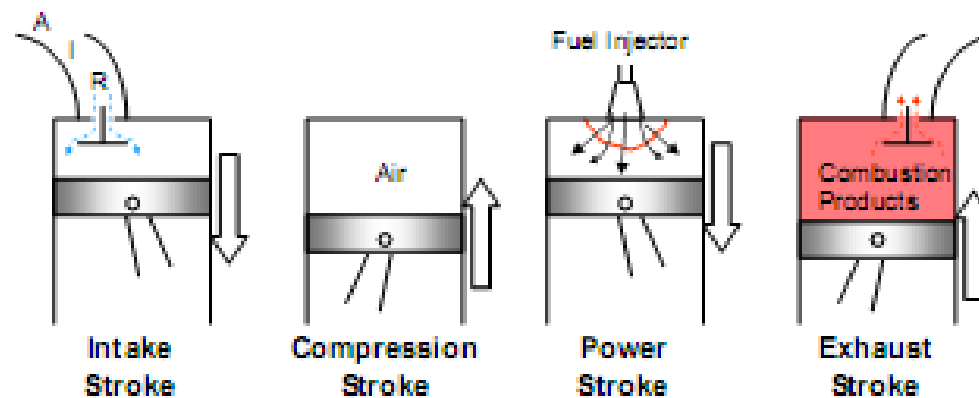


Ignition of fuel, power stroke, and exhaust stroke.

Four-Stroke CI Engine Cycle

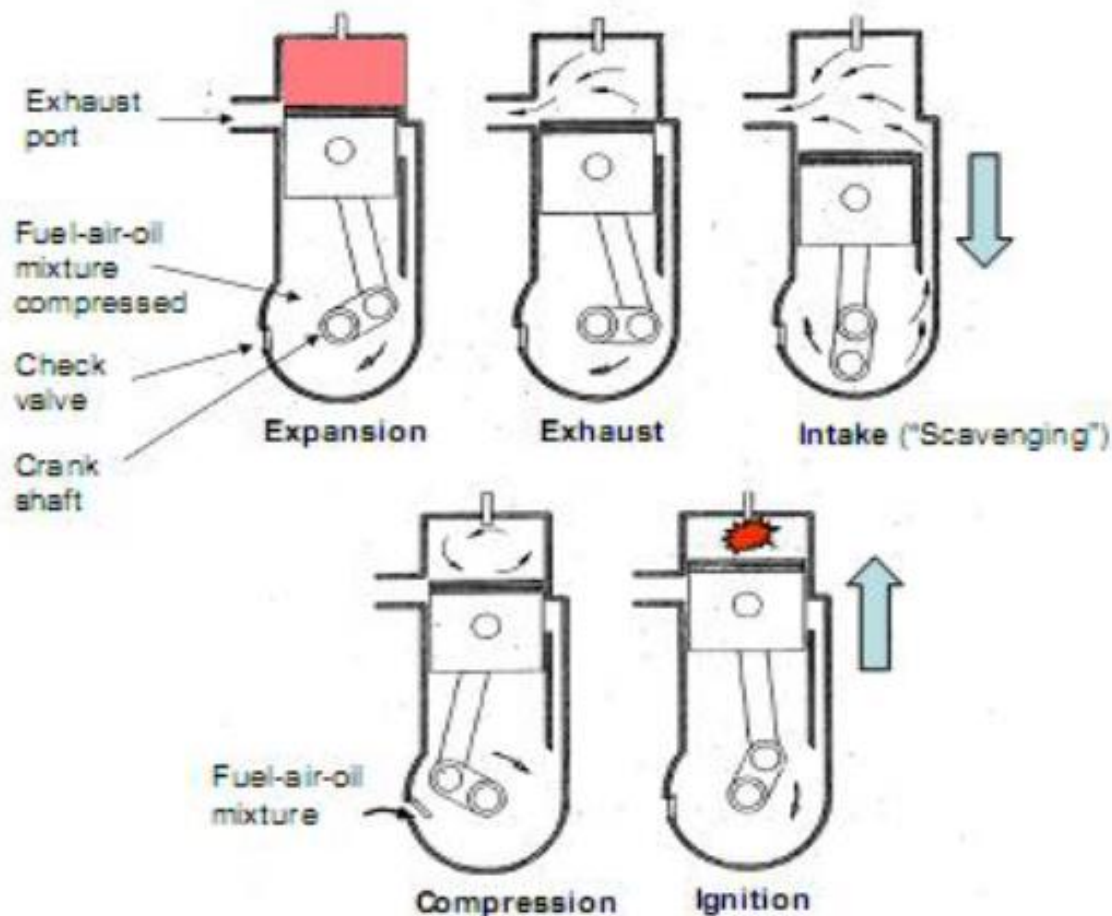


SI



CI

Four-Stroke CI Engine Cycle



CI: No fuel mixture and fuel injector in place of spark plug

Thank you