Internal Combustion Engine 1

Mechanical Engineering Department

Palestine Technical University – Kadoorie (PTUK)

Dr. Hammam Daraghma

Assistant Professor

Lecture Outlines

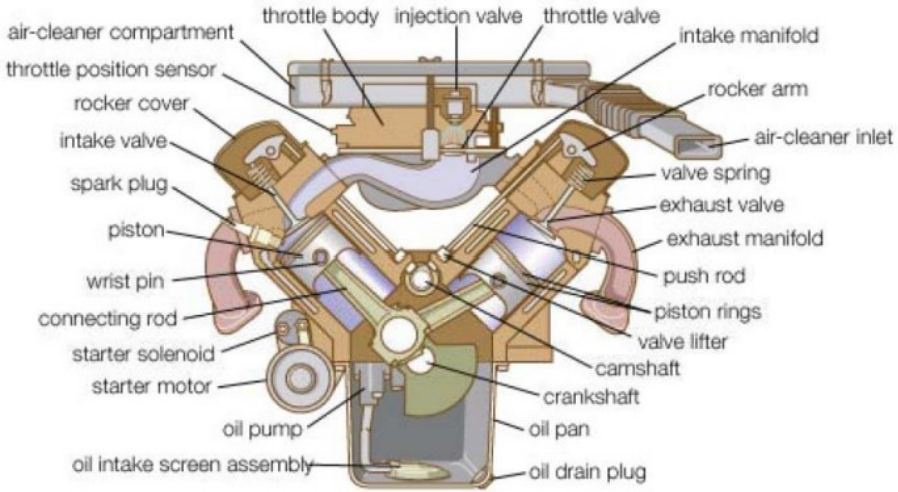
- Basic Engine Components
- IC Engine Construction - Stationary Parts
- IC Engine Construction - Moving Parts

Basic Engine Components

Basic Engine Components

- Cylinder Block
- Cylinder Head
- Crankshaft
- Camshaft
- Timing Chain
- Bearing Shell
- Oil Pump
- Water Pump
- Fly Wheel
- Valves
- Valve Springs
- Pistons
- Connecting Rod
- Piston Ring
- Cylinder Sleeve
- Inlet Manifold
- Exhaust Manifold
- Rocker Arm

Basic Engine Components



IC Engine Construction

IC Engine Construction

Engine construction can be broken down into two categories:

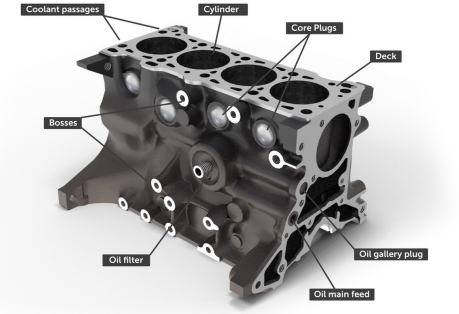
- **Stationary Parts**
  - The stationary parts of an engine include:
    - Cylinder block
    - Cylinders
    - Cylinder head
    - Crankcase
    - Oil Sump
    - Manifolds
    - Gasket
  - These parts furnish the framework of the engine.
  - All movable parts are attached to or fitted into this framework.
- **Moving Parts**

  Contains three groups according to their motion:
  - Reciprocating only
    - Pistons
    - Valves
  - Reciprocation and rotary
    - Connecting Rod
  - Rotary only
    - Crankshafts
    - Camshafts and Cams
    - Engine Bearing
    - Flywheel

Stationary Parts

Cylinder Block

- "Backbone" of the engine:
  - Supports / aligns most other components.
- Contains:
  - Cylinders
  - Coolant passages
  - Oil passages
  - Bearings
- One-piece, gray cast iron

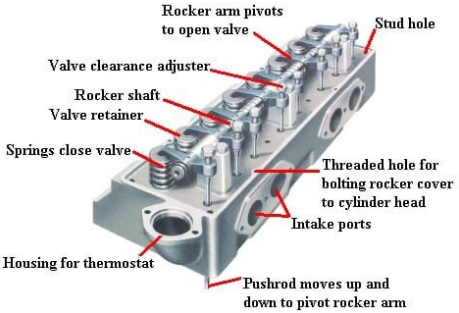


Cylinders

- Cylindrical holes in which the pistons reciprocate.
- May be
  - En-block
  - Liners
    - Wet Liners
    - Dry liners
- Cylinder bore – diameter of cylinder

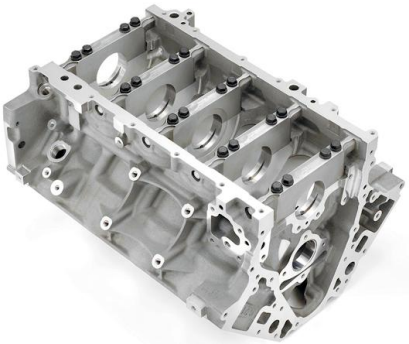
Cylinder Head

- Seals the “top-end” of the combustion chamber.
- Head bolts and head gasket ensure air-tight seal of the combustion chamber.
- Contains the valves and the intake and exhaust “ports”.
- Contains oil and coolant passages.
- One–piece castings of iron alloy.



Crankcase

- The Crankcase is that part of the engine block below the cylinders.
- It supports and encloses the crankshaft and provides a reservoir for the lubricating oil.
- Contains a place for mounting: Oil pump, Oil filter, Starting motor.
- The lower part of the crankcase is the **Oil Sump**, which is bolted at the bottom. It is used as a reservoir for collecting and holding lube oil.



Oil Sump

- **Description:**
  - Bottom of crankcase, sealed with gasket.
  - Reservoir for engine oil, with drain plug for oil replacement.
- **Functions:**
  - Stores and collects engine oil.
  - Contains impurities.
  - Cools engine oil.
- **Materials:**
  - Pressed steel sheet or aluminum alloy.

Manifolds

- **Description:**
  - Pipes attached to the cylinder head.
  - Carry air-fuel mixture (petrol) or air (diesel) and exhaust gases.
  - Include flanges for engine connections.
- **Types:**
  - Inlet Manifold
    - Distributes air or air-fuel mixture equally to cylinders.
    - Aids vaporization and prevents condensation.
    - Cast iron, aluminum, plastic.
  - Exhaust Manifold
    - Conveys burnt gases from engine cylinders to the atmosphere via exhaust system components.
    - Cast iron.

Gasket

- **Definition:**
  - Mechanical seals filling the space between mating faces to prevent leakage.
- **Requirements:**
  - **Conformity:** Adapts to surface roughness or warpage.
  - **Resistance:** Withstands high pressures, extreme temperatures, vibrations, and chemicals (fuel, combustion products, coolant, oil).
  - **Impermeability:** Impervious to fluids.
  - **Openings:** Must accommodate studs, bolts, and passage of coolant, lubricants, air, and exhaust.

Gasket - Cont.

- **Types and Functions:**
  - **Cylinder Head Gasket:** Seals between cylinder head and crankcase.
  - **Oil Sump Gasket:** Seals between oil sump and crankcase.
  - **Oil Pump Gasket:** Seals between oil pump and cylinder block.
  - **Manifold Gasket:** Seals between manifolds (inlet and exhaust) and cylinder block.
- **Materials:**
  - Asbestos, Copper, Steel, Synthetic Rubber

Moving Parts

Pistons

Pistons are crucial engine components.

- They are cylindrical plugs that move up and down in the cylinder.
- Pistons are forged with cooling spaces inside to allow engine oil to carry away heat.
- They are connected to the **connecting rod** by a **gudgeon pin**.

Materials Used

- **Cast Iron:** Chosen for its high compressive strength
- **Aluminum Alloy:** Preferred for its lightness

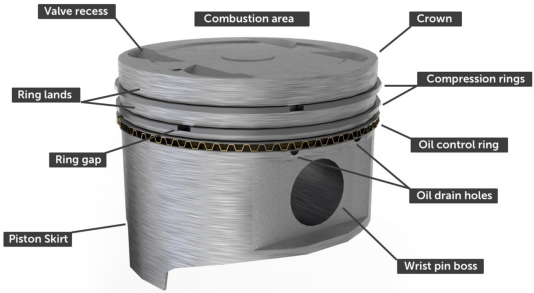
Pistons - cont.

1. The Piston Head

The top of the piston, exposed to combustion heat and pressure. It must be thick and shaped to match the combustion chamber.

2. The Piston Skirt

The side of the piston below the last ring, includes space for the gudgeon pin and helps transfer the side thrust from the connecting rod. It prevents the piston from tipping and jamming.



Pistons - cont.

i. The Slipper Skirt

Provides clearance between the piston and crankshaft counterweights, allowing the piston to slide further without hitting the crankshaft.

ii. The Straight Skirt

Flat across the bottom, this style is no longer common in automotive engines.

Straight Skirt Piston

Slipper Skirt Piston

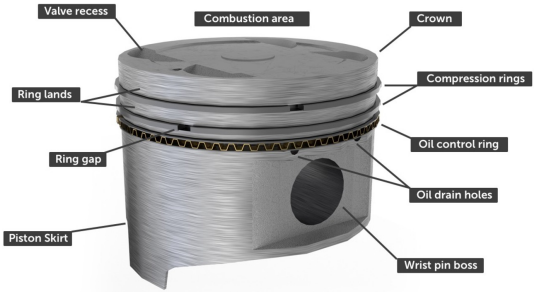
Pistons - cont.

3. The Piston Ring Grooves

Slots machined in the piston to accommodate the piston rings. The upper grooves accommodate compression rings, and the lower groove accommodates the oil ring.

4. The Piston Oil Hole

Allows oil to pass through the piston and onto the cylinder wall.



Pistons - cont.

5. The Piston Ring Lands

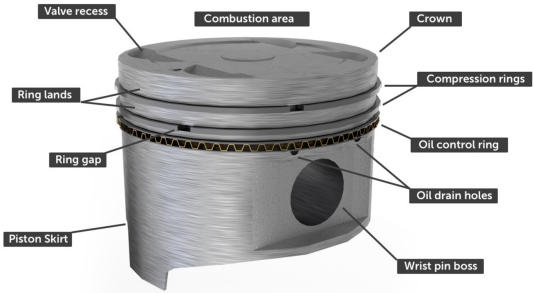
Areas between and above the ring grooves that separate and support the piston rings.

6. The Piston Boss

Reinforced area around the piston pin hole, strong enough to support the piston pin under severe loads.

7. The Piston Pin Hole

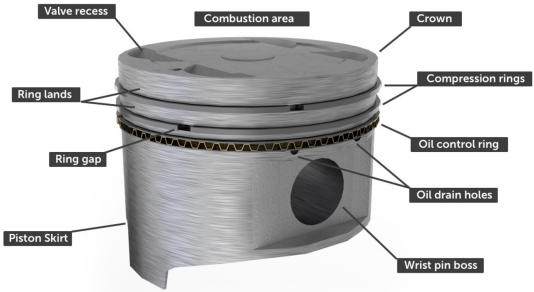
Machined through the pin boss for the piston pin, slightly larger than the pin.



Pistons - cont.

Qualities of Pistons

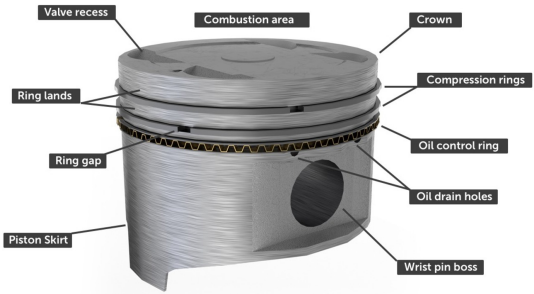
- Rigid to withstand high pressure and temperature
- Light in weight for reduced reciprocating mass
- Good heat conductivity
- Low noise during operation



Pistons - cont.

Functions of Pistons

- Converts heat energy from combustion into mechanical power
- Transfers power to the crankshaft via connecting rod
- Forms a seal to prevent escape of high-pressure combustion gases
- Supports the small end of the connecting rod
- Assists in intake and exhaust of gases



Piston Rings

Piston rings are fitted into grooves cut in the piston. They are split at one end to allow them to expand or be slipped over the piston end.

- **Materials**
  Made of cast iron with fine grain and high elasticity, resistant to working heat. Sometimes made from alloy spring steel.

Piston Rings - Cont.

Types of Piston Rings

- **Compression Ring**

  Usually plain, single-piece rings placed in the grooves nearest to the piston head. Prevents gas leakage and helps increase compression pressure inside the cylinder.

- **Oil Scraping Ring**

  Grooved or slotted rings located either in the lowest groove above the piston pin or in a groove above the piston skirt. They control the distribution of lubrication oil in the cylinder.

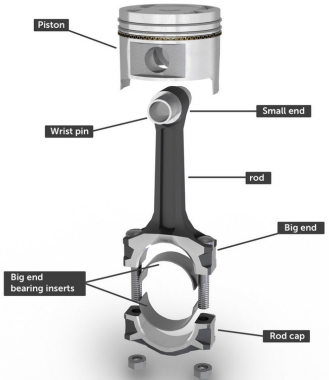
Piston Rings - Cont.

Functions

- Forms a gas-tight combustion chamber for all piston positions.
- Reduces contact area between the cylinder wall and piston wall, preventing friction losses and excessive wear.
- Controls cylinder lubrication.
- Transmits heat away from the piston to the cylinder walls.

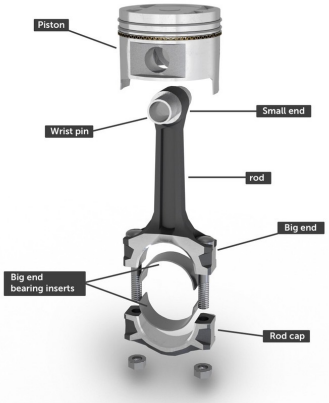
Connecting Rod

- Connects the piston to the crankshaft.
- Converts reciprocating piston motion to rotary motion at the crankshaft.
- Drop-forged steel.



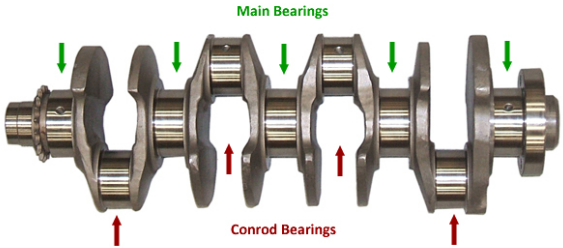
Gudgeon/Piston Pin

- The gudgeon pin, also known as the **wrist pin**, is generally hollow and tubular.
- It fits through the hole in the piston and the small end of the connecting rod.
- **Function:** Connects the piston to the small end of the connecting rod.
- **Material:** Made from low carbon case-hardened steel, consisting of 0.15% Carbon, 0.30% Silicon, 0.50% Manganese, and 99.05% Iron.



Engine Bearing

- **Description:**
  - Supports moving parts like the crankshaft and connecting rod big end.
  - Essential for rotary action in engines.
- **Function:**
  - Reduces friction between moving parts.
  - Uses sliding (bushings) and rolling types; sliding bearings connect the rod to the piston and crankshaft.
- **Materials:**
  - Made of steel or bronze with a soft lining.



Crankshaft

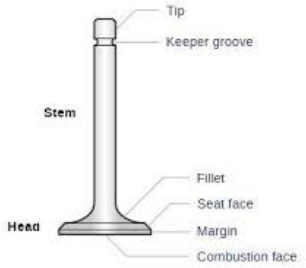
- Works with connecting rod to change reciprocating motion of the piston to rotary motion.
- Transmits mechanical energy from the engine to drives camshafts, generator, pumps, etc.
- Made of heat-treated steel alloys.

Flywheel

- Rotating mass with a large moment of inertia connected to the crankshaft of the engine.
- The purpose of the flywheel is to store energy and furnish a large angular momentum that keeps the engine rotating between power strokes and smooths out engine operation.

Valves

- Each cylinder will have:
  - Intake: open to admit air to cylinder (with fuel in Otto cycle).
  - Exhaust: open to allow gases to be rejected
- Valve Terminologies
  - Head
  - Margin
  - Face
  - Tulip
  - Stem



Valves Train

- Controls flow into and out of the combustion chamber.
  - Time and Duration
- Components (for OHV).
  - Valve tappets
  - Push rods
  - Rocker arm
  - Valves
  - Valve springs
  - Valve rotators
  - Valve seats

Camshaft and Cams

- Used to time the addition of intake and exhaust valves.
- Operates valves via pushrods and rocker arms.
- Driven by gear (or chain) from the crankshaft.
- 2:1 crankshaft to camshaft gear ratio.

End of Lecture 4