Engine Components and Operation

Objectives

- Explain the basic function of an internal combustion engine.
- Describe the five events required for internal combustion engine operation.
- Describe selected individuals and events in the history of engine development.
- Identify and describe the construction and function(s) of primary engine components.
- Explain principles of 2- and 4-stroke cycle engine operation, both S.I. And C.I.

Internal Combustion Engine

- Function - Converts potential chemical energy in fuel into heat energy then to mechanical energy to perform useful work.

Chemical → Heat → Mechanical

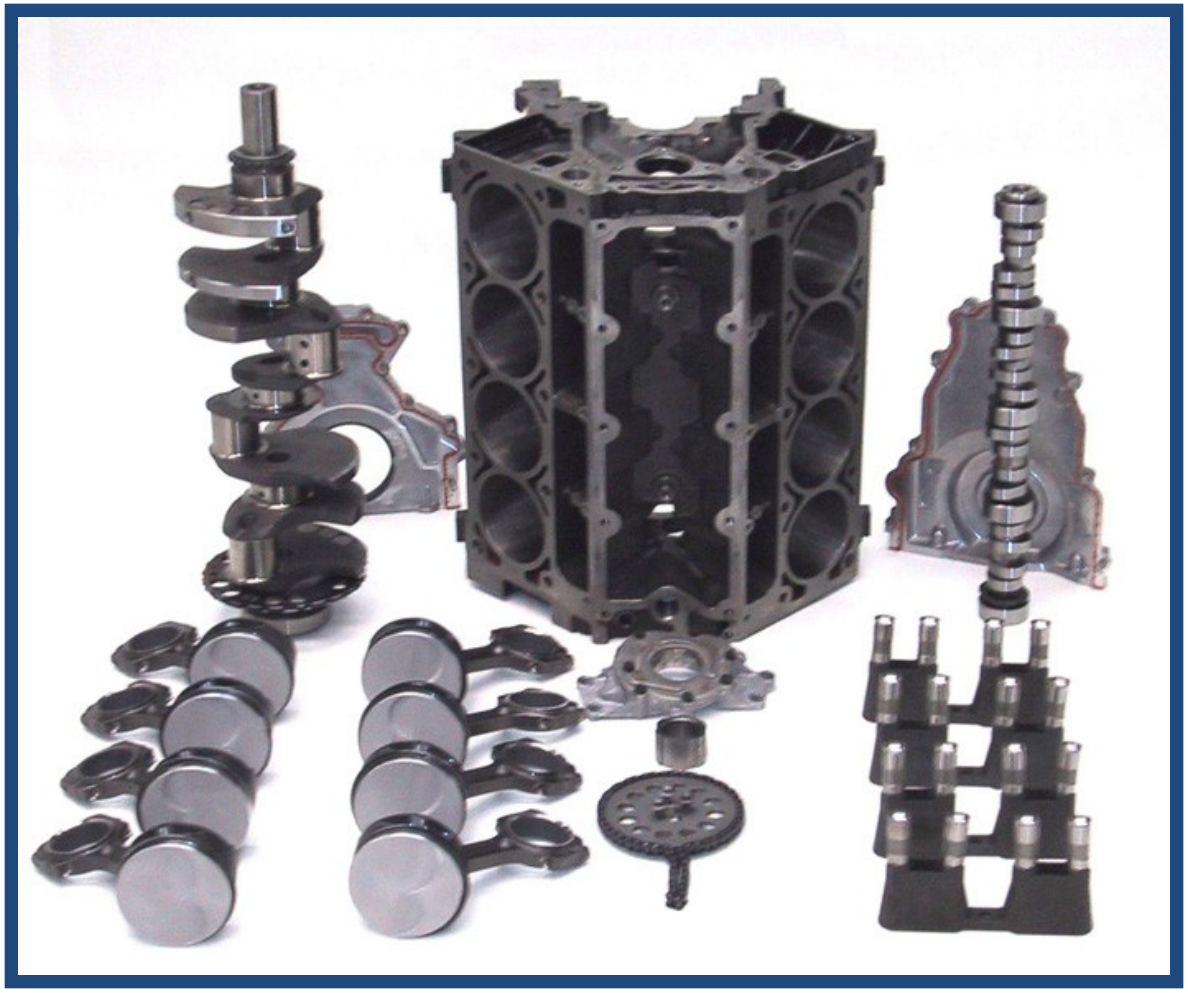
Requirements for I.C. Engine Operation

- All Internal combustion engines must carry out five events:
  - Air-fuel mixture must be brought into the combustion chamber.
  - Mixture must be compressed.
  - Mixture must be ignited.
  - Burning mixture must expand into increasing combustion chamber volume.
  - Exhaust gasses must be removed.

Historical Development of the I.C. Engine

- 1862 -- Rochas described the basic principles essential for efficient engine operation.
- 1878 – Otto built the first successful 4-stroke cycle engine.
- 1891 – Day built an improved 2-stroke cycle engine.
- 1892 – Diesel patented the compression-ignition (diesel) engine.
- To present – emphasis on improved engine efficiency, through refinement.

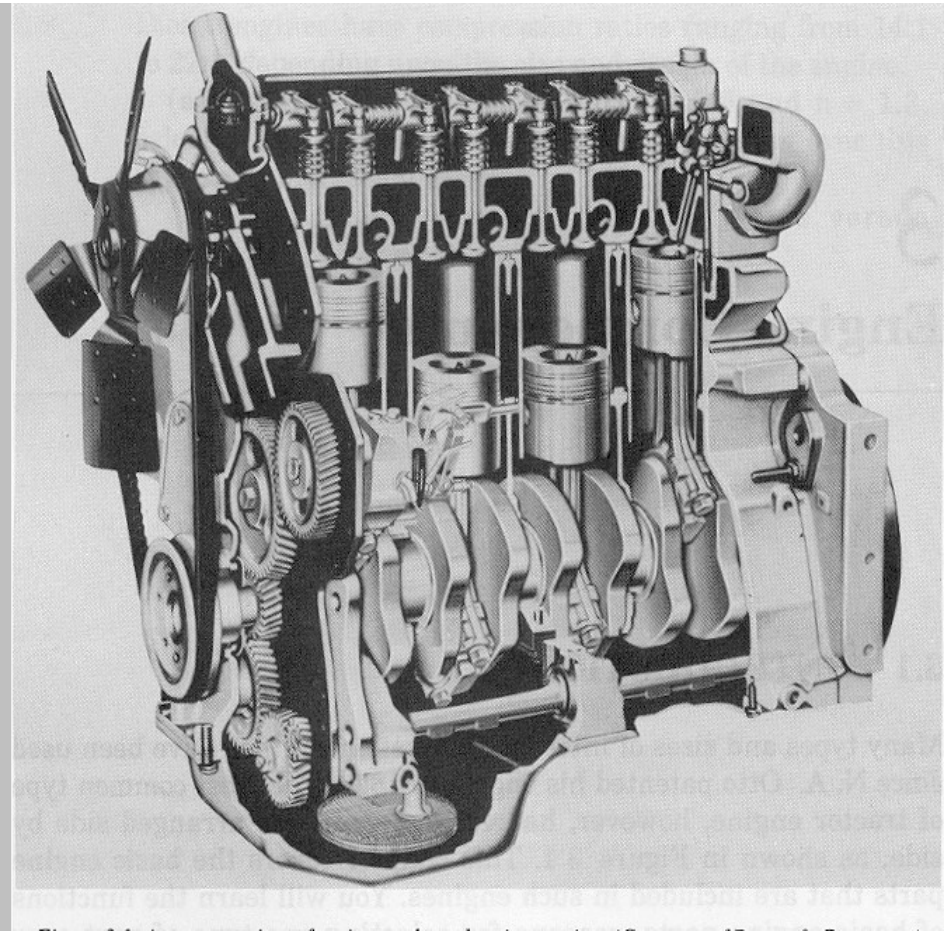
Engine Components and Functions



Engine Parts ID Scoring

- 14 - 15 correct – Master Gearhead
- 12-13 – Gearhead
- 10 -11 – Mechanic
- 8 - 9 -- Apprentice Mechanic
- 6 – 7 – Wrench Turner
- 4 – 5 – Wrench Loser
- 2 -- 3 – Jiffy Lube Customer
- 0 – 1 Can’t Find Jiffy Lube
  - Looking for Lube in all the Wrong places????

Cylinder Block



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

Cylinders

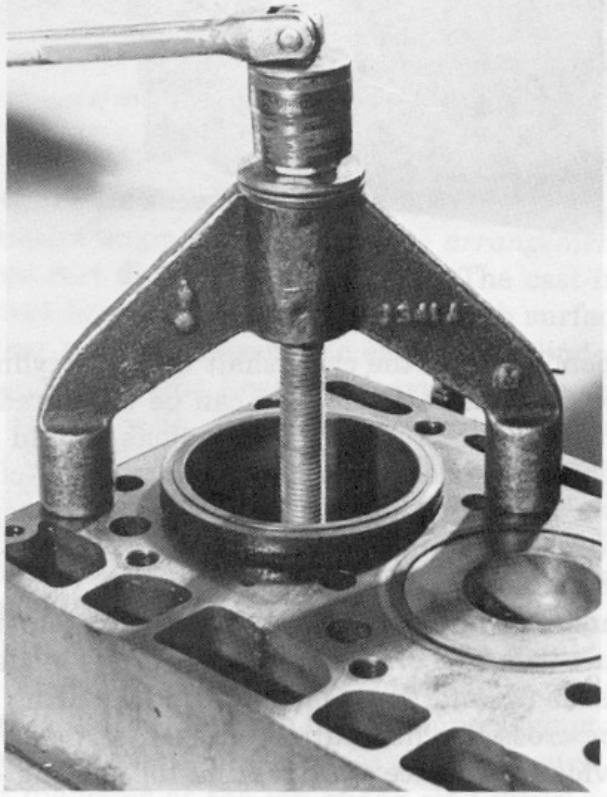
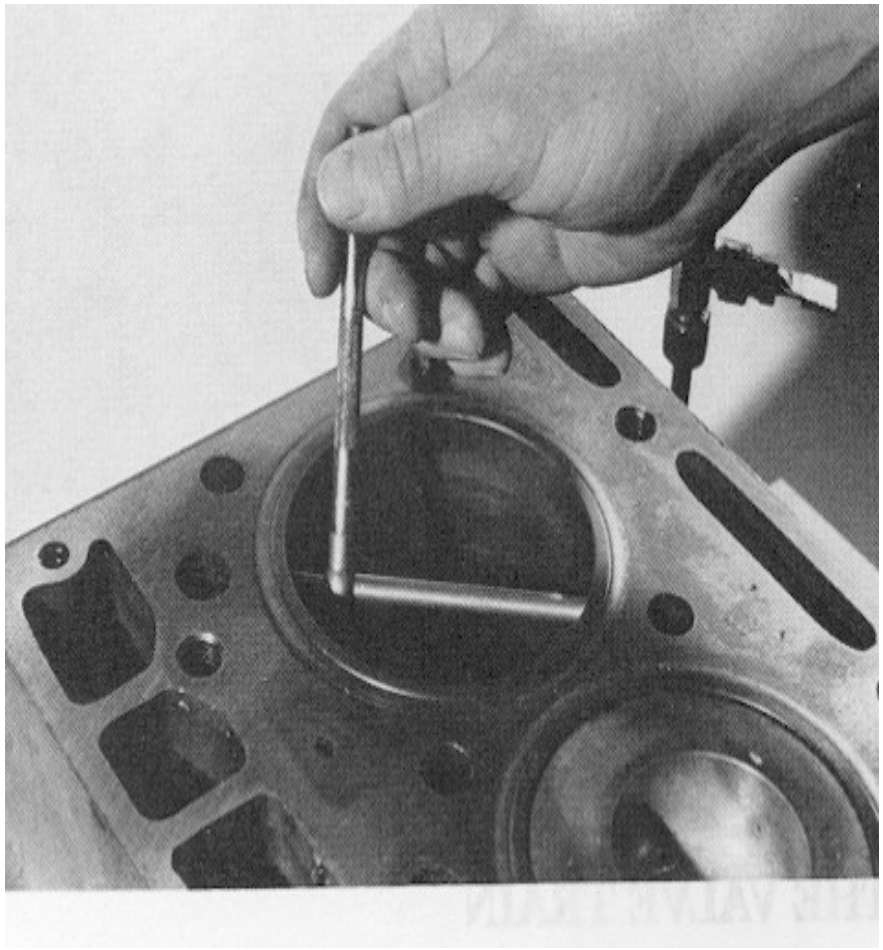


Figure 3.4–Removal of a cylinder liner. (Photo by Laurie Goering.)

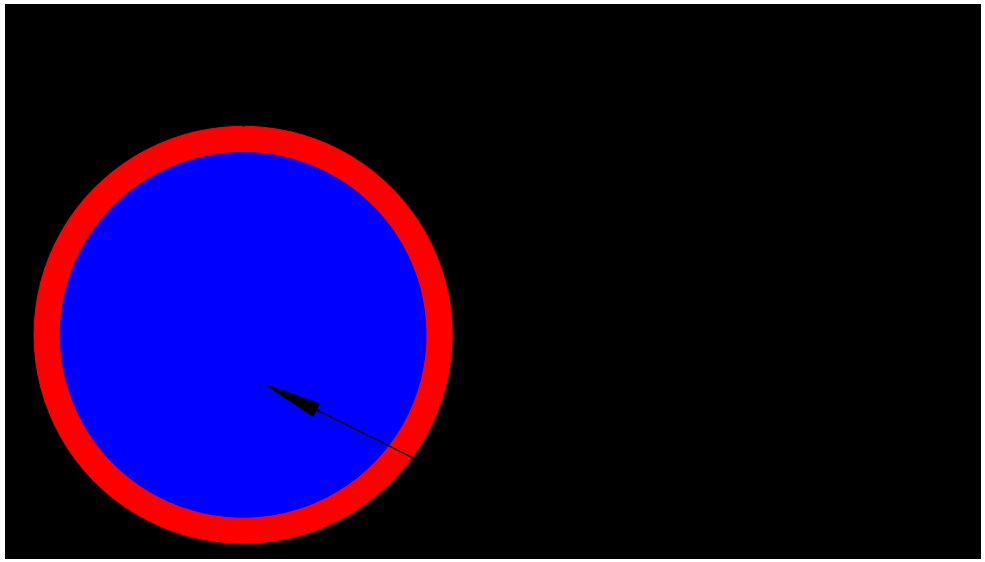
- Cylindrical holes in which the pistons reciprocate.
- May be:
  - Enblock
  - Liners
    - **Wet liners**
    - **Dry liners**
- Cylinder bore – diameter of cylinder

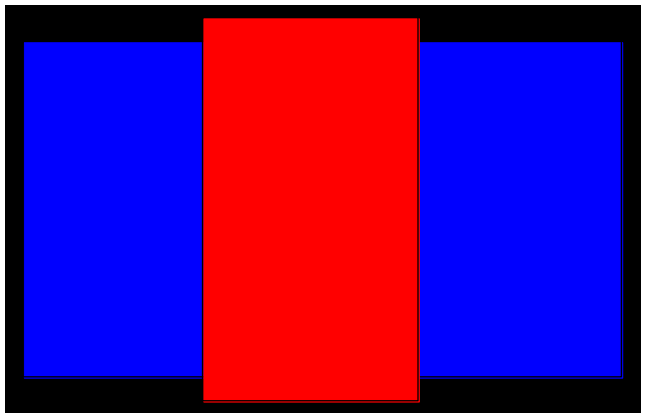
Checking Cylinder Condition



- During engine overhaul, cylinder is checked for:
  - Excessive wear (oversize)
  - Out-of Round
  - Taper

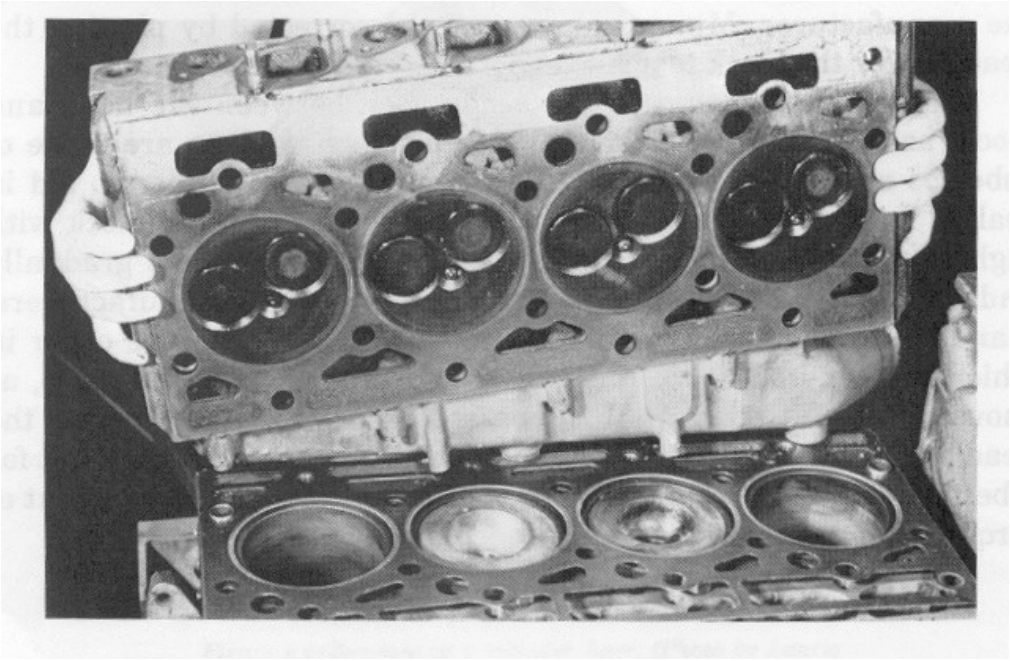
Bearings and Journals





- Bearing – Stationary (non-rotating) surfaces providing support to moving (rotating) component.
  - Main bearings
  - Rod bearings
  - Cam bearings
- Journal – Surface of moving component supported by a bearing.

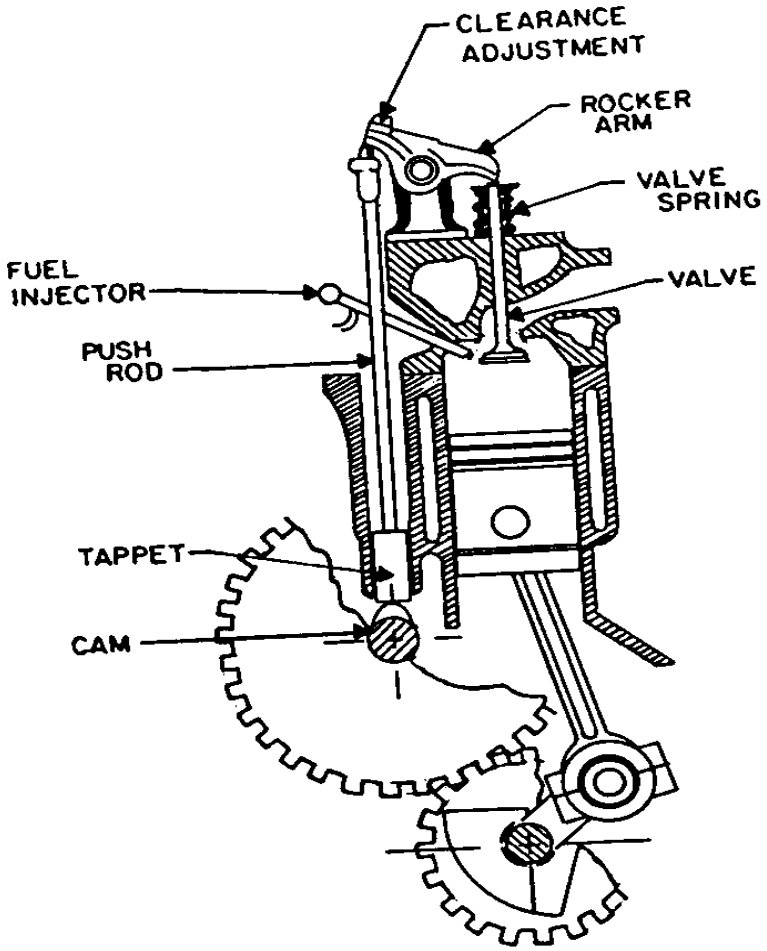
Cylinder Head



- Seals the "top-end" of the combustion chamber.
- Contains the valves and the intake and exhaust "ports".
- Head bolts and head gasket ensure air-tight seal of the combustion chamber.
- Contains oil and coolant passages.

- One-piece castings of iron alloy.

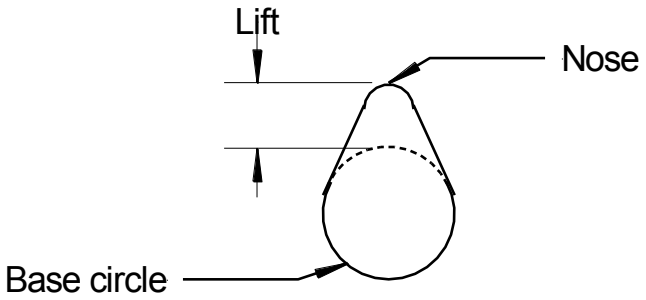
Valve Train



- Controls flow into and out of the combustion chamber.
  - **Time and Duration**
- Tractor engines use “Overhead Valve (OHV)” configuration.
- Components
  - **Camshaft**
  - **Valve tappets**
  - **Push rods**
  - **Rocker arm**
  - **Valves**
  - **Valve springs**
  - **Valve rotators**
  - **Valve seats**

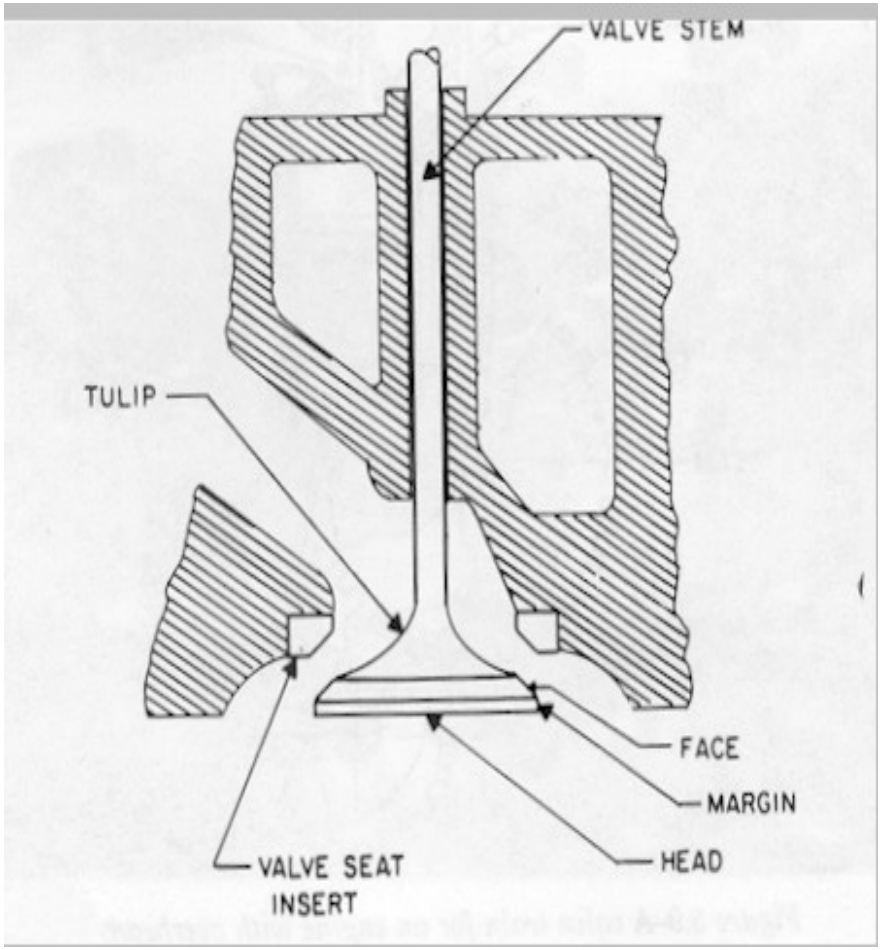
Camshaft

- **Open the intake and exhaust valves at correct time and for correct duration.**
- **Driven by gear (or chain) from the crankshaft.**
- **2:1 crankshaft to camshaft gear ratio.**



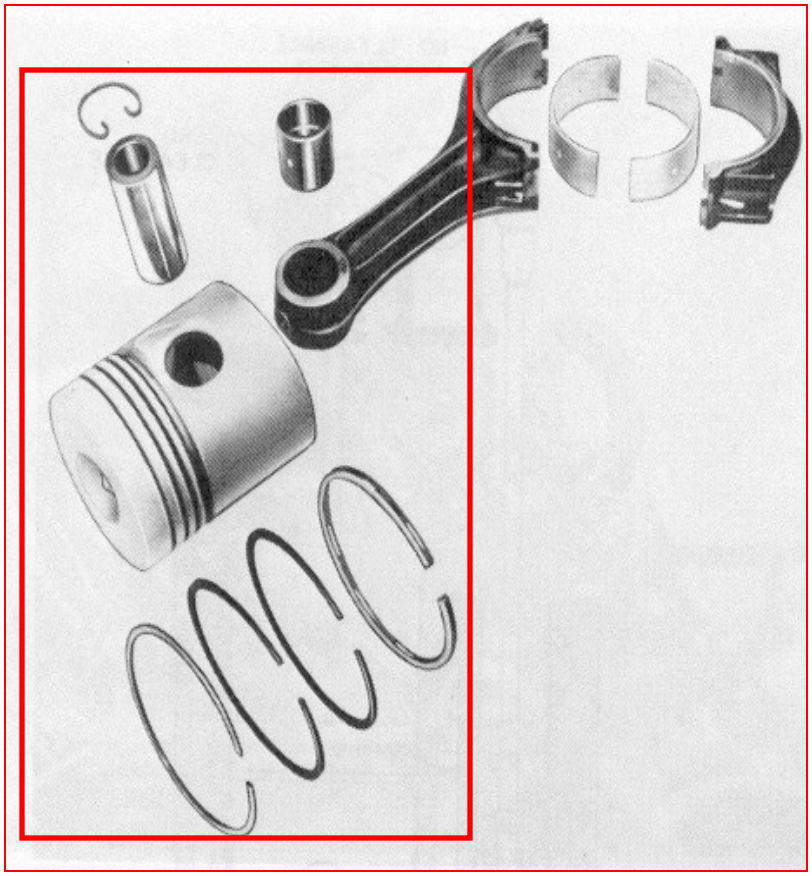
Cam Profile

Valves



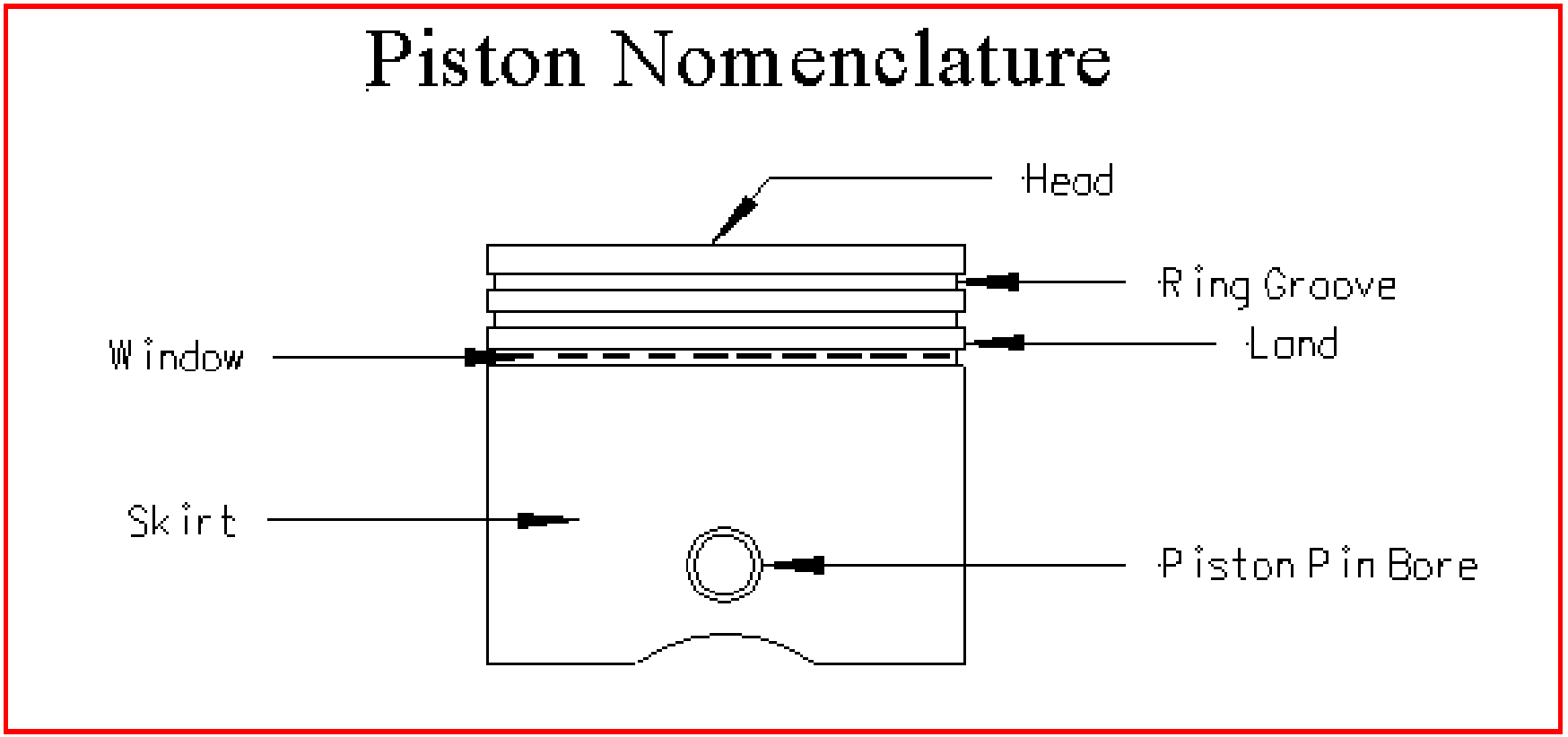
- Each cylinder will have:
  - **Intake valve**
  - **Exhaust valve**
- **Valve nomenclature**
  - **Head**
  - **Margin**
  - **Face**
  - **Tulip**
  - **Stem**

Piston and Rings

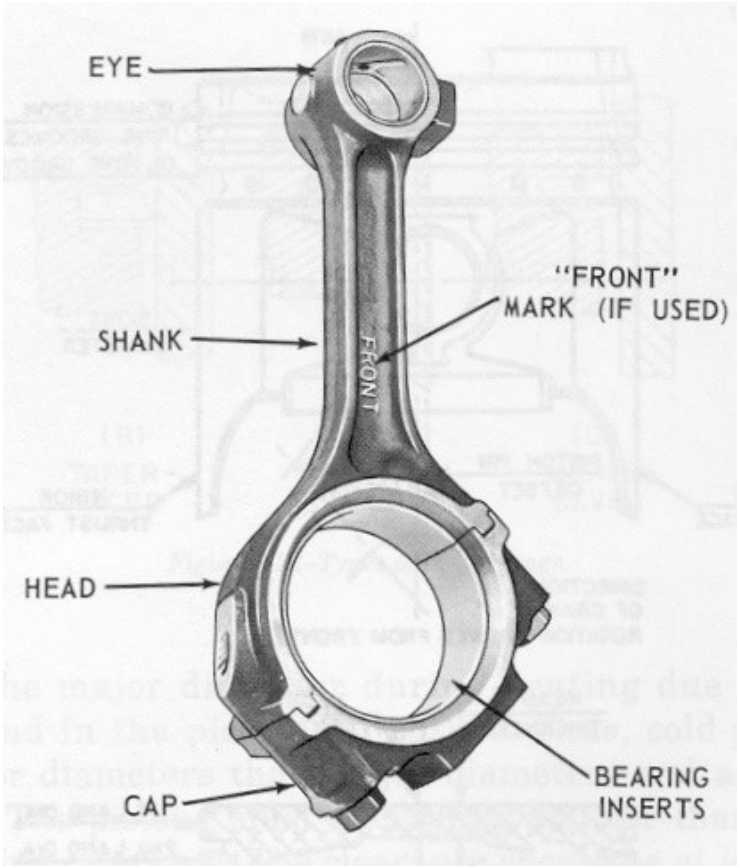


- Piston
  - Forms the “moveable bottom’ of the combustion chamber.
    - Iron alloy or aluminum
- Rings
  - Compression
  - Oil-control
    - Cast iron
- Piston pin

Piston

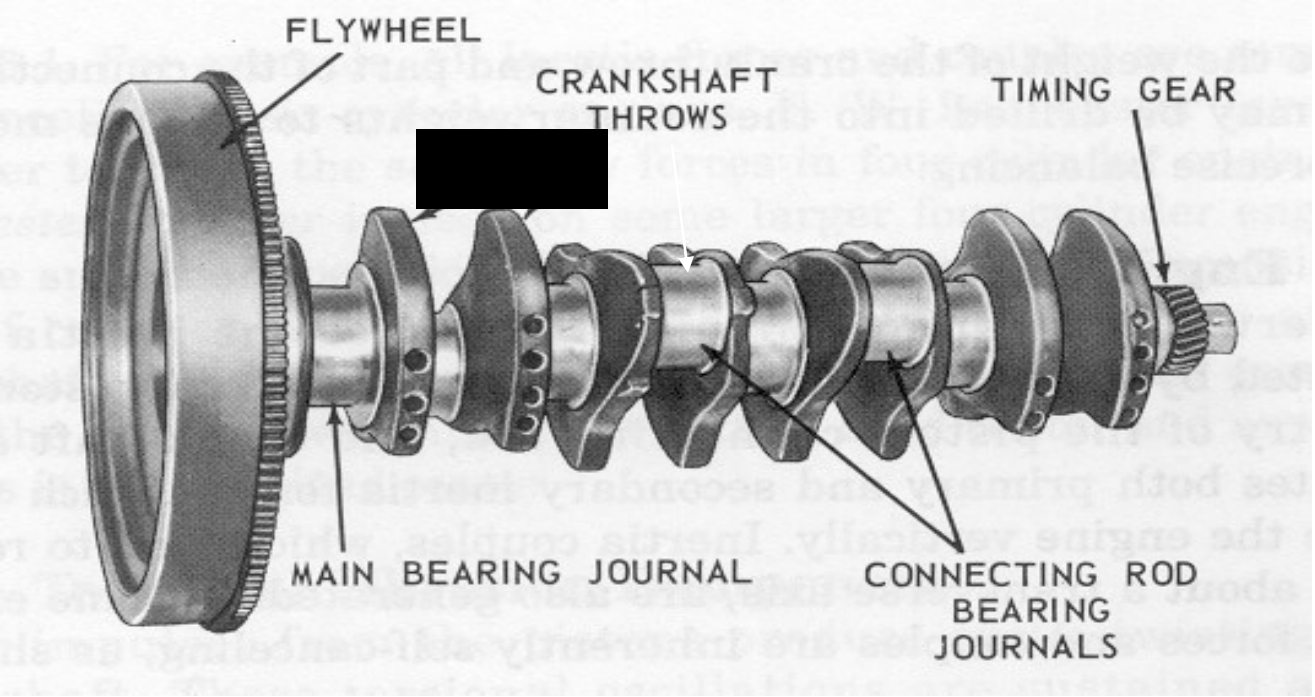

Piston Nomenclature
Head
Ring Groove
Land
Window
Skirt
Piston Pin Bore

Connecting rod



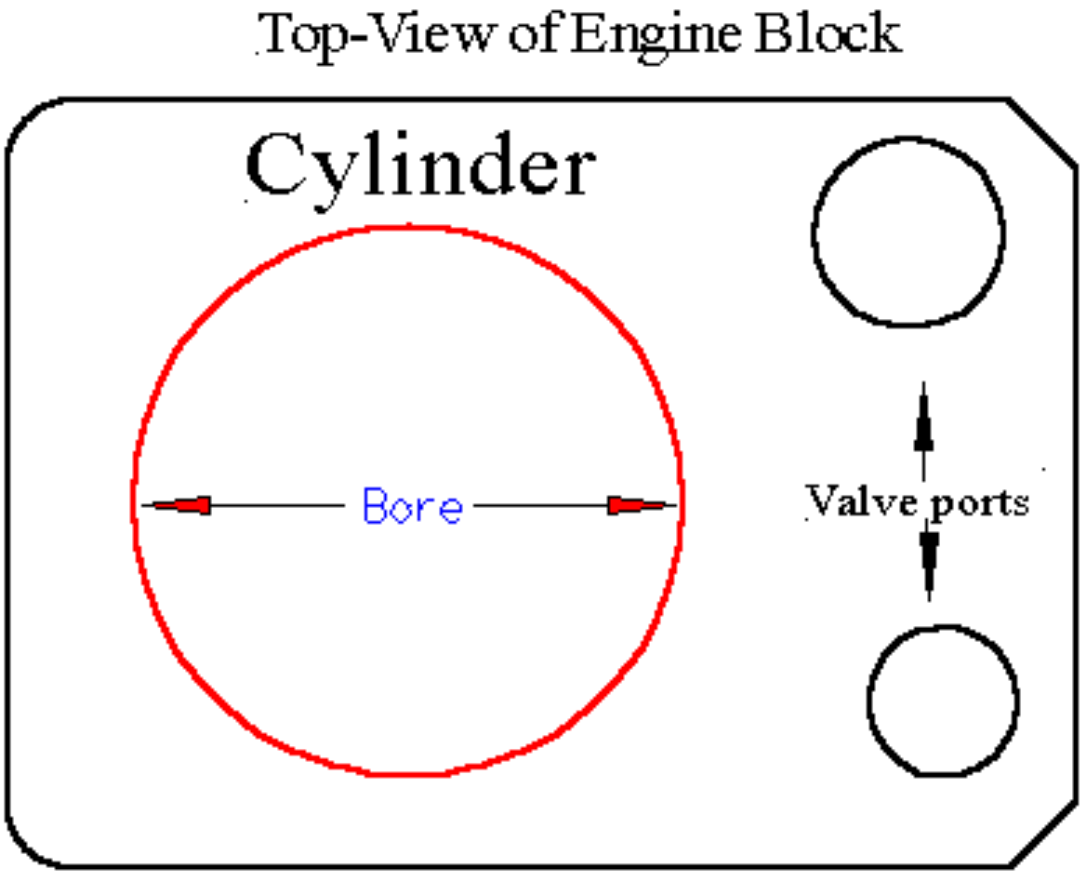
- Connects the piston to the crankshaft
- Converts reciprocating piston motion to rotary motion at the crankshaft.
- Nomenclature
- Drop-forged steel

Crankshaft



- Works with connecting rod to change reciprocating to rotary motion.
- Transmits mechanical energy from the engine.
- Made of heat-treated steel alloys.

Cylinder Bore



•Bore is the diameter of the cylinder

Stroke

- Linear distance piston travels from Top Dead Center (TDC) to Bottom Dead Center (BDC).

Piston and Engine Displacement

- $Pd = (B^2 \times pi \times s) / 4$
- $Ed = [(B^2 \times pi \times s) / 4] \times n$

Compression Ratio

- Ratio of “Total Volume” in cylinder at BDC to TDC.
- C.R. = (Pd + ClV) / ClV

4-Stroke Cycle Engine Operation

- 4-stroke cycle engines require four strokes of the piston to complete the five events necessary for engine operation.
  - 1 piston stroke = ½ crankshaft revolution.
  - 4 piston strokes = 2 crankshaft revolutions.

4-Stroke Cycle Engine Operation

- Intake Stroke
  - Intake valve open.
  - Piston moves down (TDC to BDC) in cylinder.
  - Low pressure is created in cylinder.
  - Air is brought into the combustion chamber due to pressure differences.

4-Stroke Cycle Engine Operation

- Compression Stroke
  - **Both valves closed.**
  - **Piston moves from BDC to TDC**
  - **Air in combustion chamber is compressed, raising its temperature.**
  - **Near TDC of Compression stroke, diesel fuel is injected into the combustion chamber.**

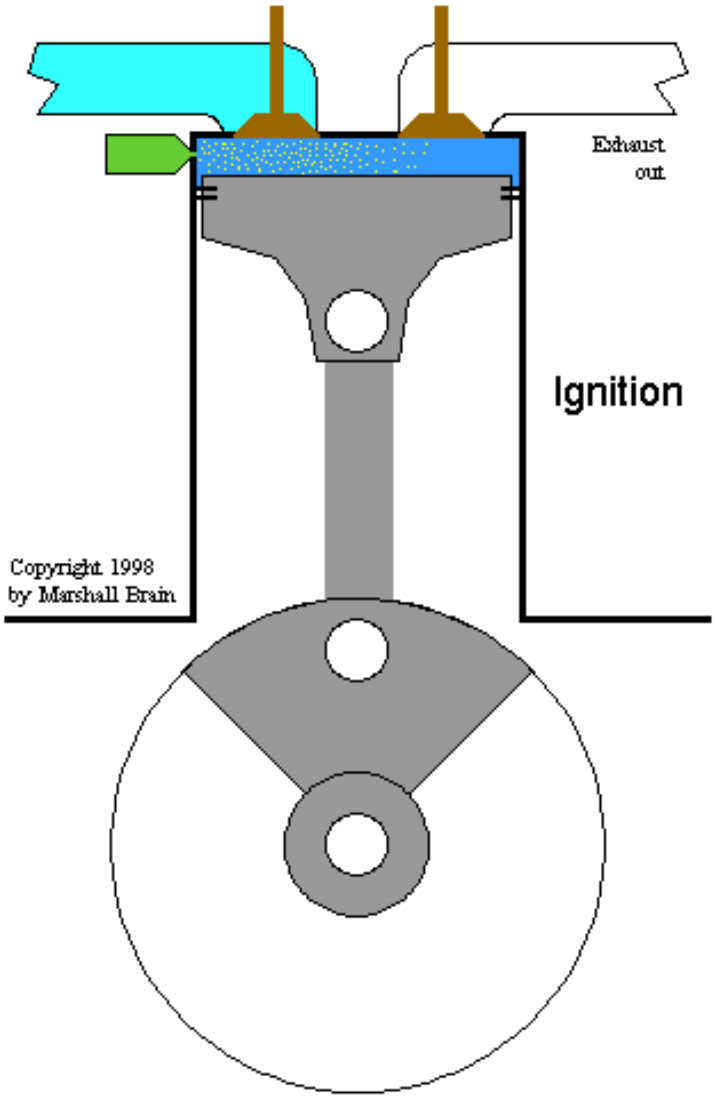
4-Stroke Cycle Engine Operation

- Power Stroke
  - Both valves are closed
  - Air-fuel mixture burns rapidly
  - Expansion of the burning air-fuel mix applies force to the head of the piston
  - Piston is driven down in the cylinder.

4-Stroke Cycle Engine Operation

- Exhaust Stroke
  - Piston moves from BDC to TDC.
  - Exhaust valve is open.
  - Burnt air-fuel mixture is scavenged from combustion chamber.

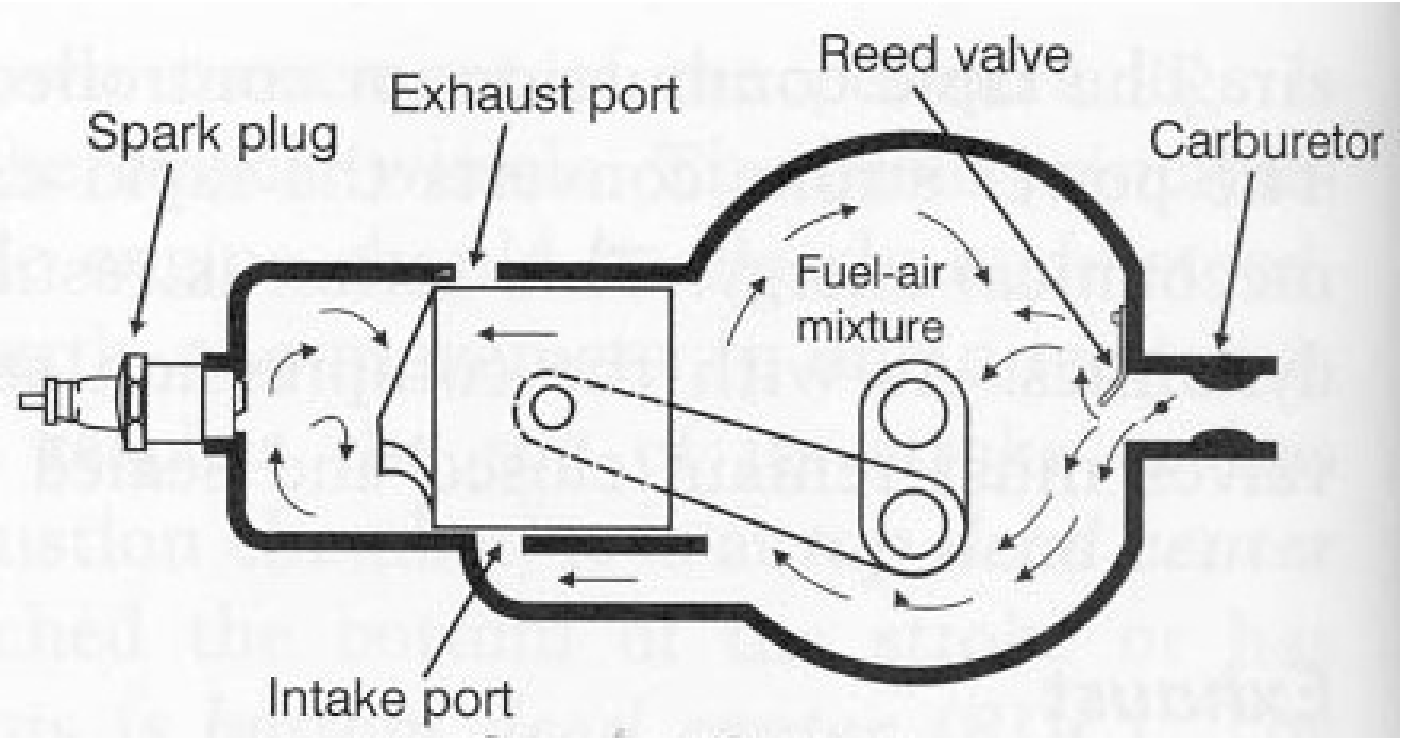
4-Stroke Cycle C.I. Engine



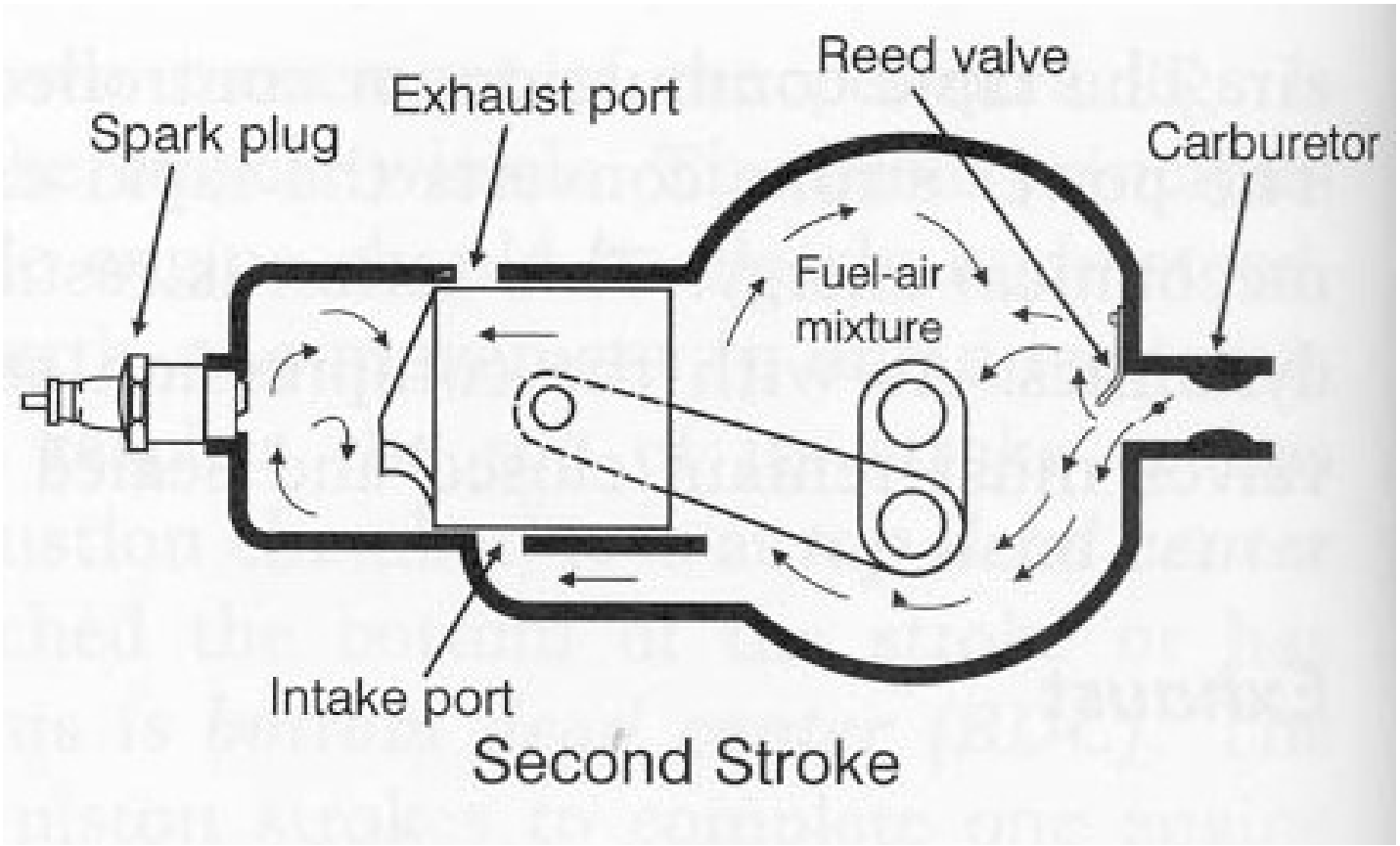
Comparison of 4-Stroke Cycle for C.I. And S.I. Engines

Stroke	C.I. (Diesel)	S.I. (Gasoline)
Intake	Air only	Air-fuel mix
Compression	C.R. $\geq$ 14:1 Temp > 729 ^{o}F	C.R. 6:1 – 12:1
Power	No difference	
Exhaust	No difference	

Two-Stroke Cycle Engines



Two-Stroke Cycle Engine Operation



Comparison of Two-Stroke vs. Four-Stroke Cycle Engines

Two-Stroke Cycle Engines	Four-Stroke Cycle Engines
Lighter weight	Heavier weight
Operates in many positions	Operates in limited positions
Higher power to weight ratio	Lower power to weight ratio
Engine oil usually mixed with fuel	Engine oil in a reservoir
Louder operation	Quieter operation
Higher engine speeds	Slower engine speeds
More vibration	Smoother operation
Rough idling operation	Smoother Idling operation