Internal Combustion Engine 1

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Lecture Outlines

- Classification of IC Engines

Valve/Port Design and Location

Valve/Port Design and Location

According to the arrangement of the intake and exhaust valves, whether the valves are located in the cylinder head or cylinder block.

Design

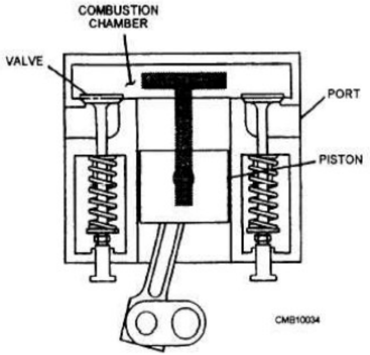
1. Poppet Valve
2. Rotary Valve
3. Reed Valve
4. Piston Controlled Porting

Location

1. The T-head
2. The L-head
3. The F-head
4. The I-head:
   - Overhead Valve (OHV)
   - Overhead Cam (OHC)

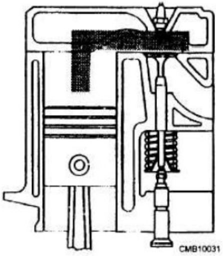
T-Head

- The intake and the exhaust valves are located on opposite sides of the cylinder in the engine block, each requires their own camshaft.



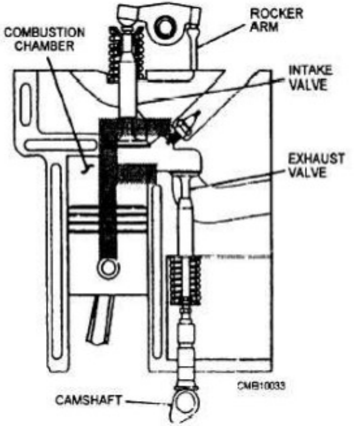
L-Head

- The intake and the exhaust valves are both located on the same side of the piston and cylinder.
- The valve operating mechanism is located directly below the valves, and one camshaft actuates both the intake and the exhaust valves.



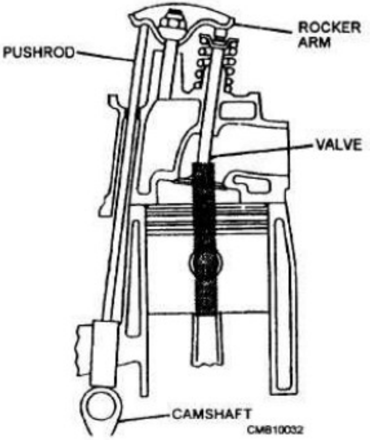
F-Head

- The intake valves are normally located in the head, while the exhaust valves are located in the engine block.
- The intake valves in the head are actuated from the camshaft through tappets, push-rods, and rocker arms.
- The exhaust valves are actuated directly by tappets on the camshaft.



I-Head

- The intake and the exhaust valves are both mounted in a cylinder head directly above the cylinder.
- This arrangement requires a tappet, a pushrod, and a rocker arm above the cylinder to reverse the direction of valve movement.
- Although this configuration is the most popular for current gasoline and diesel engines.
- It was rapidly superseded by the overhead camshaft.



Fuel

Fuel

1. Conventional Fuels
    1. Crude Oil Derived
        1. Petrol
        2. Diesel
2. Alternate Fuels
    1. Bio-mass Derived
        1. Alcohols (methyl and ethyl)
        2. Vegetable oils
        3. Producer gas and biogas
        4. Hydrogen
3. Blending
    1. Engines that use a blend of conventional and alternative fuels
        1. Example: ethanol-blended petrol
4. Dual Fueling
    1. Engines that can operate on two different fuels, either simultaneously or switching between them
        1. Example: a diesel engine that can also run on natural gas

Mixture Preparation

Mixture Preparation

This process involves creating the optimal air-fuel mixture necessary for efficient combustion. The process is critical for engine performance, fuel efficiency, and emissions control.

1. Carburetion
2. Fuel Injection
    1. Diesel
    2. Gasoline
        1. Manifold
        2. Port
        3. Cylinder

Type of Ignition

Type of Ignition

1. Spark Ignition (SI)
   - The engine starts the combustion process in each cycle by use of a spark plug.
2. Compression Ignition (CI)
   - The combustion process in a CI engine starts when the air-fuel mixture self-ignites due to high temperature in the combustion chamber caused by high compression.

Stratification of Charge

Stratification of Charge

- This refers to a technique used in internal combustion engines, particularly in stratified-charge engines.
- The air-fuel mixture is not uniform throughout the combustion chamber.
- Instead, a rich mixture is concentrated around the spark plug.
- The rest of the chamber has a leaner mixture.
- This technique is often used to:
  - Improve fuel efficiency.
  - Reduce emissions, especially under low-load conditions.

Homogeneous Charge Compression Ignition (HCCI)

- Operates with a homogeneous air-fuel mixture.
- Compression leads to auto-ignition of the mixture.
- Aims for low emissions and high efficiency.

Stratified-Charge Spark-Ignition Engines

- Rich air-fuel mixture around the spark plug.
- Leaner mixture in the rest of the chamber.
- Improves fuel efficiency and reduces emissions at low load.

Dual-Mode Stratified-Charge Engines

- Switches between stratified-charge and homogeneous charge modes.
- Stratified mode for efficiency at low load.
- Homogeneous mode for performance at higher loads.

Direct Injection Stratified-Charge Engines

- Direct fuel injection into the combustion chamber.
- Allows precise control of fuel-air mixture.
- Enhances fuel efficiency and reduces emissions.

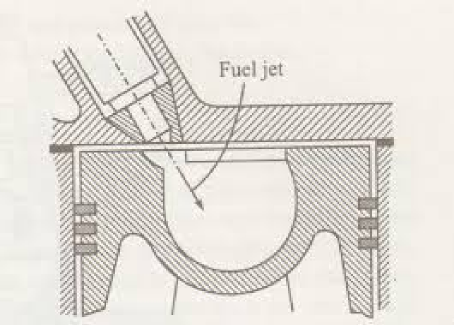
Combustion Chamber Design

Pre-Mixed Stratified-Charge Engines

- Air and fuel are mixed before entering the chamber.
- Stratification controlled within the chamber.
- Potential for better control of emissions and fuel consumption.

Open Combustion Chamber

- The combustion chamber is not enclosed by the piston at top dead center.
- Simple design.
- Typically found in older or simpler engine designs.
- Examples: Traditional side-valve engines.



Semi-Open Combustion Chamber

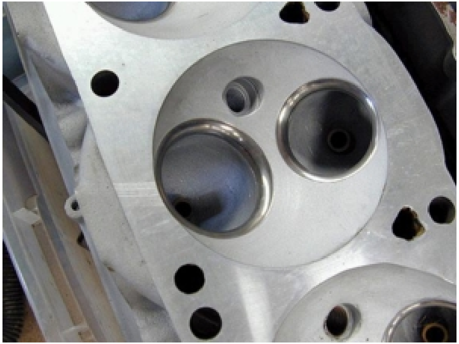
- Combines some enclosed features with open flow for the air-fuel mixture.
- Improved efficiency compared to open chambers.
- Examples: Some older overhead valve (OHV) engines.

Closed Combustion Chamber

- Fully enclosed by the piston at top dead center.
- Better control over air-fuel mixture and combustion.
- Examples: Modern overhead cam (OHC) engines, many modern diesel engines.

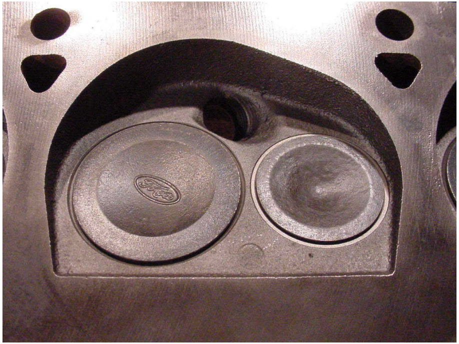
Hemisphere Combustion Chamber

- Shaped like a hemisphere.
- Promotes better fuel-air mixing and combustion efficiency.
- Examples: Some high-performance gasoline engines.



Wedge-Shaped Combustion Chamber

- Shaped like a wedge.
- Improves squish and turbulence, aiding in efficient combustion.
- Examples: Many modern four-stroke engines.



Pancake (Flat) Combustion Chamber

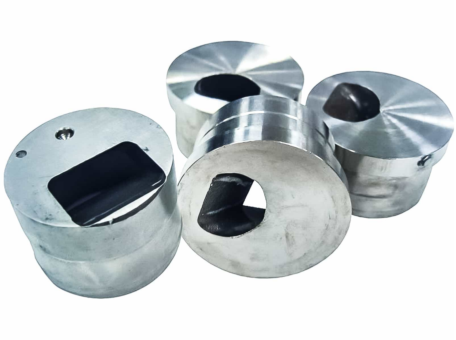
- Features a relatively flat design.
- Simple design, often used in smaller engines.
- Examples: Some older or simpler engine designs.

Toroidal Combustion Chamber

- Shaped like a toroid (doughnut shape).
- Promotes efficient combustion and reduces emissions.
- Examples: Some modern diesel engines.

Pre-Chamber Combustion Chamber

- Includes a smaller pre-chamber for initial combustion.
- Enhances ignition and combustion efficiency.
- Examples: Certain diesel engines and some early research engines.



Method of Load Control

Method of Load Control

- **Throttling**
  - To keep mixture strength constant
  - Also called Charge Control
  - Used in the Carbureted SI Engine
- **Fuel Control**
  - To vary the mixture strength according to load
  - Used in the CI Engine
- **Combination**
  - Used in the Fuel-injected SI Engine

Cooling

Cooling

- Direct Air-cooling
- Indirect Air-cooling (Liquid Cooling)
- Low Heat Rejection (Semi-adiabatic) engine

Method of Increase Inlet Pressure

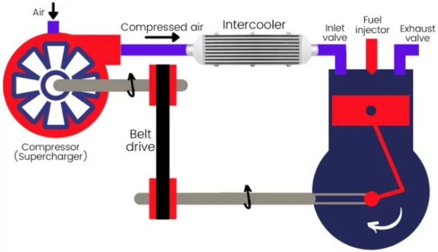
Naturally Aspired and Supercharger

Naturally Aspired

- No intake air pressure boost system.

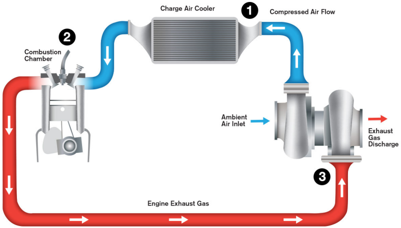
Supercharger

- Intake air pressure increased with the compressor driven off of the engine crankshaft.



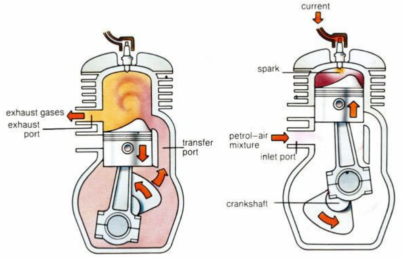
Turbocharged

- Intake air pressure increased with the turbine-compressor driven by the engine exhaust gases.



Crankcase Compressed

- Two Stroke cycle engine which uses the crankcase as the intake air compressor.
- Limited development work has also been done on design and construction of four stroke cycle engines with crankcase compression.



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