Lecture 1
INTRODUCTION

INTERNAL COMBUSTION ENGINES

By

Lecturer

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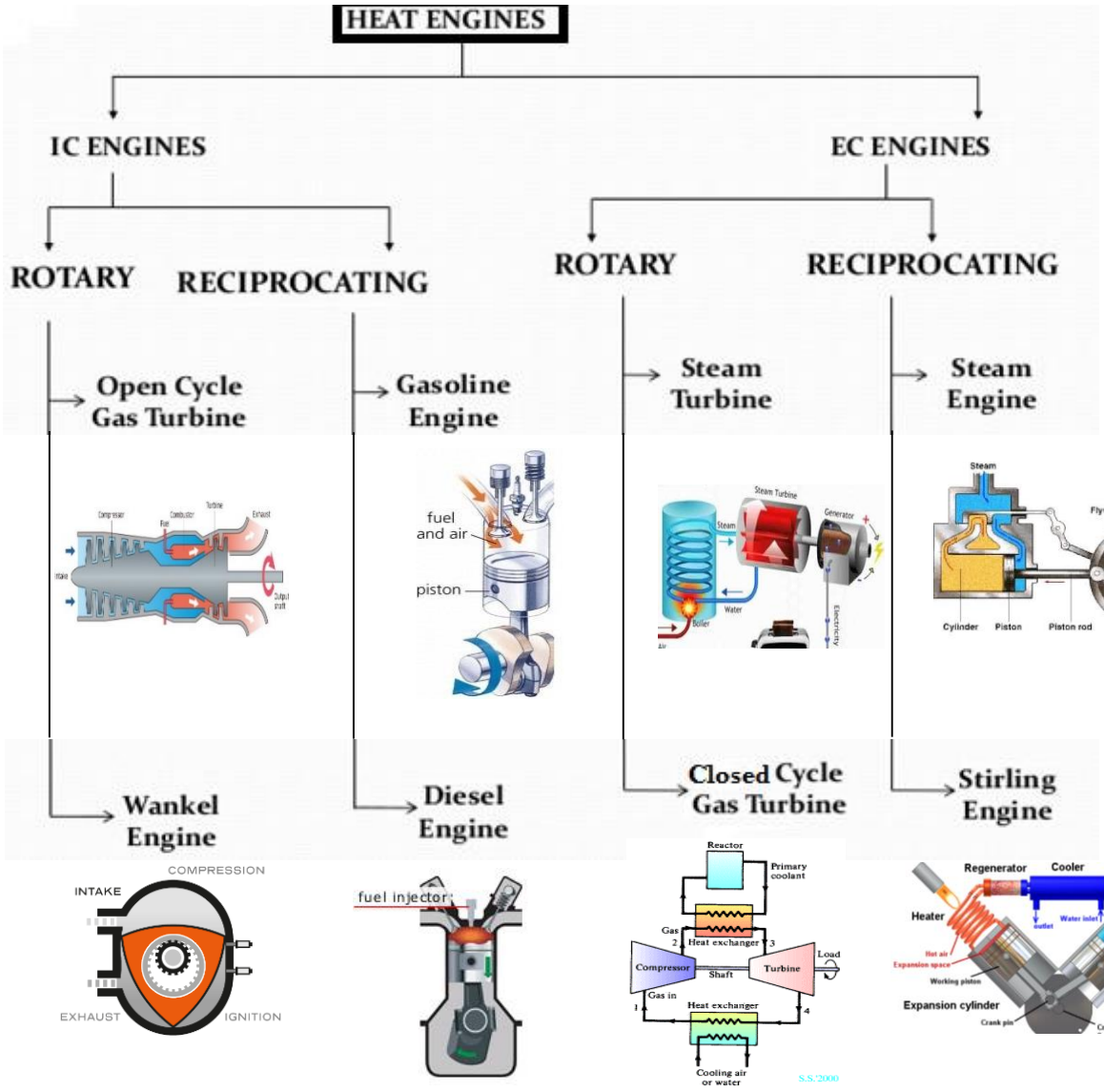
CHAPTER 1

1.1 INTRODUCTION

A combustion engine is a heat engine which generates mechanical power by combustion of a fuel.

Types of Combustion Engines

1. **External Combustion Engines**
2. **Internal Combustion Engines**



External Combustion Engines (E.C engines)

Is a heat engine where working fluid is heated by combustion in an external source, through the engine wall or a heat exchanger, where the oxidation of the fuel occurs outside the engine, which provides heat to the motive portion of the engine.

Examples of external combustion engines:

1) wood-burning or coal burning steam-powered locomotives

2) Coal and oil-fired boilers on steamships

3) Steam engine

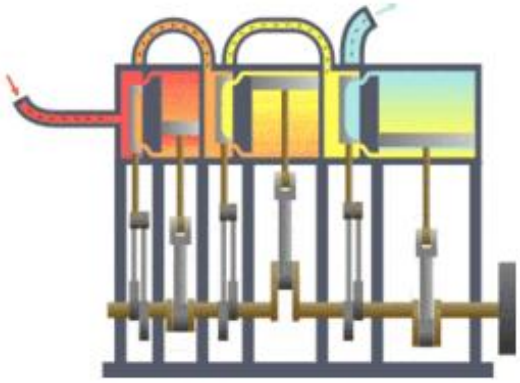


Fig.1: E.C Engine (Steam Engine)

Internal Combustion Engines (IC Engines)

The **internal combustion engine** (IC) is a heat engine that converts chemical energy in a fuel into mechanical energy, where the combustion of a fuel occurs with an oxidizer (usually air) in a combustion chamber that is an integral part of the working fluid flow circuit.

Chemical energy of the fuel is first converted to thermal energy by means of combustion or oxidation with air inside the engine. This thermal energy raises the temperature and pressure of the gases within the engine and the high-pressure gas then expands against the mechanical mechanisms of the engine. This expansion is converted by the mechanical linkages of the engine to a rotating crankshaft, which is the output of the engine. The crankshaft, in turn, is connected to a transmission and/or power train to transmit the rotating mechanical energy to the desired final use.

Fig.2: IC 4-strock Engine

Table 1: The Difference between IC Engines & EC Engines

	IC Engines	EC Engines
Fuel Combustion	Takes place inside the cylinder	Takes place outside the engine cylinder.
Temperature & Pressure	much higher	less
Materials resistance	Better resistant to heat and pressure	Less resistant to heat and pressure
Piston Connecting	The piston directly connected to connecting rod	There is a stuffing box that prevents the leakage of steam from the cylinder.
Efficiency	Higher	Less
The required equipment	required only a much smaller tank to store fuel	Boilers are required to store water, which is to be converted to steam.
Started and Stopped	Can be started or stopped quickly	Cannot be started or stopped quickly, because it takes time to initiate boiling of water and generate steam.
Weight	Lighter	Weightier
Cost	Cheaper	More cost

1.2 Applications of I.C Engine

1. **The propulsion of a vehicle (i.e., automobile, truck, locomotive, marine vessel, or airplane).**
2. **Stationary engines to drive generators or pumps, and**
3. **Portable engines for things like chain saws and lawn mowers.**

1.3 IC ENGINE CLASSIFICATIONS

Internal combustion engines can be classified in a number of different ways:

1. Types of Ignition

(a) Spark Ignition (SI). An SI engine starts the combustion process in each cycle by use of a spark plug.

(b) 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.

2. Engine Cycle

(a) Four-Stroke Cycle. A four-stroke cycle experiences four piston movements over two engine revolutions for each cycle.

(b) Two-Stroke Cycle. A two-stroke cycle has two piston movements over one revolution for each cycle.

3. Valve Location (see Fig. 3)

(a) Valves in head (overhead valve), also called **I Head engine.**

(b) Valves in block (flat head), also called **L Head engine.** Some historic engines with valves in block had the intake valve on one side of the cylinder and the exhaust valve on the other side. These were called **T Head engines.**

(c) One valve in head (usually intake) and one in block, also called **F Head engine;** this is much less common.

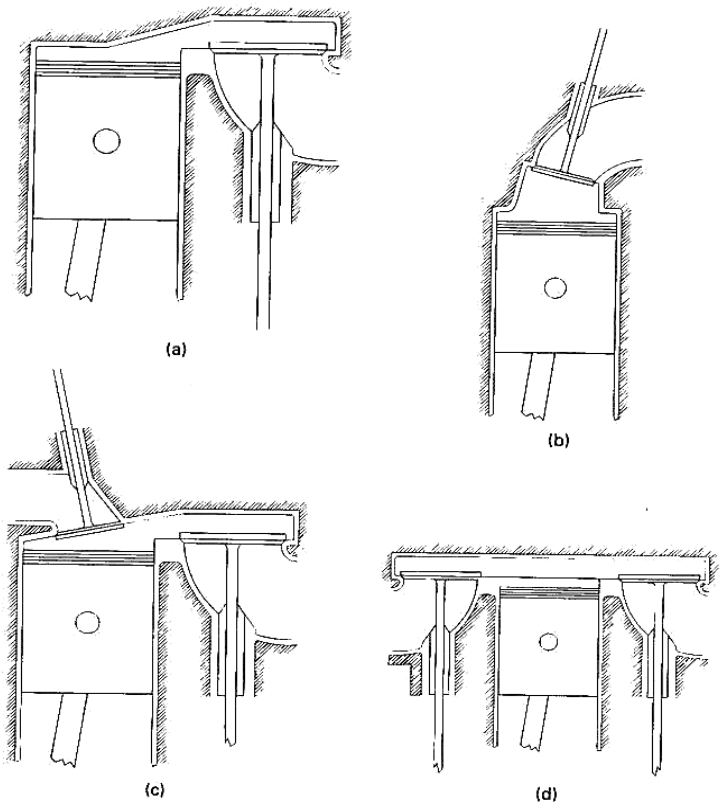


Figure 3 Engine Classification by Valve Location. **(a)** Valve in block, L head. Older automobiles and some small engines. **(b)** Valve in head, I head. Standard on modern automobiles. **(c)** One valve in head and one valve in block, F head. Older, less common automobiles. **(d)** Valves in block on opposite sides of cylinder, T head. Some historic automobile engines.

4. Basic Design

(a) Reciprocating. Engine has one or more cylinders in which pistons reciprocate back and forth. The combustion chamber is located in the closed end of each cylinder. Power is delivered to a rotating output crankshaft by mechanical linkage with the pistons.

(b) Rotary. Engine is made of a block (stator) built around a large non-concentric rotor and crankshaft. The combustion chambers are built into the nonrotating block.

5. Position and Number of Cylinders of Reciprocating Engines *(Fig. 1-7)*

(a) Single Cylinder. Engine has one cylinder and piston connected to the crankshaft.

(b) In-Line. Cylinders are positioned in a straight line, one behind the other along the length of the crankshaft. They can consist of 2 to 11 cylinders or possibly more.

(c) V Engine. Two banks of cylinders at an angle with each other along a single crankshaft. The angle between the banks of cylinders can be anywhere from 15° to 120°, with 60°-90° being common. V engines have even numbers of cylinders from 2 to 20 or more. V6s and V8s are common automobile engines, with V12s and V16s (historic) found in some luxury and high-performance vehicles.

(d) Opposed Cylinder Engine. Two banks of cylinders opposite each other on a single crankshaft (a V engine with a 180° V). These are common on small aircraft and some automobiles with an even number of cylinders from two to eight or more. These engines are often called flat engines (e.g., flat four).

(e) W Engine. Same as a V engine except with three banks of cylinders on the same crankshaft. Not common, but some have been developed for racing automobiles, both modern and historic. Usually 12 cylinders with about a *60°* angle between each bank.

(f) Opposed Piston Engine. Two pistons in each cylinder with the combustion chamber in the center between the pistons. A single-combustion process causes two power strokes at the same time, with each piston being pushed away from the center and delivering power to a separate crankshaft at each end of the cylinder.

(g) Radial Engine. Engine with pistons positioned in a circular plane around the central crankshaft. The connecting rods of the pistons are connected to a master rod which, in turn, is connected to the crankshaft.

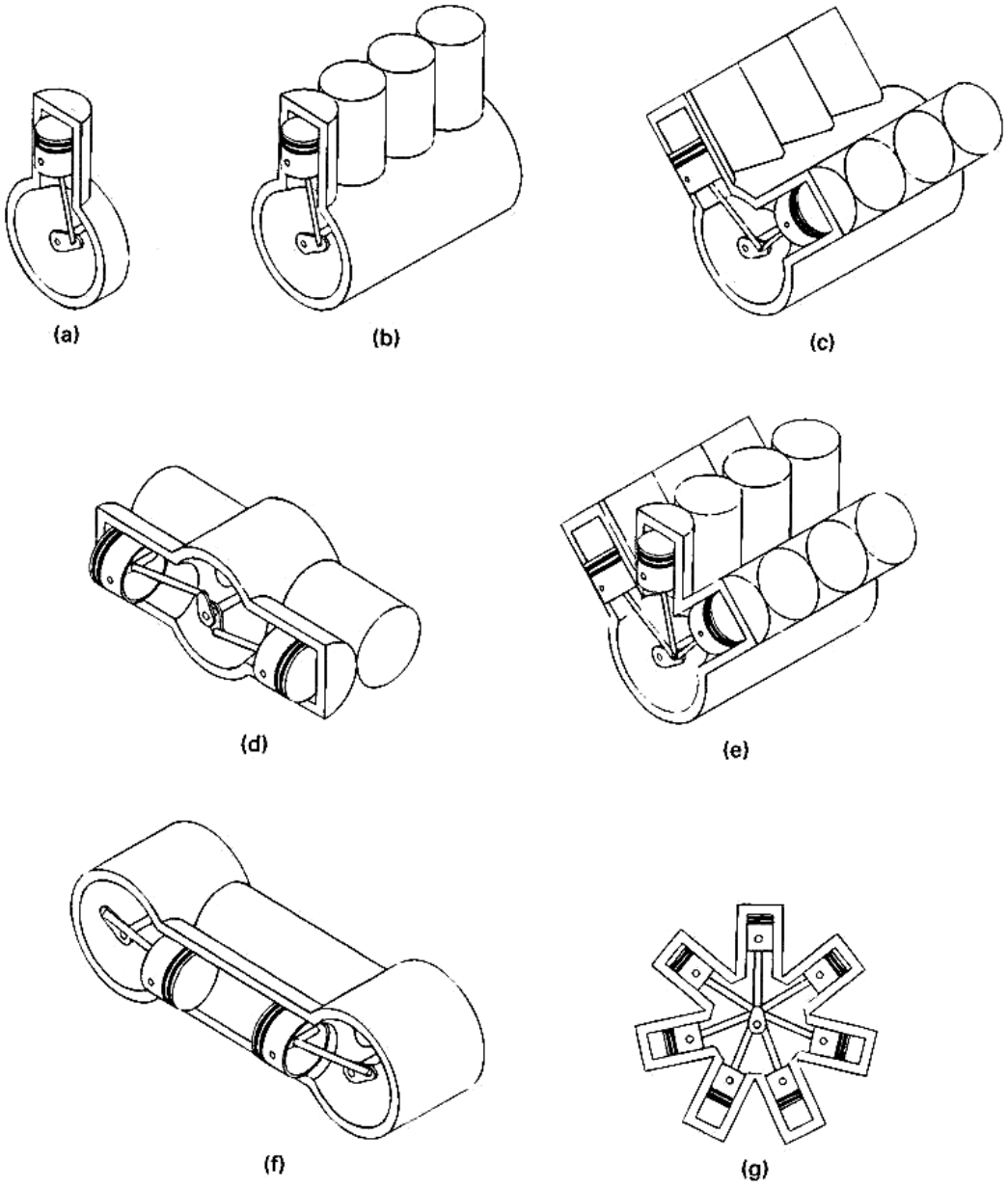


Figure 1-7 Engine Classification by Cylinder Arrangement. **(a)** Single cylinder. **(b)** In-line, or straight. **(c)** V engine. **(d)** Opposed cylinder. **(e)** W engine. **(f)** Opposed piston. **(g)** Radial.

6. Air Intake Process

(a) Naturally Aspirated. No intake air pressure boost system.
(b) Supercharged. Intake air pressure increased with the compressor driven off of the engine crankshaft .

(c) Turbocharged. Intake air pressure increased with the turbine-compressor driven by the engine exhaust gases.

(d) 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.

7. Method of Fuel Input for SI Engines

(a) Carbureted.
(b) Multipoint Port Fuel Injection. One or more injectors at each cylinder intake.
(c) Throttle Body Fuel Injection. Injectors upstream in intake manifold.

8. Fuel Used

(a) Gasoline.
(b) Diesel Oil or Fuel Oil.
(c) Gas, Natural Gas, Methane.
(d) LPG.
(e) Alcohol-Ethyl, Methyl.
(f) Dual Fuel. There are a number of engines that use a combination of two or more fuels. Some, usually large, CI engines use a combination of methane and diesel fuel. These are attractive in developing third-world countries because of the high cost of diesel fuel.
(g) Gasohol. Common fuel consisting of 90% gasoline and 10% alcohol.

9. Application

(a) Automobile, Truck, Bus. (b) Locomotive. (c) Stationary. (d) Marine. (e) Aircraft. (f) Small Portable, Chain Saw, Model Airplane.

10. Type of Cooling

(a) Air Cooled. (b) Liquid Cooled, Water Cooled.

Several or all of these classifications can be used at the same time to identify a given engine. Thus, a modern engine might be called a turbocharged, reciprocating, spark ignition, four-stroke cycle, overhead valve, water-cooled, gasoline, multipoint fuel-injected, V8 automobile engine.