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## Learning Objectives

• To learn about the self-propelled vehicle with stage by stage improvement from past to present.

# 4.0 INTRODUCTION4.1 HISTORY OF AUTOMOBILE

In the early days, the man began his journey by walking. Then he used animals like horse, elephant, camel, donkey for his journey. Wheels are the most



ancient discovery for human kind. With the help of wheel, the mankind designed horse carriage, bullock cart for transportation of people and goods. As time has gone on, they have devised increasingly more effective and efficient methods of travel. The automobile made a dramatic change in the way people travel.

Leonardo da Vinci considered the idea of a self-propelled vehicle in the 15<sup>th</sup>century. In 1680, Sir Issac Newton discovered that if steam is sent out in the rear direction, the vehicle will move forward. In 1769, Nicolas-Joseph Cugnot of France was the constructor of the first true automobile. Cugnot's vehicle was a steam-powered tri cycle carrying four people, and run for 20 minutes at3.6 km per hour.

During the 18<sup>th</sup> century, James Watt invented the steam engine and it leads to many developments in road transportation. In 1801, Richard Trevithick of Great Britain invented a steam-powered road carriage. Following him, W.H. James invented the automobile running with different speed. Till then, the research was focused on the External combustion engine. In 1863, Jean-Joseph-Etienne Lenoir, a Belgian engineer invented the "horseless carriage" and it uses an internal combustion engine. This is the first commercially successful internal combustion engine. In 1867, Nikolaus August Otto, German engineer invented the four-stroke internal combustion engine. This engine is the first to efficiently burn fuel directly in a piston chamber.

Two-stroke internal combustion engine was invented by Sirclerk, a German scientist in 1880. In 1885, a German engineer, Karl Benz builds the first true automobile powered by a gasoline engine. It has three wheels and looked similar to a carriage. In 1886, Gottlieb Wilhelm Daimler and Wilhelm Maybach invent the first four-wheeled, four-stroke engine in Germany. It is known as the "Cannstatt-Daimler."

In 1892, Rudolf Diesel was a German thermal engineer, invented the internal-combustion engine that runs on diesel. In 1894, Benherd developed an automobile by placing the engine in the front part of the chassis.

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#### Horsepower

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James Watt

The term was adopted in the late 18th century by Scottish engineer James Watt to compare the output of steam engines with the power of draft horses.

It was later expanded to include the output power of other types of piston engines, as well as turbines, electric motors and other machinery. When the steam engine began to do the work of horses in the mines during the early 1800s, the mine owners began to ask how many horses an engine would replace.

Watt measured the capability of a big horse to pull a load and found it could pull a weight of 150-pounds while walking at 2.5 miles per hour.

This works out to 33,000 foot-pounds per minute or 550 foot-pounds per second.

It was later expanded to include the output power of other types of piston engines, as well as turbines, electric motors and other machinery.

The definition of the unit varied among geographical regions. Most countries now use the SI unit watt for measurement of power.



In 1900, a steering wheel is designed to replace the steering tiller and the vehicle was used for road transportation. In 1906, the first automobile was produced and sold. In 1908, henry ford manufactured 20000 cars. A lot of research and development had been made from 1910. In 1920, spark plug engine, water cooled engines are introduced.

Later, many vehicle manufacturers start begins to manufacture and sell their vehicle on the market. Many models based on the utility and usage has been introduced. Some of them include two-wheeler, three wheelers, passenger cars, luxury cars, buses, trucks etc.

#### 4.2 ENGINE

The engine is the power plant of an automobile. A device which is used to convert one form of energy into mechanical energy is called an Engine. The heat energy produced by burning of the fuel is converted into mechanical power, then it is called a Heat Engine.

Heat engines are classified into two types.

- 1. External Combustion Engine
- 2. Internal Combustion Engine

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### 4.2.1 External Combustion Engine

An external combustion engine is a heat engine where a working fluid, is heated by combustion in an external source like Boiler. The fluid then, by expanding and acting on the mechanism of the engine, produces motion and usable work.

In external combustion engines, the combustion process takes place outside the mechanical engine system. External Combustion Engines are used in the following.

#### **Ancient Marine Engine**



Ancient Road Roller Engine Steam Locomotive



Figure 4.2.1

## 4.2.2 INTERNAL COMBUSTION ENGINE

An internal combustion engine (ICE) is a heat engine where the combustion of a fuel and air occurs inside the engine combustion chamber that is an integral part of an engine.

#### 4.2.3 Classification of Internal Combustion Engine

Internal Combustion Engines are classified in many different ways as follows

- 1. According to the Cycle of Operation
  - a) Otto Cycle
  - b) Diesel Cycle
- 2. According to the No. of Stroke
  - a) Two stroke engine
  - b) Four stroke engine



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- 3. According to the Fuel used
  - a) Petrol or Gasoline Engine
  - b) Diesel Engine
  - c) Gas Engine



- 4. According to the Combustion System
  - a) Spark ignition system
  - b) Compression ignition system
- 5. According to the No. of cylinder
  - a) Single cylinder engine
  - b) Multi-cylinder engine
- 6. According to the arrangement of Cylinder
  - a) Inline engine
  - b) V type engine
  - c) Opposed cylinder engine
  - d) Radial engine





**Inline Engine** 

- V Type Engine
- 7. According to the construction of Valve
  - a) L head engine
  - b) T head engine
  - c) I head engine
  - d) F head engine

- 8. According to the Cooling System
  - a) Air cooled engine
  - b) Water cooled engine



- 9. According to the Speed
  - a) Low-speed engine
  - b) Medium speed engine
  - c) High-speed engine

10. According to the Usage

- a) Stationary engine
- b) Automotive engine
- c) Locomotive engine
- d) Marine engine
- e) Aircraft engine



**Stationary Engine** 



**Marine Engine** 



**Aircraft Engine** 



**Automotive Engine** 



**Locomotive Engine** 

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#### Internal compression engine



**Nikolaus Otto** 

Nikolaus August Otto (14 June 1832, Holzhausenan der Haide, Nassau – 26 January 1891, Cologne) was a German engineer who successfully developed the compressed charge internal combustion engine which ran on petroleum gas and led to the modern internal combustion engine.

The VDI (Association of German Engineers) created DIN standard 1940 which says "Otto Engine: internal combustion engine in which the compressed fuel-air mixture is initiated by a timed spark ignition", which has been applied to all engines of this type since.

His main interest in school had been in science and technology but he graduated after three years as a business apprentice in a small merchandise company.



## 4.3 TECHNICAL SPECIFICATION OF THE ENGINE

- Top Dead Centre (TDC) is the outermost point of forward travel of the piston in the cylinder.
- 2. Bottom Dead Centre (BDC) is the innermost point of backward travel of the piston in the cylinder.
- Stroke Length is the distance between TDC and BDC travelled by the piston in the cylinder. It will be twice the crankshaft throw.
- 4. Crankshaft throw is the distance between the centre of the crankshaft main bearing

to the centre of the crank pin. It will be half of the stroke length.

- 5. Cylinder bore is the inside diameter of the cylinder.
- 6. Clearance volume is the volume of the cylinder above the piston when the piston is at TDC.
- Swept volume / Displaced volume is the volume displaced by the piston when piston moves from TDC to BDC
- Total volume is the volume of the cylinder above the piston when the piston is at BDC.

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Figure 4.3 Technical Specification of the Engine

- 9. Compression ratio is the ratio of total volume of the cylinder to clearance volume.
- 10. Indicated power is defined as the power developed by combustion of fuel inside the engine cylinder.

$$IP = \frac{P_m LAN}{60 \times 1000}$$

I.P. = Indicated Power, kW

 $P_m =$  Mean Effective Pressure, N/m<sup>2</sup>

L =Stroke Length, m

A = Cross section area of Piston,  $m^2$ 

- N = Crankshaft RPM (for 2 Stroke engine N, for 4 Stroke engine N/2)
- 11. Brake power is the actual work output of an engine or the actual work available at the crankshaft. It can be measured with the help of brake dynamometer.

$$B.P = \frac{2\pi NT}{60 \times 1000}$$

B.P. = Brake Power, kWN = Crankshaft RPMT = Torque or Resisting torque in the dynamometer, Nm and

- 12. Frictional power: Engine brake power is always less than Indicated power, due to frictional losses at the working surfaces like bearings, piston rings and valves. The power loss due to friction is called as frictional power.
- Friction power, F.P. = Indicated power, I.P. Brake power, B.P.

Efficiency: The ratio of power output and power input to the engine is called as Efficiency. It is calculated by Volumetric Efficiency, Thermal Efficiency and Mechanical Efficiency.

Volumetric Efficiency is defined as the ratio of the actual volume of air inducted during the intake stroke to the theoretical volume of a cylinder.

Thermal Efficiency is the ratio of the useful work obtained to the heat supplied to the engine.

Mechanical Efficiency is defined as the ratio of flywheel output to the useful work obtained from the engine.

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## Who made the first motor cycle?

First motor cycle was designed and built by the German inventors Gottlieb Daimler and Wilhelm Maybach in 1885.

It was designed as a testbed for their new engine, rather than a true prototype vehicle.



- 14. Brake Mean Effective Pressure (BMEP) is the mean (average) pressure on the piston uniformly acting during the power stroke, which would produce the same measured (brake) power output.
- 15. Specific fuel consumption (SFC) is defined as the total fuel consumption per hour per kW power developed. SFC is the rate of fuel consumption per kWh. It allows comparing engines of different sizes to see which is the most fuel efficient. It helps to determine which engine uses the least amount of fuel while producing high power. When Indicated power (IP) is used to calculate SFC, then it is known as Indicated Specific fuel consumption (ISFC) and when Brake power (BP) is used to calculate SFC, then it is known as Brake Specific fuel consumption (BSFC).



## 4.4 ROYAL AUTOMOTIVE CLUB RATING

RAC Rating was introduced by the Royal Automobile Club in England. The tax horsepower or taxable horsepower was an early system by which taxation rates for automobiles were calculated. Taxable horsepower is a calculated figure based on the engine's bore size, number of cylinders but does not reflect on developed horsepower.

- RAC rating =  $(D \times N) / 2.5$
- D = the diameter of the cylinder in inches
- [1'' = 25.4 mm], and
- N = the number of cylinders

## 4.5 SOCIETY OF AUTOMOTIVE ENGINEERS RATING

Society of Automotive Engineers Rating is based on net power developed on the engine. Net power is the power developed by the engine by removing engine belt-driven accessories, air cleaner, emission controls, exhaust system, and other power-consuming accessories.

**Student Activity** 

- 1. Students should prepare the list of most widely used cars by the public.
- 2. Students should prepare an album containing the cars used in India and other foreign countries.
- 3. Students should visit the nearby workshops to learn the functioning of Internal and External combustion engines

### Diesel engine

Rudolf Christian Karl Diesel (German: 18 March 1858 – 29 September 1913) was a German inventor and mechanical engineer, famous for the invention of the diesel engine, and for his mysterious death. Diesel was the subject of the 1942 film Diesel



**Rudolf Diesel** 

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Diesel was born in Paris, France in 1858 the second of three children of Elise and Theodor Diesel.

His parents were Bavarian immigrants living in Paris. Theodor Diesel, a bookbinder by trade, left his home town of Augsburg, Bavaria, in 1848.



He met his wife, a daughter of a Nuremberg merchant, in Paris in 1855 and became a leather goods manufacturer there.

Figure 4.5

Glossary			
	Transportation	-	போக்குவரத்து
	Dramatic	-	நடைமுறை மாற்றம்
	Discovered	-	கண்டுபிடிப்பு
	Commercially	-	வணிகரீதியாக
	Combustion	-	எரியூட்டுதல்
	Efficiently	-	திறமையான
	Manufactured	-	தயாரித்தல்
	Luxury	-	சொகுசான

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### **SAMPLE QUESTIONS**

#### Choose the correct answer:

- 1. In which year Nikolos otto invented four stroke internal combustion engine?
  - a) 1863 b) 1866
  - c) 1880
- 2. In which year Rudalf Diesel invented diesel engine?
  - a) 1886 b) 1892
  - c) 1894

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- 3. Crank throw is
  - a) The distance between TDC & BDC
  - b) half of the stroke length
  - c) Double time of the stroke length
- 4. Which type of steam engine is used in locomotive?
  - a) Internal combustion engine
  - b) External combustion engine
  - c) opposite cylinder engine
- 5. Stroke is
  - a) Distance between TDC & BDC
  - b) Equal to crank throw
  - c) Half of the crank throw

#### Answer the following questions:

- 1. What is meant by Automobile?
- 2. In which year and by whom the Automobile Vehicle is invented?
- 3. Describe the History of Automobile.
- 4. Based on the Fuels how the Automobile Vehicle is classified? Mention the Names.
- 5. State three examples of External Combustion Engine.
- 6. What is Internal Combustion Engine?
- 7. How do you classify the Internal Combustion Engine?
- 8. What is Stroke?
- 9. Write short notes on TDC & BDC.
- 10. Define Compression Ratio.