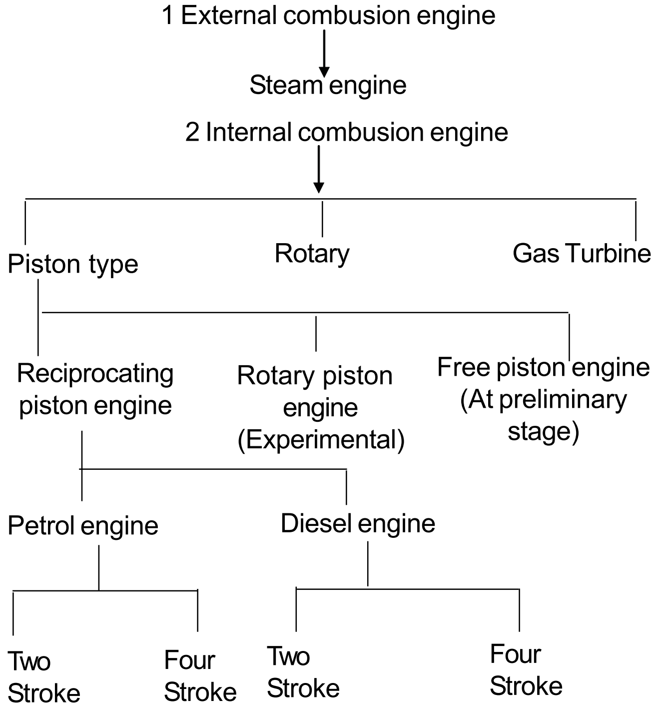
Internal and external combustion engine

Objectives : At the end of this lesson you shall be able to
- **type of heat engine**
- **state the internal and external combustion engine**
- **difference between an internal and external combustion engine.**

Types of heat engines



As indicated above, modern automobile engines are:

With regard to their construction and operation:

i Piston type

ii Rotary

iii Turbine

Internal combustion engine

Internal combustion engine means, that combustion takes place inside the cylinder, this definition including the two stroke and four stroke engine, spark ignition and compression ignition engine, wrankle, austine and jet engines are also i.e engine.

External combustion engine

External combustion engine is that type of engine in which combustion takes place outside the engine cylinder. ex: steam engine.

Difference between internal and external combustion engine

Sl.No	Internal combustion engine	External combustion engine
1	Occupies less space.	Occupies more space.
2	Lighter in weight.	Heavier in weight.
3	High speed engine.	Slow speed engine.
4	Combustion of fuel takes palce inside the engine.	Combustion of fuel takes palce inside the engine.
5	Fuels used in when engine is not running.	Soild or liquid fuels used to form steam.
6	No loss of fuel when engine is not running.	Fuel has to burn even when the engine is not running for small halts.
7	Could be started or stopped at will.	Cannot be started unless steam is prepared which takes much time.
8	Temperature produced inside the cylinder is too high.	Works at comparatively low temperature.
9	Cooling arrangement necessary.	No cooling of the cylinders required. Rather it is steam jacketed.
10	Single acting.	Mostly double acting.
11	Exhause gas temperature as high as 300°C.	The temperature of exhaust steam is quite low.
12	Thermal efficiency of diesel engine up to 40%.	Thermal efficiency up to 24% as that of petrol engine.
13	No needs boiler, furnace or condenser.	Boilder, furnace and condenser are must.

Classification of engine

Objective: At the end of this lesson you shall be able to
- **state the classification of engines.**

Engines are classified according to the following factors.

Number of cylinders

Single cylinder

Multi cylinder

Arrangements of cylinders

In-line engine (Fig 1)

`V' shape engine (Fig 2)

Opposed engine (Fig 3)

Horizontal engine

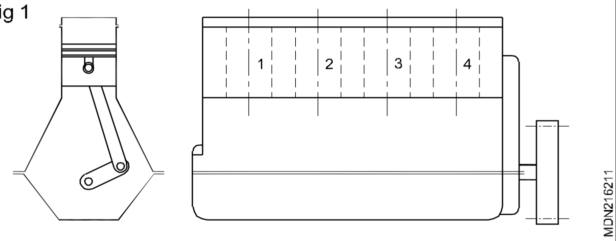
Radial engine (Fig 4)

Vertical engine

Types of engines as per cylinder arrangement

In-line engines

Fig 1

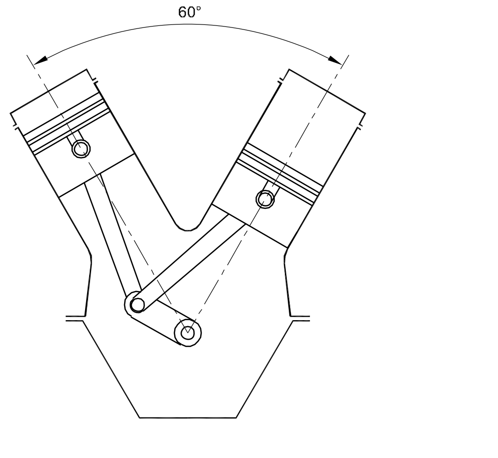


In this type, the cylinders are arranged in one line. The length of the crankshaft is longer than that of the other types of engines, and hence a limited number of cylinders are used. Better balancing and more uniform torque is obtained in this type.

V engines

In this type, the cylinders are arranged in V shape at an angle, of usually 60°. This engine is more economical and compact. For multi-cylinder engines, the length of the crankshaft is much shorter than that of the in- line engine. In this type, the engine height is also lower than it is in the in-line engine.

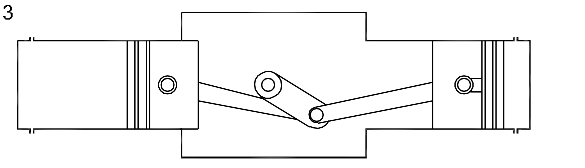
Fig 2



Opposed engines

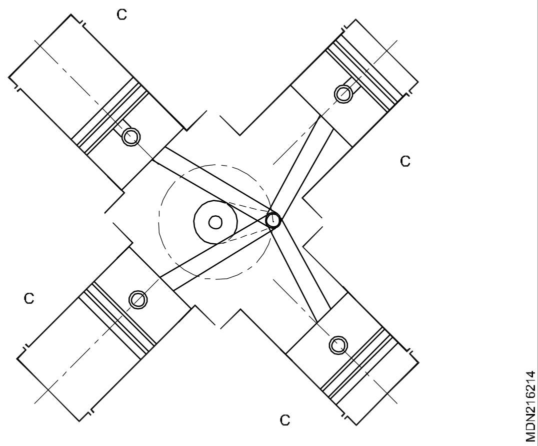
In this type the cylinders are arranged horizontally opposite to each other. This provides better mechanical balance. This type of engine can run smoothly even at a much higher speed. It also gives higher output. The length of the engine is too much, and therefore engine has to be placed in the transverse direction in the vehicle.

Fig 3



Radial engines

Fig 4



In this type, the cylinders are arranged radially. This type of engine is shorter, lighter and more rigid. Since it is rigid, a higher engine speed is possible and a higher combustion pressure can be obtained. This leads to high fuel efficiency. The radial type engines are used mostly in aeroplanes.

Types of engine as per number of cylinders

Single cylinder engines

An engine which has only one cylinder is called a single cylinder engine. Since it is a single cylinder engine it cannot develop more power. It is normally used only in two wheelers like scooters and motor cycles.

Multi cylinder engines

These engines have more than one cylinder. Two-cylinder engines are usually used in tractors. Three or four cylinder engines are used in cars, jeeps and other vehicles. In heavy vehicles six-cylinder engines are used. A greater number of cylinders gives smoother engine operation.

Types of fuel used

Petrol

Diesel

Types of valve arrangements

`I' head engine

`F' head engine

`L' head engine

`H' head engine

`T' head engine

Application of engine

Constant speed engine

Variable speed engine

Cooling system

Air cooled engine

Water cooled engine

Strokes of engine

Four-stroke engine

Two-stroke engine

Rotary engine

Function of Diesel engine

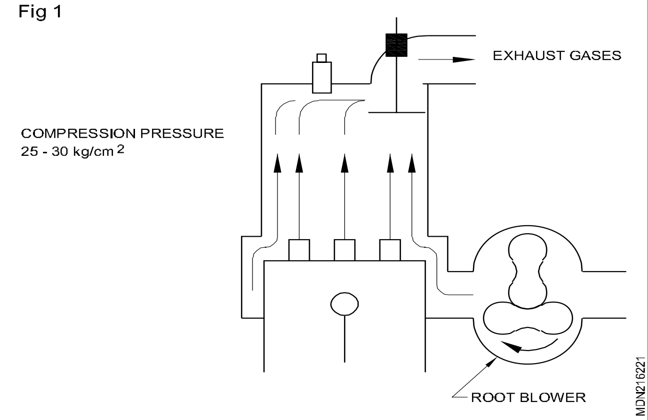
Objectives : At the end of this lesson you shall be able to
- **describe the function of a two-stroke diesel engine**
- **describe the function of a four-stroke diesel engine.**

Two strke diesel engine:

To produce power in a two stroke engine the following operation take place in the sequence given.

First stroke: Piston at BDC the scavenging port and outlet valve open (Fig 1). A root blower sucks in pure air and presses it through the scavenging port into the cylinder. The tangential layout of the scavenging port brings the air into a turbulent motion. The cylinder is completely flushed out in the direct current and filled with fresh air. The exhaust gases flow out towards the outlet valve.

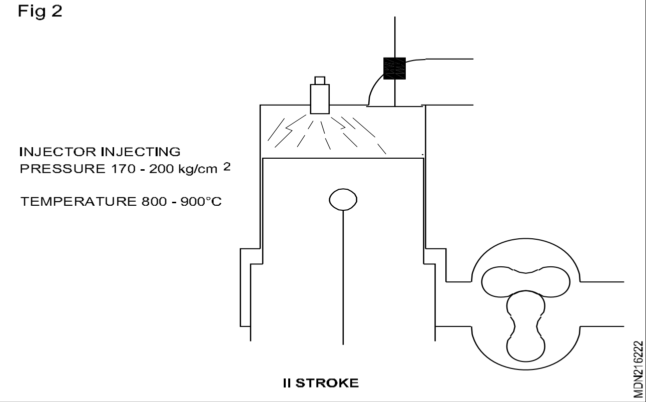
Fig 1



As the piston moves up from BDC the scavenging port and outlet valve closed. The piston compresses the fresh air to the compression chamber. The air temperature increases intensively.

Second stroke: Piston at TDC (Fig 2) scavenging port and outlet valve closed. The fuel is directly injected into the cylinder with the help of a fuel injection pump and an injector fitted in the cylinder head. The fuel gets vaporised into an ignitable fuel air mixture by the hot air. After attaining the ignition temperature the mixture gets automatically ignited and burns. The heat increases the pressure in the combustion chamber. The gases get expanded and push the piston to the bottom dead centre.

Fig 2



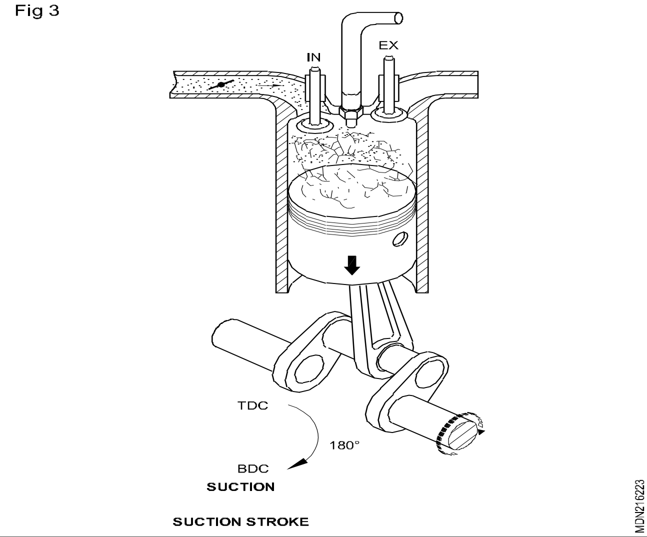
Four-stroke engine

To produce power in a four-stroke engine the following operations take place in the sequence given.

Suction stroke

The piston moves from TDC to BDC (Fig 3). A vacuum is created inside the cylinder. The inlet valve opens while the exhaust valve remains closed. The charge (air/air-fuel mixture) enters the cylinder.

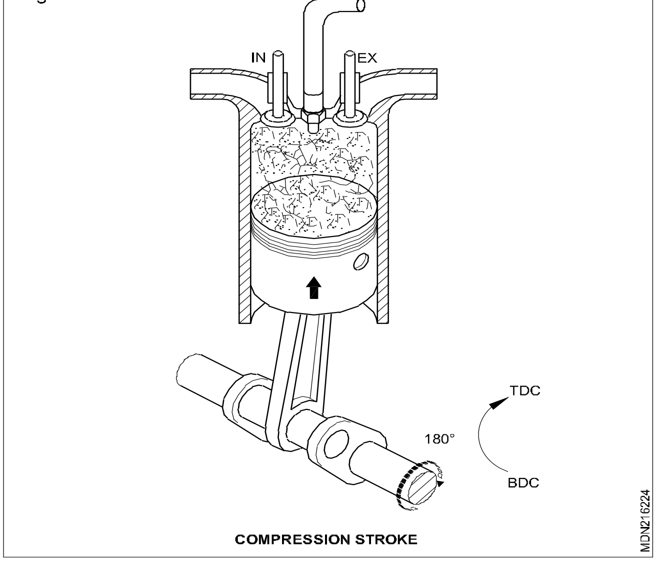
Fig 3



Compression stroke

The inlet valve closes. The exhaust valve remains closed. The piston moves from BDC to TDC (Fig 4). The charge (air/air-fuel mixture) is compressed.The pressure and temperature rise.

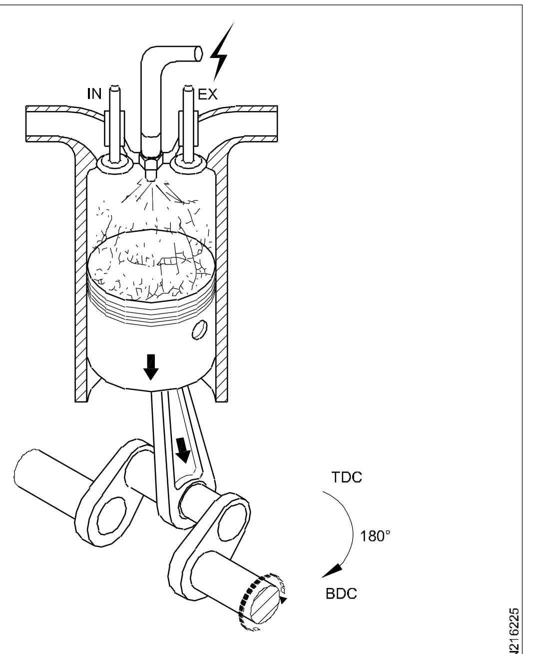
Fig 4



Power stroke

At the end of compression stroke diesel fuel is injected into the hot compressed air in the combusion chamber; result in instances burning of diesel with an explosion the gas expand for is the piston down and power is produced and pressure develops inside the cylinder. The gas expands and the piston is forced down from TDC to BDC (Fig 5). Both the valves remain closed. Power is supplied to the flywheel.

Fig 5



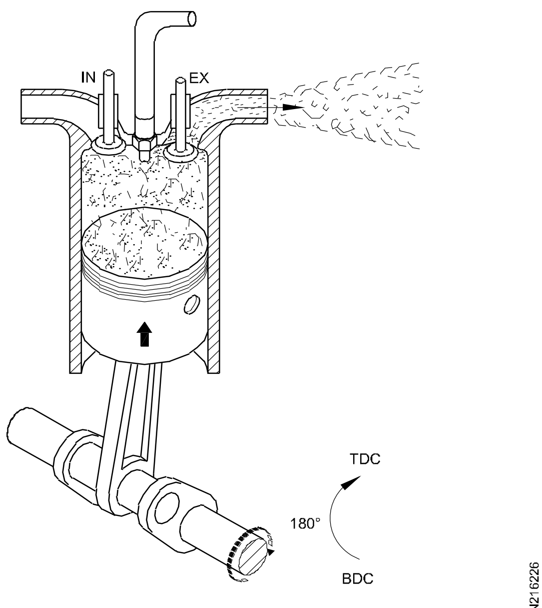
POWER STROKE

Exhaust stroke

The inlet valve remains in the closed position. The exhaust valve opens, the piston moves from BDC to TDC (Fig 6) due to the energy stored in the flywheel. The burnt gases inside the cylinder go out through the exhaust valves. At the end of the stroke the exhaust valve closes.

The cycle of suction, compression power and exhaust are repeated. In this type of engines one power stroke is obtained in two revolutions of the crankshaft.

Fig 6



EXHAUST STROKE

Function of spark ignition

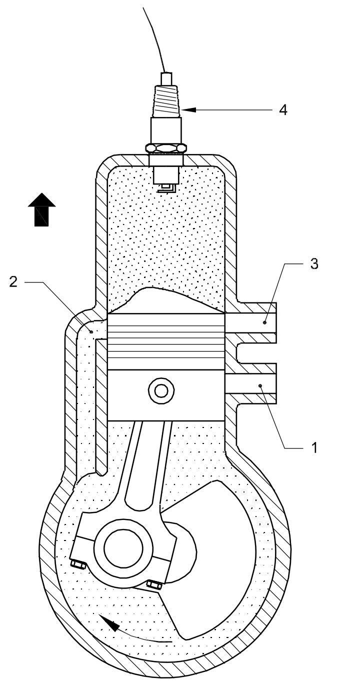
Objectives : At the end of this lesson you shall be able to
- **describe the function of a two-stroke engine**
- **describe the function of a four-stroke engine**
- **differentiate between a four-stroke and a two-stroke engine**
- **explain an OTTO cycle**
- **explain a diesel cycle.**

Two-Stroke spark ignition engines

To produce power in two stroke engine the following operations take place in the sequence given.

First stroke (Suction and compression)

Fig 1



FIRST STROKE

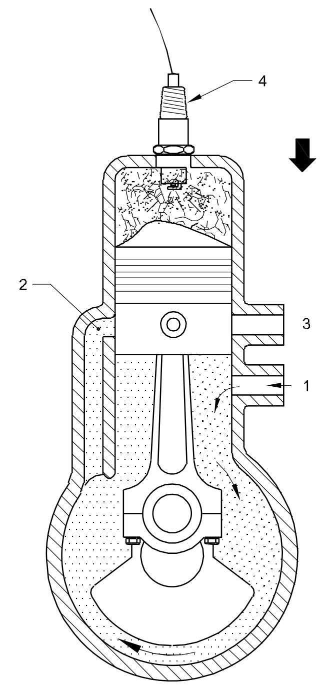
As the piston moves up from BDC,(Fig 1) it closes the inlet port (1), the exhaust port (3) and the transfer port (2). Further upward movement of the piston results in compressing the mixture in the cylinder and opening of the inlet port (1). The upward motion of the piston creates a partial vacuum inside the crank-case below the piston, and the air/fuel mixture is drawn into the crank-case through the inlet port (I). The exhaust and transfer ports remain closed during the operation of the upward stroke and the charge which reached above the piston during the previous stroke is compressed.

At the end of this stroke the mixture is ignited by an electric spark (4). This causes the pressure to rise.

Second stroke (power and exhaust)

The piston is forced downward from the TDC (Fig 2). During this stroke the exhaust port opens and burnt gases escape into the atmosphere.

Fig 2



FIRST STROKE

Further downward movement of the piston opens the transfer port and allows the partially compressed mixture, received during the previous stroke, to reach the combustion chamber from the crankcase.

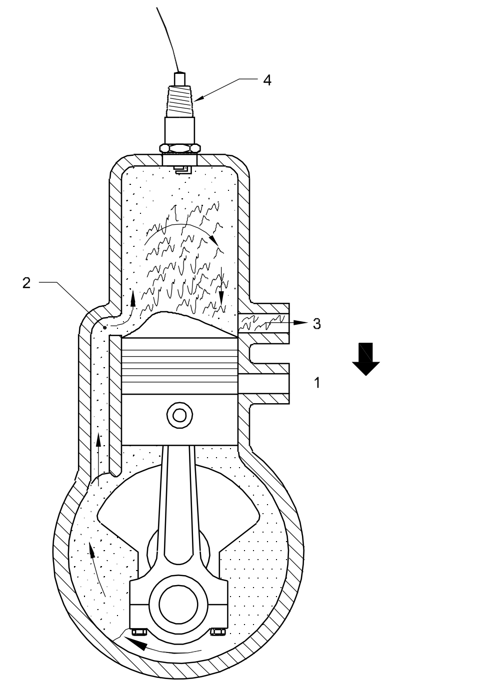
The piston head has a special shape. It deflects a fresh change of fuel mixture up into the cylinder. The mixture flows down and pushes the burnt gas out. Through the exhaust port. This process is called scavenging. Once the flywheel has completed one revolution, the cycle is repeated. In this engine one power stroke is obtained in each revolution of the crankshaft.

Spark ignition (Fig 3)

In a spark ignition (SI) engine, petrol is used as fuel. During the suction stroke the air and fuel mixture is sucked into the cylinder. The quantity of the mixture is metered by the carburettor according to the load and speed. The ratio of air/fuel mixture is also metered by the carburettor. During the compression stroke, this air/fuel mixture is ignited by the spark and the mixture is burnt. It raises the pressure of the gas above the piston. The piston is forced down and this power is supplied to the flywheel. During the exhaust stroke burnt gases escape through the exhaust port/valve.

In this type of engine the compression ratio is low.

Fig 3



SECOND STROKE

Four-stroke spark ignition engine

To produce power in a four-stroke engine the following operations take place in the sequence given.

Suction stroke

The piston moves from TDC to BDC (Fig 4). A vacuum is created inside the cylinder. The inlet valve opens while the exhaust valve remains closed. The charge (air/air-fuel mixture) enters the cylinder.

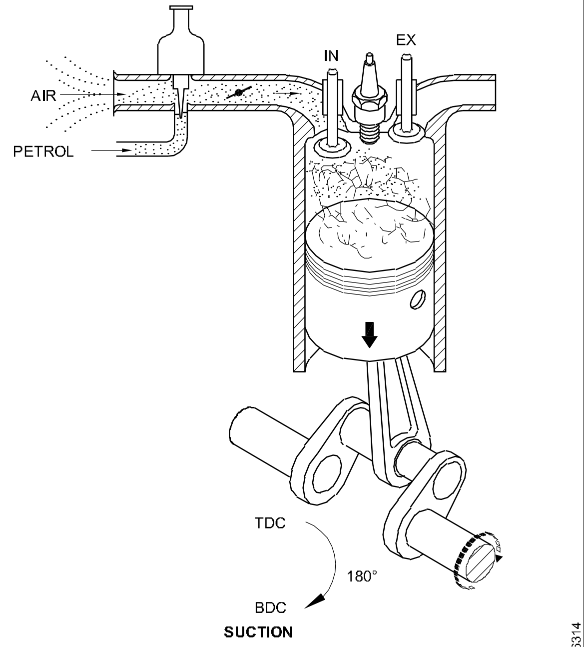
Compression stroke

The inlet valve closes. The exhaust valve remains closed. The piston moves from BDC to TDC (Fig 5). The charge (air/air-fuel mixture) is compressed. The pressure and temperature rise.

Power stroke

The charge is ignited and pressure develops inside the cylinder. The gas expands and the piston is forced down from TDC to BDC (Fig 6). Both the valves remain closed. Power is supplied to the flywheel.

Fig 4



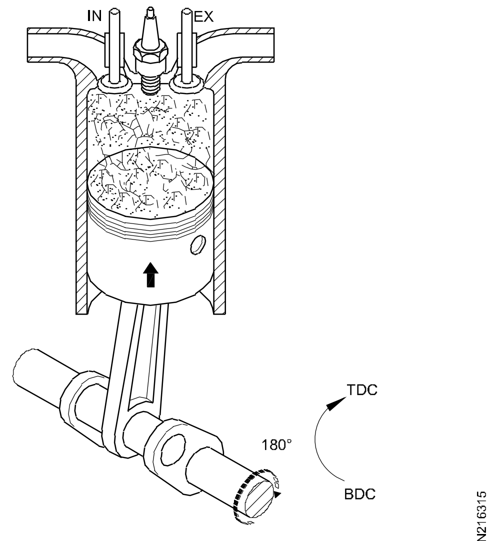
SUCTION STROKE

Exhaust stroke

The inlet valve remains in the closed position. The exhaust valve opens, the piston moves from BDC to TDC (Fig 7) due to the energy stored in the flywheel. The burnt gases inside the cylinder go out through the exhaust valves. At the end of the stroke the exhaust valve closes.

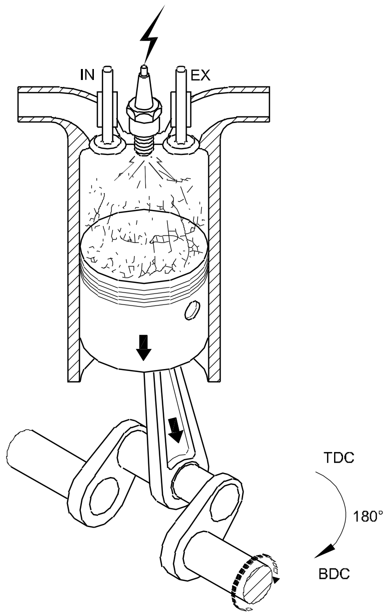
The cycle of suction, compression power and exhaust are repeated. In this type of engines one power stroke is obtained in two revolutions of the crankshaft.

Fig 5



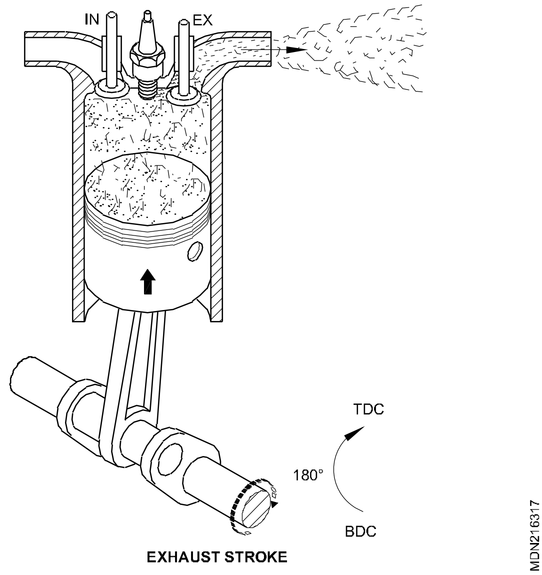
COMPRESSION STROKE

Fig 6



POWER STROKE

Fig 7



EXHAUST STROKE

Comparison between four-stroke engine and two-stroke engine

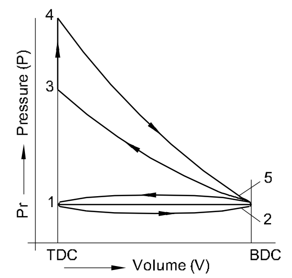
Four-stroke engine	Two-stroke engine
Four operations (suction, compression, power and exhaust) take place in the four strokes of the piston.	The four operations take place in two strokes of the piston.
It gives one power stroke in the four strokes, i.e in two revolutions of the crankshaft. As such three strokes are idle strokes.	The power stroke takes place in every two strokes i.e. one power stroke for one revolution of the crankshaft.
Due to more idle strokes and non-uniform load on the crankshaft, a heavier flywheel is required.	The engine has more uniform load as every time the piston comes down it is the power stroke. As such a lighter flywheel is used.
The engine has more parts such as valves and its operating mechanism. Therefore, the engine is heavier.	The engine has no valves and valve-operating mechanism therefore it is lighter in weight.
The engine is costlier as it has more parts.	The engine is less expensive as it has a lesser number of parts.
The engine efficiency is more as the charge gets completely burnt out. Consequently the fuel efficiency is more.	The engine efficiency is less. A portion of the chargescapes through the exhaust port, and because of this, the fuel efficiency is less.

Comparison between S.I and C.I. Engine

SI engine	CI engine
Petrol is used as fuel.	Diesel is used as fuel.
During the suction stroke air and fuel mixture is sucked in.	During the suction stroke air alone is sucked in.
Compression ratio is low. (Max. 10:1)	Compression ratio is high. (Max. 24:1)
Compression pressure is low. (90 to 150 PSI)	Compression pressure is high. (400 to 550 PSI)
Compression temperature is low.	Compression temperature is high.
It operates under constant volume cycle (otto cycle).	It operates under constant pressure cycle (diesel cycle).
Fuel is ignited by means of an electric spark.	Fuel is ignited due to the heat of the highly compressed air. Combustion takes place at constant pressure.
A carburettor is used to atomize, vaporize and meter the correct amount of fuel according to the requirement.	Fuel injection pumps and atomizers are used to inject metered quantities of fuel at high pressure according to the requirement.
Less vibration, and hence, smooth running.	More vibration, and hence, rough running and more noisy.
Engine weight is less.	Engine weight is more.
It emits carbon monoxide. (CO)	It emits carbon dioxide. (CO_2)

Otto Cycle

Fig 8



1 - 2 - Suction
2 - 3 - Compression
3 - 4 - Heat addition
4 - 5 - Power
5 - 2 - 1 - Exhaust

In otto cycle engine,(Fig 8) combustion takes place at constant volume.

Suction takes place at a pressure below atmospheric pressure when piston moves from TDC to BDC. (1-2)

Compression takes place when piston moves from BDC to TDC. (2-3)

Fuel mixture is ignited by introducing a spark at constant volume. (3-4)

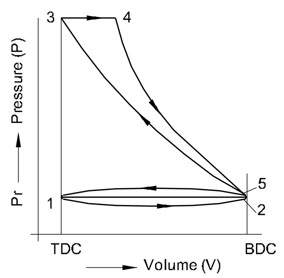
The gas expands during the power stroke (4-5), reducing both pressure and temperature.

Heat is rejected at constant volume. (5-2)

Burnt gases exhaust when piston moves from BDC to TDC. (2-1)

Diesel Cycle

Fig 9



1 - 2 - Suction
2 - 3 - Compression
3 - 4 - Heat addition
4 - 5 - Power

Suction takes place at (Fig 9) pressure below atmospheric pressure when piston moves from TDC to BDC. (1-2)

Compression takes place when piston moves BDC to TDC. (2-3) (Both the valves closed).

Fuel is sprayed at high pressure and ignited by hot compressed air (3-4), and this process takes place at constant pressure.

Fuel ignites, pressure of burnt gas increases, gas expands and piston is forced from TDC to BDC. (4-5)

Heat is rejected at constant volume. (5-2)

Burnt gases exhaust when piston moves from BDC to TDC. (2-1)

Main parts of Internal Combustion engine

Objectives : At the end of this lesson you shall be able to
- **location of an engine parts fitting.**

Internal combustion engine parts

Internal combustion engine's function is accomated with the different types of components and it is connected in outer JPG & inside of the engine.

Name of the components (Fig 1, 2 & 3)

1 Air compressor

2 F.I.P

3 Injector

4 Air cleaner

5 High pressure fuel

6 Fly wheel

7 Oil filter

8 Fuel filter

9 Fan belt

10 Alternator

11 Self starter

12 Water pump

13 Cam shaft

14 Inlet manifold

15 Exhaust manifold

16 Valve door (cover)

17 Rocker assembly

18 Push rod

19 Tappets

20 Cylinder head

21 Piston

22 Turning chain

23 Oil sump

24 Strainer

25 Fly wheel housing

26 Dip stick

27 Connecting rod

28 Crank shaft

29 Remove the timing gear and chain (22). (Notedown timing marks.)

30 Remove the cam shaft

31 Remove the oil sump (23)

32 Disconnect the oil pipes from the oil pump.

33 Remove the oil pump and strainer (24)

34 Remove the oil filter

35 Remove the connecting rod caps. (Note down Nos. on the caps)

36 Remove the piston (21) and connecting rod (27) from engine. (Note down the marks/Nos. on the piston)

37 Remove the main bearing caps. (Note down them No. on the caps)

Fig 1

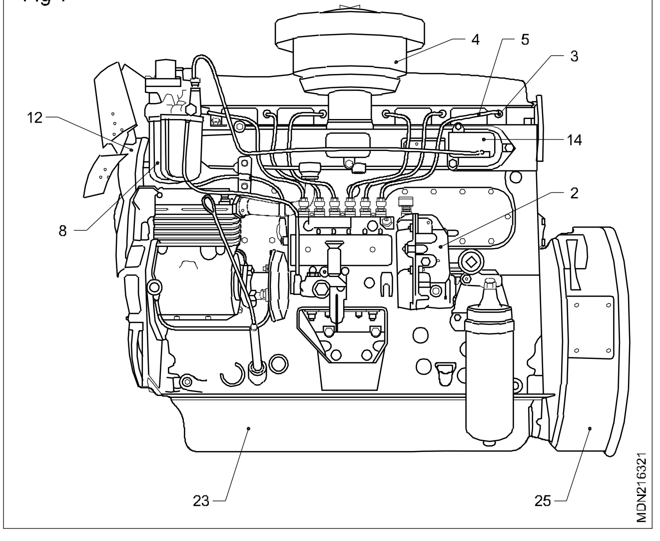


Fig 2

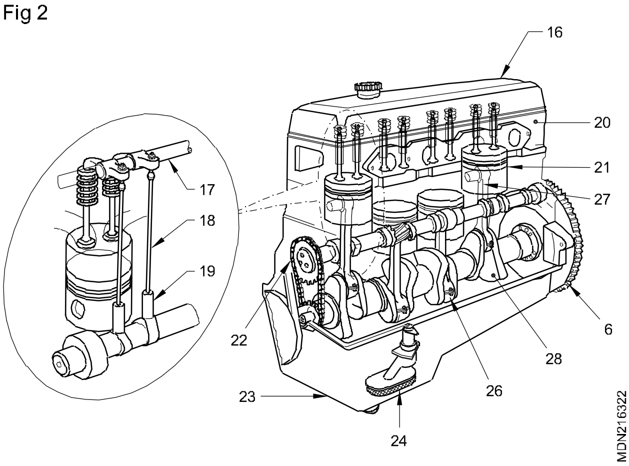
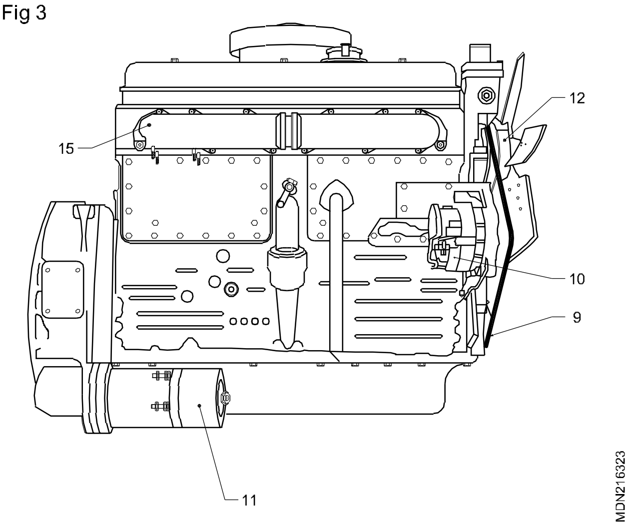


Fig 3



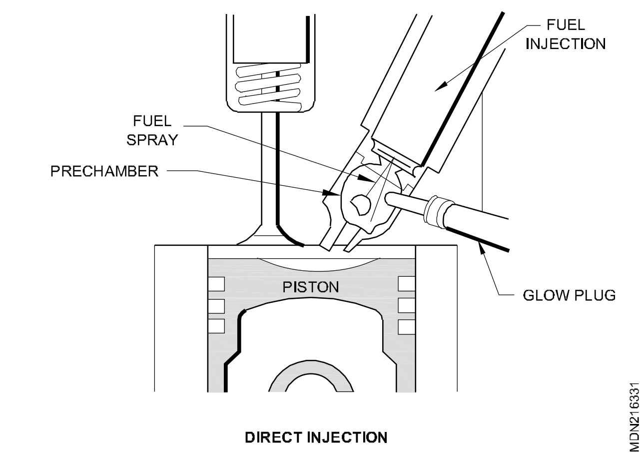
Direct and indirect fuel injection system

Objectives : At the end of this lesson you shall be able to
- **state the function of direct fuel injection**
- **state the function of indirect fuel injection.**

Direct Fuel Injection Works (Fig 1)

Gasoline engines work by sucking a mixture of gasoline and air into a cylinder, compressing it with a piston, and igniting it with a spark. The resulting explosion drives the piston downwards, producing power. Traditional indirect fuel injection systems pre-mix the gasoline and air in a chamber just outside the cylinder called the intake manifold. In a direct injection system, the air and gasoline are not pre-mixed. Rather, air comes in via the intake manifold, while the gasoline is injected directly into the cylinder.

Fig 1



Advantages of Direct Fuel Injection

Combined with ultra-precise computer management, direct injection allows more accurate control over fuel metering, which is the amount of fuel injected and injection timing, the exact point when the fuel is introduced into the cylinder. The location of the injector also allows for a more optimal spray pattern that breaks the gasoline up into smaller droplets. The result is a more complete combustion - in other words, more of the gasoline is burned, which translates to more power and less pollution from each drop of gasoline.

Disadvantages of Direct Fuel Injection

The primary disadvantages of direct injection engines are complexity and cost. Direct injection systems are more expensive to build because their components must be more rugged. They handle fuel at significantly higher pressures than indirect injection systems and the injectors themselves must be able to withstand the heat and pressure of combustion inside the cylinder.

Indirect injection (Fig 2)

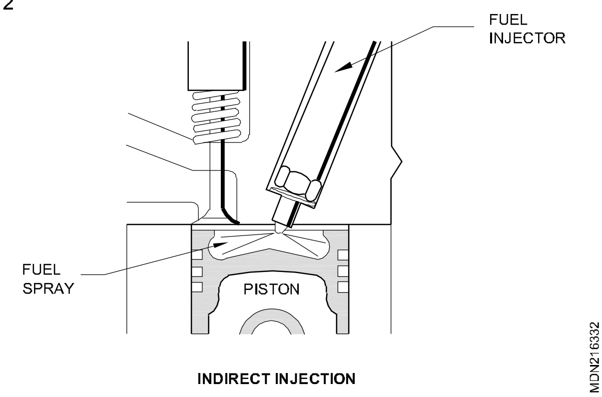
Indirect injection in an internal combustion engine is fuel injection where fuel is not directly injected into the combustion chamber. In the last decade, gasoline engines equipped with indirect injection systems, wherein a fuel injector delivers the fuel at some point before the intake valve, have mostly fallen out of favor to direct injection. However, certain manufacturers such as Volkswagen and Toyota have developed a 'dual injection' system, combining direct injectors with port (indirect) injectors, combining the benefits of both types of fuel injection. Direct injection allows the fuel to be precisely metered into the combustion chamber under high pressure which can lead to greater power, fuel efficiency. The issue with direct injection is that it typically leads to greater amounts of particulate matter and with the fuel no longer contacting the intake valves, carbon can accumulate on the intake valves over time.

Adding indirect injection keeps fuel spraying on the intake valves, reducing or eliminating the carbon accumulation on intake valves and in low load conditions, indirect injection allows for better fuel-air mixing. This system is mainly used in higher cost models due to the added expense and complexity.

Port injection refers to the spraying of the fuel onto the back of the intake port, which speeds up its evaporation.

An indirect injection diesel engine delivers fuel into a chamber off the combustion chamber, called a prechamber, where combustion begins and then spreads into the main combustion chamber. The prechamber is carefully designed to ensure adequate mixing of the atomized fuel with the compression-heated air.

Fig 2



INDIRECT INJECTION

Classification of indirect combustion chambers

- 3.1Swirl chamber
- 3.2Precombustion chamber
- 3.3Air cell chamber

Overview

The purpose of the divided combustion chamber is to speed up the combustion process, in order to increase the power output by increasing engine speed.[2] The addition of a prechamber, however, increases heat loss to the cooling system and thereby lowers engine efficiency. The engine requires glow plugs for starting. In an indirect injection system the air moves fast, mixing the fuel and air. This simplifies injector design and allows the use of smaller engines and less tightly toleranced designs which are simpler to manufacture and more reliable. Direct injection, by contrast, uses slow-moving air and fast-moving fuel; both the design and manufacture of the injectors is more difficult. The optimisation of the in-cylinder air flow is much more difficult than designing a prechamber. There is much more integration between the design of the injector and the engine.[3] It is for this reason that car diesel engines were almost all indirect injection until the ready availability of powerful CFD simulation systems made the adoption of direct injection practical.

Advantages of indirect injection combustion chambers

- Smaller diesels can be produced.
- The injection pressure required is low, so the injector is cheaper to produce.
- The injection direction is of less importance.
- Indirect injection is much simpler to design and manufacture; less injector development is required and the injection pressures are low (1500 psi/100 bar versus 5000 psi/345 bar and higher for direct injection)
- The lower stresses that indirect injection imposes on internal components mean that it is possible to produce petrol and indirect injection diesel versions of the same basic engine. At best such types differ only in the cylinder head and the need to fit a distributor and spark plugs in the petrol version whilst fitting an injection pump and injectors to the diesel. Examples include the BMC A-Series and B-Series engines and the Land Rover 2.25/2.5-litre 4-cylinder types. Such designs allow petrol and diesel versions of the same vehicle to be built with minimal design changes between them.
- Higher engine speeds can be reached, since burning continues in the prechamber.

Disadvantages

- Fuel efficiency is lower than with direct injection because of heat loss due to large exposed areas and pressure loss due to air motion through the throats. This is somewhat offset due to indirect injection having a much higher compression ratio and typically having no emissions equipment.
- Glow plugs are needed for a cold engine start on diesel engines.
- Because the heat and pressure of combustion is applied to one specific point on the piston as it exits the precombustion chamber or swirl chamber, such engines are less suited to high specific power outputs (such as turbocharging or tuning) than direct injection diesels. The increased temperature and pressure on one part of the piston crown causes uneven expansion which can lead to cracking, distortion or other damage due to improper use; use of " starting fluid" (ether) is not recommended in glow plug, indirect injection systems, because explosive knock can occur, causing engine damage.

Basic technical terms used in relation to engines

T.D.C. (Top dead centre)

It is the postion of the piston at the top of a cylinder, where the piston changes its direction of motion from the top to the bottom.

B.D.C. (Bottom dead centre)

It is the position of the piston at the bottom of the cylinder where the piston changes its direction of motion from the bottom to the top.

Stroke

The distance travelled by the piston from TDC to BDC or BDC to TDC.

Cycle

A set of operations performed in sequence by the motion of the piston in an engine to produce power.

Swept volume (VS)

Displacement volume of a piston.

Clearance volume (VC)

Volume of the space above the piston when it is at TDC.

Compression ratio (CR)

Ratio of compression volumes before the stroke and after.

$$CR = \frac{VS + VC}{VC}$$

where VS = Swept volume

VC = Clearance volume

VS+VC = Total volume at BDC.

Power

Power is the rate at which work is done in a specific time.

$$Power = \frac{(Force \times Distance\ moved)}{Time}$$

Horsepower (HP)

It is the measurement of power in SAE. One hp is the power required to lift a load of 33000 lbs, through one foot in one minute or 4500 kg through one meter in one minute (in metric system)

Thermal efficiency

It is the ratio of work output to the fuel energy burnt in the engine. This relationship is expressed in percentage.

Brake horsepower (BHP)

It is the power output of an engine, available at the flywheel,

$$BHP = \frac{2\pi NT}{4500}$$

where N is r.p.m of the crankshaft, and T is the torque produced.

Indicated horsepower (IHP)

It is the power developed in the engine cylinder.

$$IHP = \frac{PmLAN}{4500} \times K$$

Where Pm is the mean effective pressure in kg./cm².

L is length of stroke in metres

A is the area of the piston in cm²

N is the No. of power strokes per minute

K is the No. of cylinders.

Frictional horsepower

It is the horsepower lost in the engine due to friction.

FHP = IHP - BHP

Mechanical efficiency

It is the ratio of power delivered (BHP) and the power available in the engine (IHP). It is expressed in percentage

$$\text{Mechanical efficiency} = = \frac{BHP}{IHP} \times 100$$

Volumetric efficiency

It is the ratio between the air drawn in the cylinder during the suction stroke and the volume of the cylinder.

Throw

It is the distance between the centre of the crank pin to the centre of the main journal. The piston stroke is double the throw.

Firing order

The firing order is the sequence in which the power stroke takes place in each cylinder in a multi-cylinder engine.

Technical Specification of an engine

Engines are specified as per the following.

Type

Number of cylinders

Bore diameter

Stroke length

Capacity in cu.cm/cu.inch

Maximum engine output at specified r.p.m.

Maximum torque

Compression ratio

Firing order

Idling speed

Air cleaner (Type)

Oil filter (Type)

Fuel filter

Fuel injection pump

Weight of engine

Cooling system (type)

Type of fuel

Techincal specifications of vehicles

LPT - 1210 D

Specifications

Engine

Model	6692 D.I.
Number of cylinders	6
Bore	92 mm
Stroke	120mm
Capacity	4788 cc
Gross H.P. (S.A.E.)	125 at 2800 R.P.M.
Taxable H.P.	31.5
Maximum Torque	30 mkg at 2000 R.P.M
Compression Ratio	17 : 1
Compression pressure at 150-200 R.P.M.	Minimum 20 kg/cm^2
Fuel injection begins	23° before T.D.C.
Firing order	1-5-3-6-2-4
Opening pressure of the injection nozzles	200 + 10kg/cm^2 Newnozzels Min. 180 kg/cm^2 Used nozzels
Maximum variation permissible in injectionn: nozzle pressure	5 kg/cm^2
Inlect valve clearance	0.20 mm
Exhaust valve clearance	0.30 mm
Air cleaner	oil bath
Total bearing area per bearing	55 sq.cm
No.of main bearings	7
Fuel injection pump	MICO BOSCH
Weight (Dry)	382 kg
Capcity of cooling system	20 litres
Crankcase oil capacity	Maximum - 14 litres Minimum - 10 litres
Cooling water temperature	75°C - 95°C

Biasis

Raidator	Core frontal area..3500 sq.cm approx x551 (sq.in)
Clutch	Single plate dry friction type Diameter of clutch lining: Outside : 280 mm (11”) Inside : 165 mm (61/2”) Friction area (both sides) : 798 sq.cm approx (124 sq.in)
Transmission	No.of speeds: Forward 5 Reverse 1 Gear Ratio : 1st 7.37 :1 2nd 4.23 : 1 3rd 2.49 : 1 4th 1.56 : 1 5th 1 : 1 Reverse 7.15 : 1 Rear Axle ratio 7.48 - 1 : 6.8.57
Steering	Heavy duty re-circulating ball type steering with universal joint Gear Ration 34.2 :1 Steering wheel diameter 550 mm $\left(21\frac{5}{8}\right)''$
Brakes	Hand brake : Mehanically operated brake acting on rear wheel Foot brake : Hydraulic brakes on front and real wheels, assisted by single chamber air pessure booster. Brake drum diameter: Front : 408 mm (16”) Rear : 408 mm (16”) Total braking area Front : 1440 sq. cm approx (223 sq.in) Rear : 1440 sq. cm approx (223 sq.in)
Frame	Side member of channel section Depth max : 223 mm $\left(8\frac{3}{4}\right)''$ Width : 60 mm $\left(2\frac{3}{4}\right)''$ Thickness : 7 mm $\left(\frac{1}{4}\right)''$
Springs	No.of cross members : 8 Type : Semi-elliptical Composition of steel : silicon -manganese No.of leaves:

	Front	rear
Main	12	12
Auxillary	-	5

Leaf thickness

Main 11 mm $\left(\frac{3}{8}\right)''$ 13 mm $\left(\frac{1}{2}\right)''$

Auxillary —
Total thickness of spring with bottom plate:

132 mm $\left(5\frac{1}{6}\right)''$ 233 mm $\left(9\frac{3}{8}\right)''$

Width of spring leaf:

60 mm $\left(2\frac{3}{8}\right)''$ 80 mm $\left(3\frac{1}{6}\right)''$

Total weight of spring
50 kg. (123 lb) 123 kg. (271 lb)

Shock Absorbers	Hydraulic telescopic type on fron and rear axles.
Wheels and tyres	No.of wheels : Total 7 : Front 2, Rear 4, spare 1. Rim size : 7.00 x 20 No.of Tyres : Toral 6 : Fron 2, Rear 4 Tyre size : 9.00 x 20 ... 12 ply EHD

Dimesions	LPT 1210D/36	LPT 1210D/42
Wheel base	3625 $\left(142\frac{3}{4}''\right)$	4225 mm $\left(166\frac{1}{4}''\right)$
Wheel track : Front	1925 mm $\left(75\frac{3}{4}''\right)$	1925 mm $\left(75\frac{3}{4}''\right)$
Rear	1755 mm $\left(69\frac{1}{8}''\right)$	1755 mm $\left(69\frac{1}{8}''\right)$

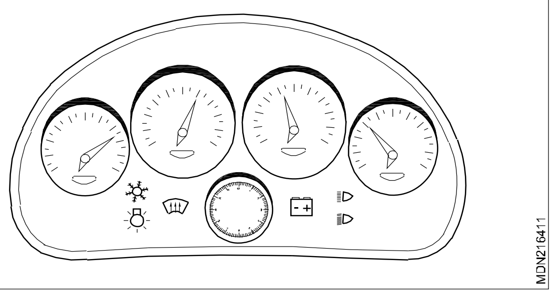
Dashboard gauges, meters and warnings lights

Objectives: At the end of this lesson you shall be able to
- **state different type of meters and their uses**
- **describe the purpose of each warning lights**
- **specify the purpose of each gauges.**

Odometer

An odometer (Fig 1) is an instrument that indicate distance travelled by a vehicle, such as motor cycle and motor vehicle automobile. The device may be electronic, mechanical, or a combination of both. It is also called as trip meter in case of short trips of every ride. The distance mentioned in the odometer generally in kms.

Fig 1



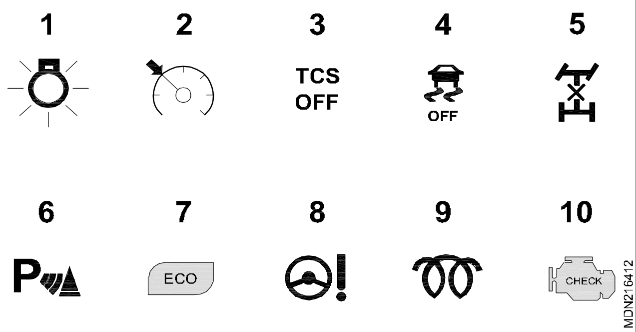
Speedometer

A speedometer or a speed meter is a gauge that measures and displays the instantaneous speed of a vehicle. The unit in which the display shown is in Km/hr. There are both analog and digital meters are available now a days.

Engine RPM meter

An engine rpm meter (Fig 2) is used to display the engine rotation in revolution per minute.

Fig 2



1 **Bulb indicator :** This shows you that you have a dead bulb. Not all cars have this, but it's a helpful warning.

2 **Cruise control indicator :** This indicator is used to display the accelerator opening level to maintain the set speed. This reminds you that cruise control is on.

3 **Traction control indicator :** This tells you the traction control is off. A blinking traction-control light indicates that the system is preventing wheel spin. In which case you should either; let off the gas a bit and drive a little slower; or let off the gas a bit and drive much slower.

4 **Stability control indicator :** This indicates that the stability control has been turned off. There's not much reason to turn it off on the road, and some cars can be dangerous in the wet without it. A blinking light indicates that the stability control system is actively preventing loss of control. If this happens, pay attention and stop trying to drive like an idiot.

5 **Centre differential lock (or 4Hi/Lo):** This indicates that the center differential on or car with part-time four-wheel drive has been engaged. We can't stress this enough; Part time all-wheel drive is not meant for on-road use, and running it on dry tarmac can cause "binding" and other problems. We've heard sob stories from dealerships where customers had to pay for costly repairs because the later didn't realize this.

6 **Proximity sensor indicator :** Some cars have proximity sensors all around instead of just the rear bumper. This helps you park your big, cumbersome vehicle in tight parking spots. It also makes for incessant buzzing as motorcyclists and pedestrians filter around you in traffic. Recognizing whether it's on or off can help prevent a nasty scrape.

7 **Econ indicator :** This can mean different things on different cars. Some cars use it to tell you that economy mode is engaged, which means that the accelerator and the transmission are in their most relaxed mode. On some cars with cylinder deactivation, this tells you that the system is turned on (typically when you're cruising or coasting), and half your cylinders are not burning gas at the moment. On other cars, this lights up when you are driving in an "economical" manner, and it can be used as a training tool for good, efficient driving. Other cars use color-changing dash lights for the same purpose. They're educational, helpful and rather cool.

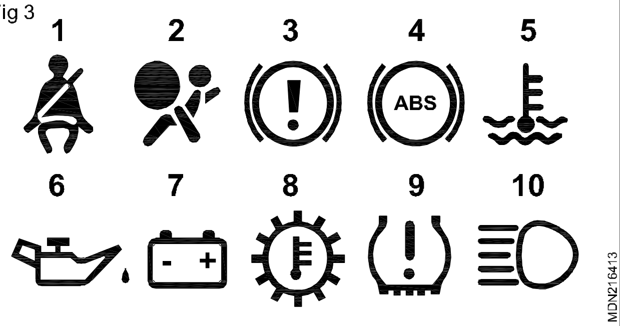
8 **Electric power steering indicator :** This indicates a fault in the EPS system. It could mean temporary overheating of the assist motor or a major fault in the system. Electric steering motors are usually compact, and violent sawing at the wheel can sometimes overtax them. This can happen when you're doing a 30-point turn in a tight garage, or when you're banging comes on a tight autocross. Best let things cool down and see if the problem goes away; otherwise, it's time for a checkup.

9 **Glow plug indicator :** Lacking spark plugs, diesels rely on pressure and heat to burn their fuel. As there's little heat in the motor when you first start it in the morning, glow plugs heat up the fuel coming out of the injectors to give the motor a better chance of starting. The light should turn on briefly after you switch the ignition to the 'on' position. Once it's off, the plugs are hot enough to start the car. A flashing light may indicate busted plugs, but some cars use the glow plug light as a catch-all indicator for problems ranging from bad injectors to exhaust gas recirculation valve issues. Get it checked as soon as possible.

10 **Check engine light :** We've saved the most crucial indicator for last. This is a confusing and often maddening-warning light. It can signal any number of issues or faults with the sensors and electronic equipment on the engine, some of which are serious, some of which are not. The most common cause is a busted exhaust oxygen sensor, which is bad for emissions but won't prevent your car from running. Other common causes include ignition coil and spark plug problems on gasoline cars, or an issue with any of the dozen-odd sensors that keep your engine happy. Even if you think it's nothing serious, don't ignore it. Have your car subjected to a diagnostic scan as soon as possible.

Mechanic motor vehicle/mechanic diesel

Fig 3



1 **Seatbelt indicator :** This one is easy. This indicates that the driver is not wearing the seatbelt. On newer vehicles, weight sensors in the seat tell the car if someone is sitting there, and warnings will appear for passengers, too. If the driver or passengers remain unbelted, a warning chime will sound. Don't ignore it. Studies show that seatbelt use reduces the chance of injury in a crash by 50%. Worse yet, being hit by an air bag with out your seat belt on can be fatal.

2 **Airbag indictor :** This signals a malfunction with the airbags or air bag sensor. This means that they may not go off in a crash. On some cars, there's also a passenger. Airbag off light that means the car has detected a small person in the front seat and has deactivated the front passenger airbag. This ensures that the (presumably short) front passenger doesn't suffocate or suffer a broken neck when the airbag goes off.

3 **Brake indicator :** This signals several things (Fig 3)

a Your parking brake is engaged, so disengage it;

b The parking brake sensor is out of alignment, so have it fixed;

c The brake fluid level is low

d The hydraulic pressure between the two braking circuits are mismatched. The last two are potentially dangerous, and could mean a possible fluid leak, as well as reduced or even completely absent braking performance.

Don't wait for the light to go off; check your fluid every morning before you go out, because sometimes the warning light comes on too late. Some newer cars also have a brake pad warning light that goes off if the pads need to be replaced.

4 **ABS indicator :** Some cars have a separate ABS light that signals a problem with the ABS system. If this goes off, that means that the Antilock Braking System has malfunctioned and the brakes may lock up under hard braking. Bring the car in for servicing immediately.

5 **Temperature warning :** Some older cars with temperature gauges merely have a red light, but many modern cars have this symbol. This indicates that your engine is overheating or is about to overheat. Best to pull over immediately to cool down, to avoid potentially expensive engine repair bills.

6 **Oil level/Pressure warning :** There's no genie in this lamp. Just the magic slippery stuff that keeps your engine lubricated. This typically signals your oil level is low by about two liters. No lasting damage should occur if you top off the oil the moment you see this warning. But if you ignore it, your motor could end up looking like a frying pen that's been left on the burner for a few hours. Not a pretty sight and a new engine is much more expensive than a new frying pan.

7 **Electrical system warning :** This one looks like a battery, which means battery problems. It could also mean alternator problems, so simply buying a new battery may not be enough. Thankfully, many shops can test the alternator's charging capacity when you go in for a battery replacement.

8 **Transmission warning light :** This comes in many different forms, and can indicate a malfunction with the transmission itself, the gearshift or transmission fluid overheating. You most often see this on trucks when you're hauling heavy loads, or in high performance cars with automatic transmission if you drive them a little too hard. Needless to say, pulling over to let the transmission cool down is a good idea.

9 **Tire pressure monitoring system :** This indicates either an issue with the TPMS itself or low pressure in one of your tires. Check immediately, Low pressure carry increased risk of blowout on the highway due to tire overheating.Not to mention the danger of hydroplaning in the rain, as wider tires slide over the water more easily than narrower ones.

10 **High beam indicator :** While not a warning light per se, this bright icon represents a big danger to other motorists, and is one of the most ignored indicators in the Philippines. Leaving your high beams on will blind other motorists and can lead to nasty accidents. Remember to turn them off when there's oncoming traffic or when driving behind another car.

You don't need to see the road 2km ahead when you can simply follow the other guy ahead of you.

You don't need to be a "car whisperer" to know something's wrong when your dashboard lights up like a Christmas tree. But knowing what these lights denote can mean the difference between a quick fix and a long walk home.

Gauges used in automobiles

Objectives: At the end of this lesson you shall be able to
- **explain the location of various gauges in a vehicle**
- **explain the purpose of a fuel gauge**
- **explain the working of a fuel gauge**
- **explain the purpose of a temperature gauge**
- **explain the working of a temperature gauge**
- **explain the purpose of an oil pressure gauge**
- **explain the working of an oil pressure gauge.**

The gauges indicate to the driver the working of the particular system to which they are connected. These gauges are located on the dashboard of the vehicle.

Some of the electrically operated gauges are the following.

- Fuel gauge (Balancing coil type)
- Temperature gauge (Balancing coil type)
- Oil pressure gauge (Balancing coil type)

Fuel gauge

Purpose

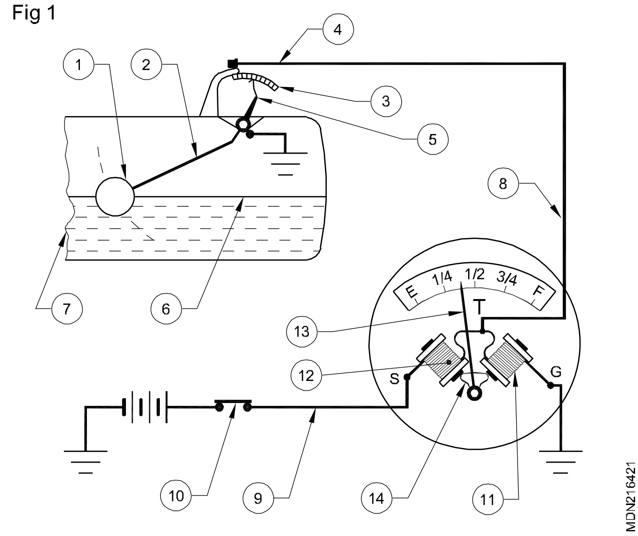
It is used to know the quantity of fuel available in the fuel tank.

Tank unit

It consists of a tank unit and the indicator unit (Fig 1). The two units are connected in series by a single wire to the battery through the Ignition switch. When the ignition switch is turned on, current passes through both the units.

The tank unit is fitted on the fuel tank and the indicator unit on the dashboard. The tank unit consists of a hinged arm with a float fitted at one end and a sliding contact at the other end and also a variable resistance. The sliding contact moves along the resistance. The float arm moves up and down as the level of fuel in the tank changes. The movement of the float arm changes the electrical resistance in the circuit.

Fig 1



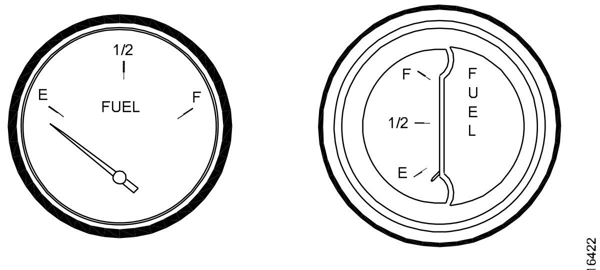
Gauge unit (Dash unit)

It is fitted on the panel board.

Two terminals (8) & (9) are connected to the tank unit's terminal (4) and ignition switch (10) respectively.

It consists of two coils (11) & (12) and a pointer (13) with the magnet (14) attached to it.

Fig 2



FUEL GAUGES

Working

When the ignition switch (10) (Fig 2) is on, current from the battery flows to the coils and a magnetic field is produced. When the tank (7) is full, the float (1) raises above and moves the sliding contact (5) to the high resistance position on the resistance coil (3). The current flowing through the coil (12) also flows through the coil (11). The magnetism of the coil (12) becomes weaker. The magnetism of the coil (11) thus becomes stronger and pulls the armature (14) and the pointer (13) to the full side of the dial. When the fuel level (6) comes down the float in the tank falls down and resistance also becomes less, thereby strengthening the magnetic field around coil (12) and forcing the armature and pointer towards the empty side of the dial.

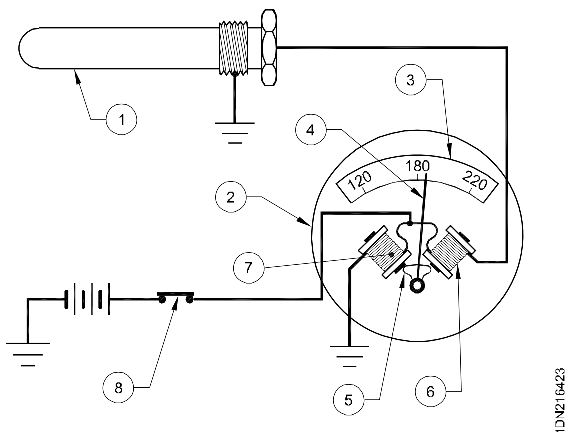
Temperature gauge

Purpose

It is used to know the temperature of water in the cooling system of engine at all times. It cautions the driver against overheating of the engine.

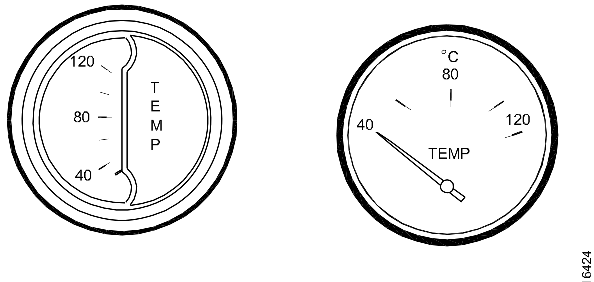
- It consists of an engine unit (1) immersed in the engine coolant in the cylinder head or cylinder block in the form of a pellet. (Fig 3)

Fig 3



- It is made of special material whose electrical resistance increases when temperature is lowered and it reduces when the temperature is increased.
- The resistance unit is provided with the dash unit (2) and it is fitted on the panel board.
- The dash unit consists of a dial (3) pointer (4), a magnet (5) and coil (6) and (7). (Fig 4)
- The two terminals of gauge are connected to the ignition switch (8) and the engine unit (1). The operating current is supplied from the battery through the ignition switch.

Fig 4



TEMPERATURE GAUGES

Working

When the coolant temperature rises, the engine unit becomes hot. When the engine unit temperature is high the resistance is less and more current passes to the right coil of the indicating units.

The difference in the strength of the magnetic field between the two coils increases and the armature and pointer move towards the right to indicate a high temperature.

When the engine coolant temperature falls down, the resistance becomes high. This results in less current flowing through the left coil, and the magnetic field becomes less and causes the armature and pointer to move towards the left to indicate lower temperature.

Oil pressure gauge

Purpose

This device is used to know the pressure of lubricating oil during the working of the engine and serves as a warning signal to the driver against any sudden failure of the lubrication system.

Types

- Bourdon tube type gauge (non-electric)
- Balancing coil type (electric)

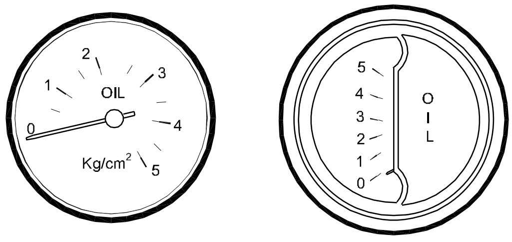
The Bourdon tube gauge is not widely used nowadays, as it has certain drawbacks i.e. the connecting tube leaks at joints.

In modern vehicles balancing coil type (electric) oil pressure gauges are used.

Working

It consists of two units (i.e) engine unit and the dash unit. (Figs 5 & 6)

Fig 5



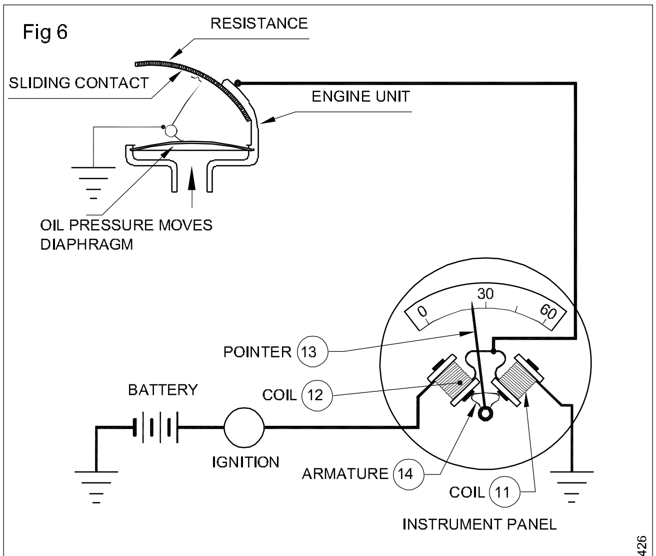
OIL PRESSURE GAUGES

The engine unit consists of a diaphragm, sliding contact, variable resistance.

The dash unit consists of two coils (11) & (12) and a pointer (13) with a magnet (14) attached to it. Both coils are connected in series with battery through ignition switch.

The increase in oil pressure pushes the diaphragm outward. This action results in increase in the resistance at the engine unit.

Fig 6



SCHEMATIC WIRING CIRCUIT OF A BALANCING -COIL OIL-PRESSURE INDICATING SYSTEM.

The right hand coil of the dash unit becomes magnetically stronger than the left hand coil.

Consequently the armature and the pointer swing towards the right side in indicate higher oil pressure.

Starting and stopping methods of engine

Objectives: At the end of this lesson you shall be able to
- **list out different ypes of engine cranking methods**
- **explain the different types of starting methods of diesel engine**
- **explain method of stopping the diesel engines.**

For starting the engine the following different methods are used.

1 Hand cranking

2 Electric Motor cranking

3 Hydraulic cranking motors

4 Compressed air cranking

5 Gasoline engine starting

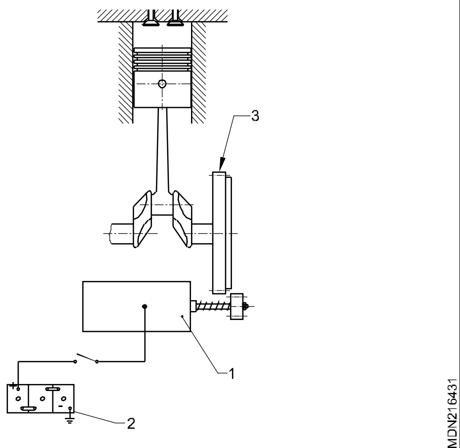
Hand cranking

Usually small diesel engines are being started using crank handle or rope.

Electric motor cranking

In this system a starter motor (1) is used to rotate flywheel (3) of the engine. A battery (2) is used to supply power to the starter motor. (Fig 1)

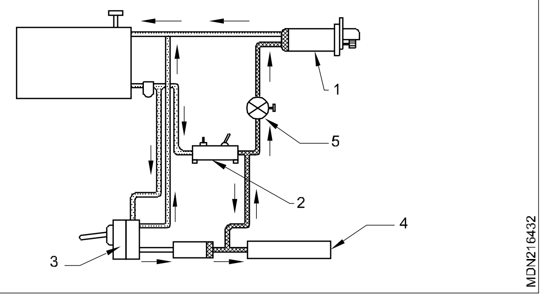
Fig 1



Hydraulic cranking motors

In this system hydraulic fluid under pressures passes through hydraulic starter motor (1) to rotate the engine flywheel. A hand pump (2) or an engine driven pump (3) is provided to create and develop pressure of fluid. This fluid under pressure accumulates in the accumulator (4). After pressing the starting lever, control valve (5) allows the hydraulic fluid under pressure to pass through the hydraulic starter motor. (Fig 2)

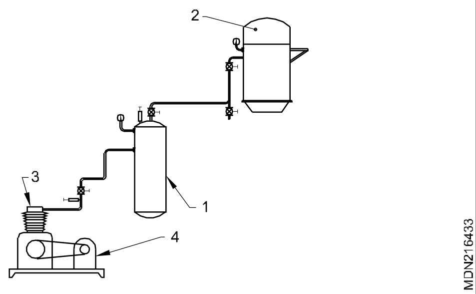
Fig 2



Compressed air cranking

In this method compressed air from the reservoir (1) is admitted through an automatic starting valve in the engine cylinder head when the piston is at the top dead centre at the beginning of the power stroke, at a pressure capable of cranking the engine (2). When the engine is turning fast enough, the injected fuel ignites and the engine runs on its own power, whereupon the air supply is cut off. An air compressor (3) is used to create air pressure. Air compressor (3) is driven by the engine or electric motor (4). (Fig 3)

Fig 3



Gasoline engine starting

This is used to start the heavy duty earth moving engines. Starting of the gasoline engine is done either by hand cranking or by an electric motor. The gasoline engine then cranks the heavy engine.

Generally diesel engines are stopped by cutting the fuel supply after reducing the engine speed to the minimum level.