CLASSIFICATION BASED ON ARRANGEMENT OF CYLINDERS

The cylinders can be arranged in several ways such as vertical, horizontal, inline, V-type, flat or pancake, radial. *Single cylinder engines* can be arranged in either vertical or horizontal direction as shown in Figure 1.5.

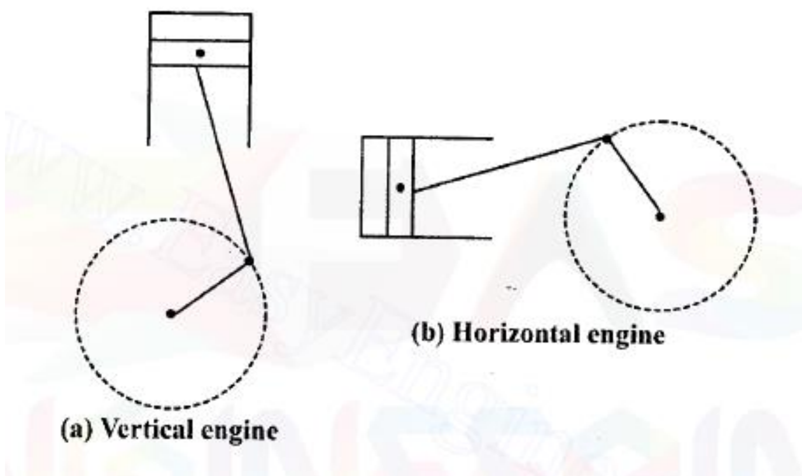

Figure 1.5 Single cylinder engines

Merits of horizontal engines:

1. The inertia forces of the reciprocating parts i.e. primary and secondary forces combine together to give an impulse to the chassis frame of the vehicle as the stroke of the engine piston is horizontal. If the cylinder head is towards the front end of the vehicle, then a driving impulse is obtained from the engine. This impulse force slides the engine forward on a smooth floor when the running engine is placed on the floor. Therefore, a vehicle fitted with horizontal engine tends to push forward the moped or the scooter by its impulsive force.

2. Fuel economy is also more.

Demerits of horizontal engines:

1. The crankcase cannot be used for storing lubrication oil for splash lubrication.

2. There will be excessive wear at the lower side of the piston and cylinder linerwhere the cylinder liner gives support to the engine because the weight of thepiston is carried by the cylinder liner.

3. Consumption of lubricating oil is more due to the lubricating oil which dribblesfrom bearings not returning to the crankcase but it is thrown out by the centrifugalforces.

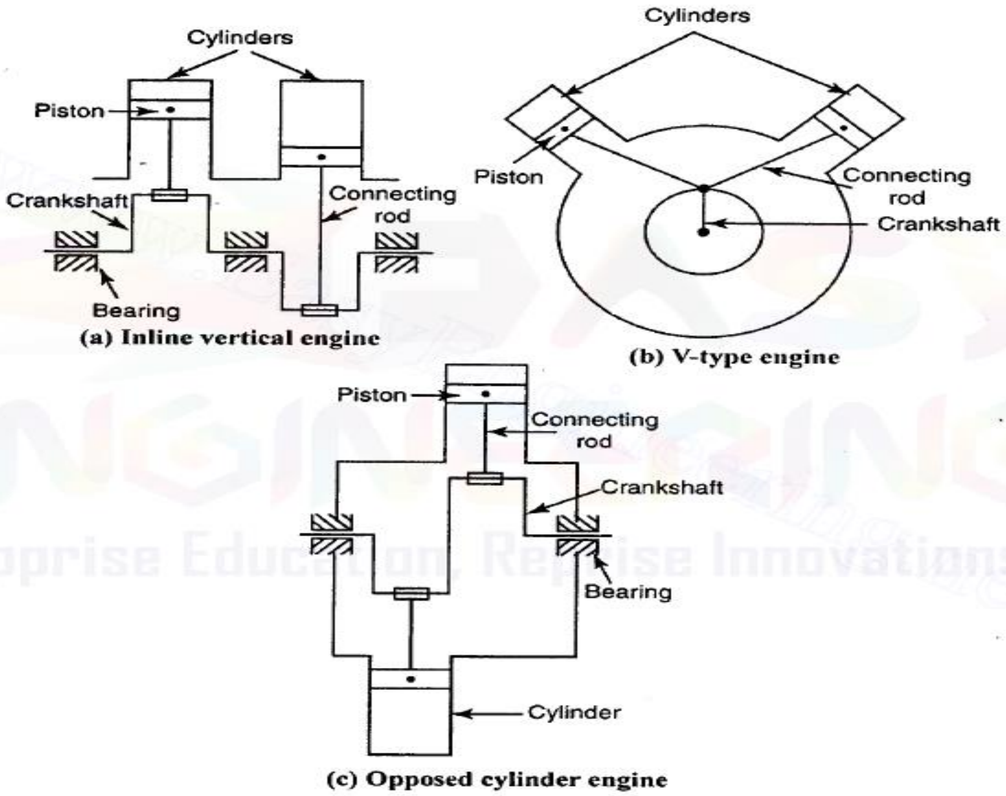

Figure 1.6 Two cylinder engines

Two cylinder engineshave two cylinders which can be arranged in three ways such as inline vertical, opposed cylinder and V-type. In inline engine, the cylinders are arranged in side-by-side, one row and parallel to each other as shown in Figure 1.6(a). The cylinders are generally placed in a vertical direction. The range of size of the twin cylinder engine varies from 500 to 1000CC for heavy vehicles and three wheelers. It varies from 600 to 800CC for small cars.

In V-type engines (Figure 1.6(b)), the cylinders are arranged in two rows. The two rows are set at an angle of 60° or 90° to each other. This arrangement is more compact and economical than inline type.

In opposed cylinder arrangement, the two cylinders are arranged horizontally opposite to each other. The piston and connecting rod movements are identical. The crankshaft and camshafts are positioned between two cylinders shown in Figure 1.6(c).

In *three cylinder engines*, cylinders are arranged vertically in-line with the crankpins arranged at 120° intervals around the shaft. They produce power impulse every 120° of crank rotation indicating that the torque produced is comparatively smooth. Three cylinder engines are only confined to two strokes. The crankcase serves as intake and pre-compression chamber. The crankcase is divided into three compartments. Each sealed off section of the crank case is provided to one of the cylinders. Figure 1.7 shows a three cylinder inline four stroke cycle engine.

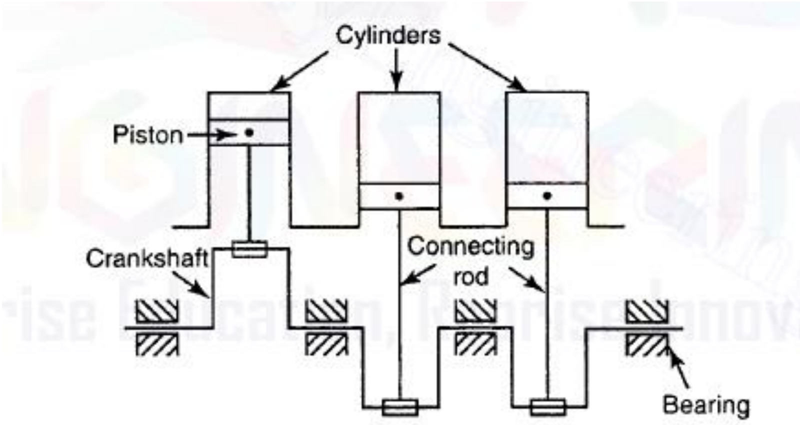

Figure 1.7 Three cylinder inline four stroke engine

Four cylinder engineshave become increasingly popular in recent years. A basic reason is the trend towards small, lightweight and fuel-efficient cars. 1800 crankshaft arrangement is always used. The balance of the four cylinder engines is not as good as the balance of the opposed two-cylinder engines. But the torque is much more uniform. In these engines, two pairs of four cylinders are moving in the opposite direction. The pairs move up and down together with each cylinder being on a different stroke. In case of four cylinders four stroke engines, four power strokes in two revolutions of the crankshaft with firing interval of 180° are produced. In a four cylinder engine, the cylinders may be arranged inline, opposed, square four or flat 4 and V-four manner.

In ***inline four cylinder engines***, piston 1 and piston 4 are always moving in pair opposite to the direction of piston pair 2 and 3 shown in Figure 1.8. In this arrangement, firing interval is regular. Since, this engine is similar to two, two-cylinder engines arranged end to end, then overall balance is very good due to the two rocking couples by neutralizing each other, the engine is not completely balanced and a secondary vibration is produced. It can be reduced by using light weight pistons and connecting rods.

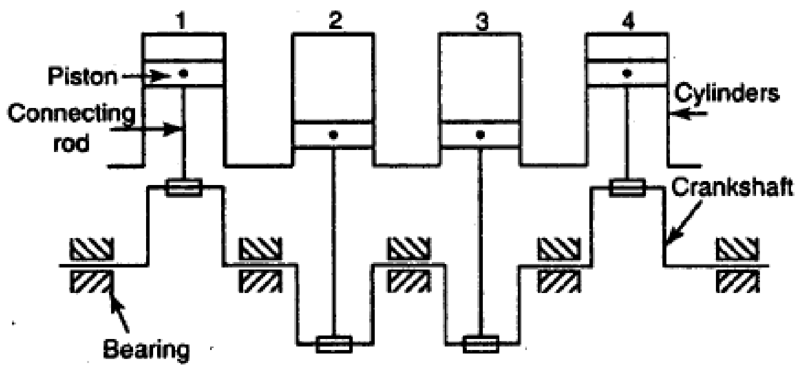

Figure 1.8 Four cylinder inline engine

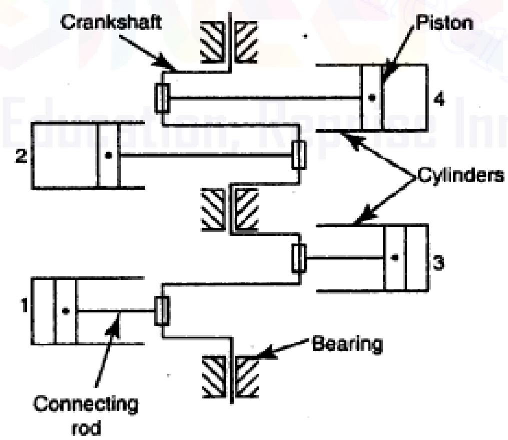

Figure 1.9 Opposed four cylinder engine

In an **opposed four cylinder engine**, the cylinders are arranged horizontally in pairs on each side of a flat four crankshaft. Here, the engine balance is superior to inline engine. In this engine, one power stroke is occurred in every 180® of crankshaft rotation. The torque is also smooth. Figure 1.9 shows this type of arrangement. This arrangement is also called *flat four or pancake engine.* This arrangement is found in air cooled Volkswagen and water cooledJewett's Javelin.

V-four engineshave cylinders arranged in two rows of two cylinders each. The two rows are set at an angle (preferably 60°) to each other. The crankshaft and cam shafts are positioned between two cylinders as shown in Figure 1.10. It is similar to two cylinder V engines having a common crank shaft. This arrangement is more compact and economical than inline type. The engine has a firing order of 1, 3, 4 and 2 with firing interval of 180°. This engine is balanced by using a balance shaft that runs in a direction opposite to the crankshaft.

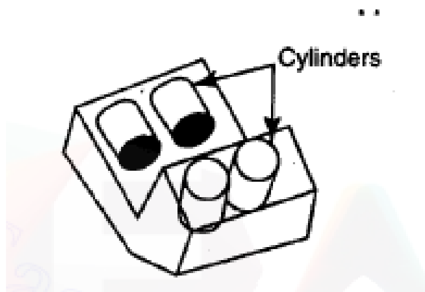

Figure 1.10 V- 4 engine

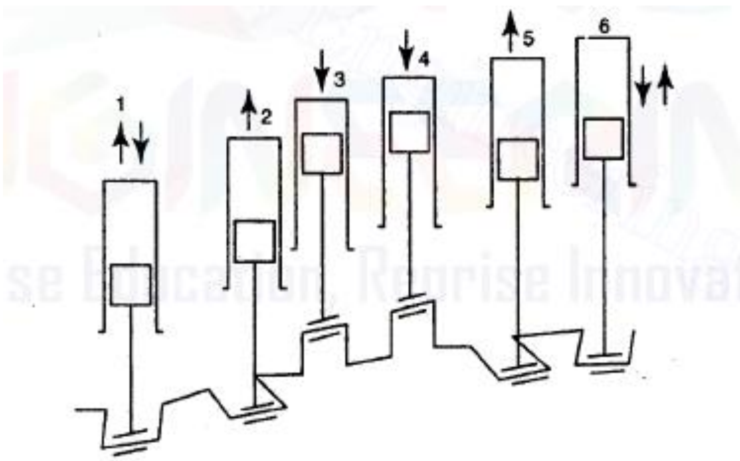

Figure 1.11 Six cylinder inline engine

Some five cylinder automotive engines are being built. Mercedes produces a five cylinder diesel engine. Volkswagen has a five cylinder inline spark-ignition engine for a front drive car.

Six-cylinder enginesgive a better dynamic balance and a more uniform torque than four cylinder engines. Most of the high powered as well as modern cars of the moderate powers are employing six cylinder engines. Though expensive and complication involve in these engines, they are much smoother; more flexible and quieter running. It requires only a light flywheel due to the lower ratio of maximum to mean torque.

Six cylinder enginesare generally inline engines built with 120° crank shafts. The arrangement of crank shaft is as shown in Figure 1.11. This arrangement is such that the crank throws of cylinders 1 and 6, 2 and 5, and 3 and 4 are in the same revolution of the crankshaft. The possible firing order for good distributions of fuel is 1-5-3-6-2-4 and 1-4-2-6-3-5.

Six cylinder V-enginesare very important engines which are built to have a bank of three cylinders set at an angle or at V to each other. Same crank pin is used to attach connecting rods from opposing cylinders in two banks. The arrangement of cylinders in V-6 engine is shown in Figure 1.12.

Opposed six-cylinder enginesare also available. The arrangement of cylinders is in the similar manner of a four cylinder opposed engine. Three cylinders are placed in each side of two rows but they are opposite to each other.

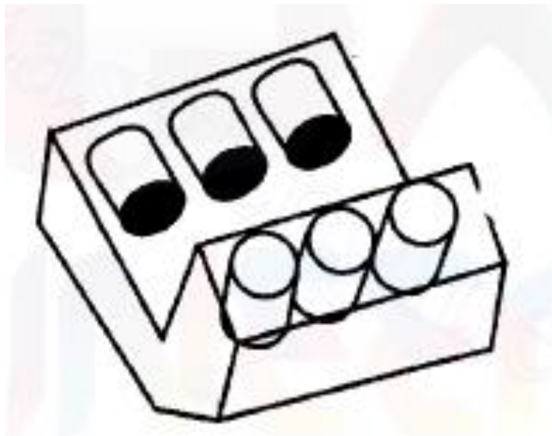

Figure 1.12 V-6 engine

The eight-cylinder engines have many advantages over six cylinder engines. Theyprovide more uniform torque and better acceleration while the balance is not very good. *Eightcylinder inline engines* provide a long engine with long and expensive crank and camshaft.

The interval of explosions of this engine is 90°. The crank throws for different pairs ofcylinders are in the same radial plane such as cylinders 1 and 8, cylinders 2 and 7, 3 and 6,and 4 and 5. The firing order is 1-6-2-5-8-3-7-4 or 1-8-2-6-4-5-3-7. The disadvantages of thisengine are long and expensive crankshaft and its liability to torsional oscillation of thecrankshaft.

Eight cylinder V-enginesemploying two banks of four cylinders each at right angle havereplaced the inline eight-cylinder models in most of the higher power automobiles. The anglebetween cylinder rows in V-8 engine is usually kept as 90°. These engines can operatesmoothly and silently. V-8 engines are almost universally in use. The *Rolls Royce* and*Daimler* car manufacturers are producing different V-8 model engines. Three big manufactures of car i.e., *Ford, Chrysler* and *General Motors* are employing V-8 engine asstandard engines.

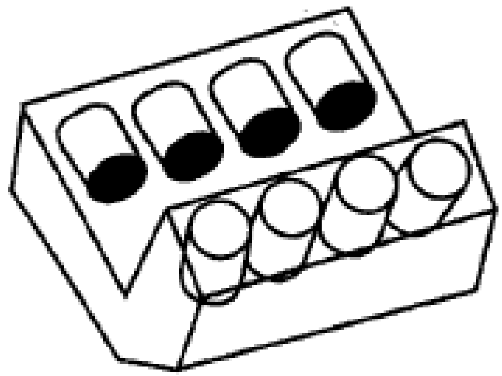

Figure 1.13 V-8 engine

Advantages of V-engines over inline engines:

The main advantages ofV-8 engines are summarized as follows.

1. It is the shortest of all the eight-cylinder engines other than radial engines. It is also alighter and more rigid engine. The shorter engine provides more space for passengeron small wheel base.

2. It provides relatively a simple valve gear, arranged both for the side valve oroverhead valve type engine, enabling a single crankshaft to be located above thecrank shaft for 90° angle arrangement of two cylinder banks.

3. It permits the use of intake manifolds that assure relatively even distribution of airfuelmixture to all cylinders since all cylinders are relatively close together.

4. Good engine balance can be obtained by suitable choice of crankshaft angles. A goodbalance would be resulted if two outer cranks at 90° to the parallel inner pairs in thesame plane are provided.

5. It is not affected by similar torsional vibrations similar to an in-line type.

6. Since, the carburettor and other parts are rested between two rows of cylinders, itpermits lowering the engine load line and thus it lowers the car profile.

7. Instead of an eight-throw as inline type, only a four throw crankshaft is used. In thiscase, same crank pin is used for operating two connecting rods from oppositecylinders. This arrangement provides even firing intervals between cylinders.

Twelve cylinder engineswere originally designed for aeroplanes. But certain cars such asRolls Royse, Daimler and Lincoln Zephyer also use these engines. These engines consist oftwo sets of six cylinder inline engines with each forming a bank V-inclined at 60° or 75°. They have common crankshaft and camshaft with six sets of forked and plain connecting rods.The Italian Ferrari is the only car which is being manufactured with a twelve-cylinder engine.

Sixteen-cylinder engineshaving two sets of straight light cylinders inclined at an angle ofV have been used in Cadillac cars. These engines have been perfectly balanced with top gearperformance. The cylinders arranged in two banks of eight cylinders each are inclined at 135°.

Radial enginesare mostly used in aircrafts. These engines are air-cooled and they havecylinders arranged in a star form about the crankshaft axis. The cylinders are radiating from acommon centre similar to spokes of the wheel. A common crankpin is employed for allconnecting rods. To get uniform firing intervals, the cylinders are odd in number such as 5, 7,9 etc. These engines are compact with low weight per horsepower and accessibility, simplicityof the single throw crank shaft and single cam ring for operating the valves. But, they are notused in motor vehicles due to more frontal area and more complicated exhaust pipe system.

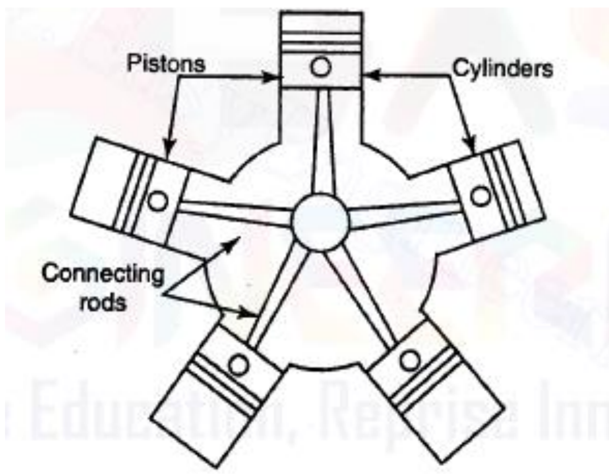

Figure 1.14 Radial engines

<u>Evaluation</u>

1. Write any two merits and demerits of horizontal engines?

2. State the main difference between two cylinder engine and four cylinder engine?

3. State theadvantages of V-engines over inline engines?