### Working

When the cam shaft rotates, the cam lobe (1) lifts the tappet (2) upward. When the tappet (2) moves up, it pushes the push-rod (3) and one end of the rocker arm upwards. The other end of the rocker arm's (4) tip, moves downward and the valve (5) opens against the spring's (6) tension.

When the cam lobe (1) reaches the maximum height, the valve opens fully. Further rotation of the cam shaft causes the tappet (2) to move down and the valve is closed by the tension of the spring (6).

Tappet clearance is provided in between the valve (5) tip and the rocket arm's (4) tip. This clearance can be adjusted by the adjusting screw (7) and the lock- nut (8)..

### Valve timing

Each manufacturer specifies the timings of the opening and closing of the valves as per the design of the engine to give the maximum output under all loads and speeds.

The opening and closing of the valves in an IC engine in relation to the movement of the piston and flywheel is called valve timing. (Fig 7)

The opening and closing of the valves exactly at TDC & BDC do not improve the volumetric efficiency of an engine. Burnt gases also are not driven out fully.

Practically, the valves are arranged to open early and close late to fill the cylinder fuly and to allow all burnt gases to escape from the cylinder.

### Inlet valve

### Lead

Inlet valves are made to open certain degrees earlier than T.D.C. This enables air/air fuel mixture to fill the cylinder to its capacity. It also helps in scavenging burnt gases by using the momentum of intake air/air fuel mixture.

### Lag

Inlet valves are made to close certain degrees after B.D.C. to increase the volumetric efficiency by allowing more charge.

### Exhaust valve

### Lead

Exhaust valves are made to open certain degrees earlier than B.D.C.

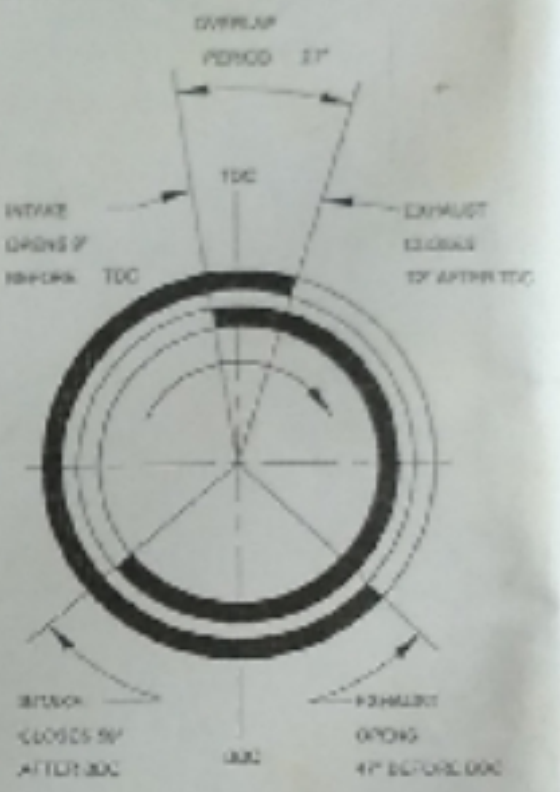
### Lag

Exhaust valves are made to close certain degrees after T.D.C. to develop a suction effect by the outgoing gases. It also helps in the scavenging of the exhaust gases using the intake charge's momentum.

### Overlap period

At the end of the exhaust stroke and the beginning of the suction stroke, both the valves remain open for certain degrees. This period during which both the valves remain open is called the valve overlap.

Fig 7




### Graphical representation of valve timing

The valve timing is represented by a diagram drawn on the face of the flywheel in degrees of the crankshaft rotation.

### Valve timing (Jeep)

- Inlet valve opens 9 degrees before T.D.C.
- Inlet valve closes 50 degrees after B.D.C.
- Exhaust valve opens 47 degrees before B.D.C.
- Exhaust valve closes 12 degrees after T.D.C.
- Overlap period 21 degrees.

Valve timing varies from one make of engine to another

# Piston and piston rings

Objectives: At the end of this lesson you shall be able to
- state the function and the requirements of a piston
- state the constructional features of a piston
- list out the different types of pistons
- list out the different types of piston rings
- state the constructional features of piston rings
- list out the material of piston rings.

A piston is of a cylindrical shape which reciprocates inside the cylinder bore. The main functions of the pistons are:

- to transmit the power developed by fuel combustion to the crankshaft through the connecting rod
- to transfer the heat generated due to combustion to the cylinder wall.

### Requirements of a piston

A piston should be:

- able to withstand high temperature and pressure of combustion
- a good conductor of heat.
- light enough to minimise the inertia load

### Construction of a piston

It has a special shape of different portions according to the design. A piston is designed with five portions according to the purpose and functional features.

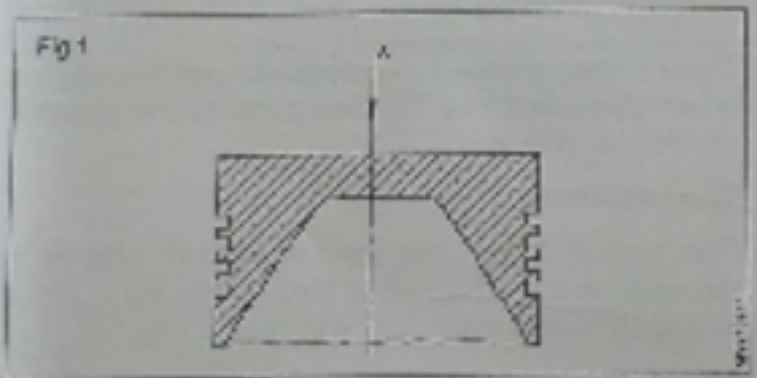
### The crown or head

It is the topmost portion of the piston. It is subjected to high pressure and temperature due to the combustion of the fuel.

Four types of heads are used.

### Flat head

Fig 1



It is simple in shape and is most commonly used. It is simple in construction. Decarbonising of this is very easy. (Fig 1)

### Domed head

It has a projection shaped like a dome on the crown. (Fig 2 & Fig 3) The dome acts as a deflector and helps to make a homogeneous mixture of air and fuel.

Fig 2

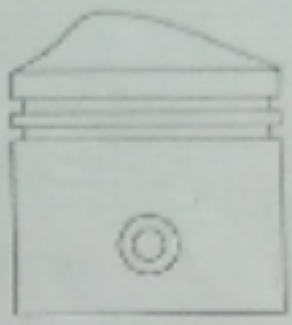
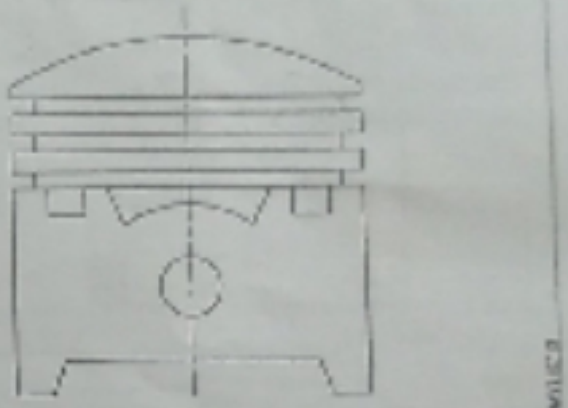


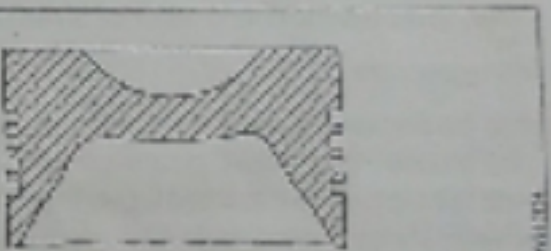
Fig 3



It is used in two stroke cycle engines. It is difficult to manufacture compared to flat heads.

### Concave head

Fig 4



It has a concave cavity on the top. (Fig 4) It is used in high compression diesel engines to reduce the clearance space.

### Irregular head (cavity piston)

It has a cavity on the top, (Fig 5) and a conical shaped projection is provided inside the cavity. This helps in swirling of air and thereby making for better homogeneous burning and it improves combustion. It is used in high compression diesel engines.

# Piston pins and connecting rod

**Objectives :** At the end of this lesson you shall be able to

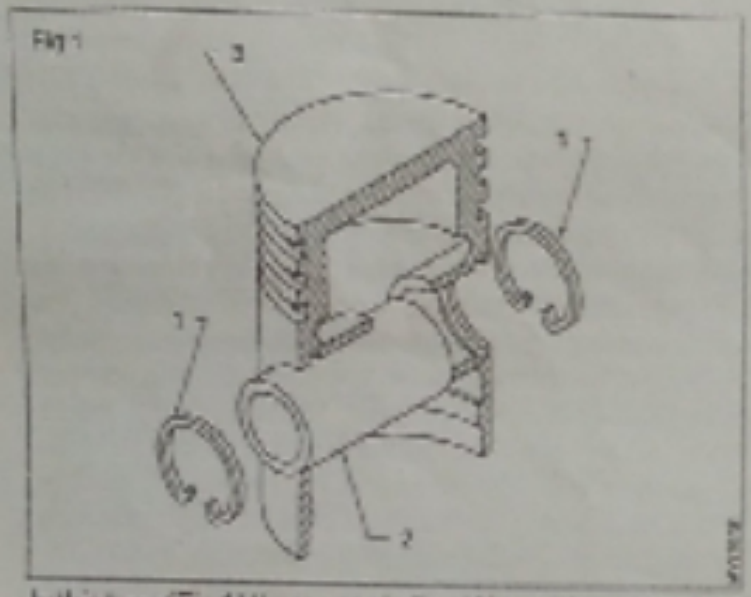
- list out the various types of piston pins and material of the position pin
- state the function and the constructional features of the connecting rod
- list out materials of the connecting rod.

The piston pin or gudgeon pin connects the piston with the connecting rod. It should be strong enough to transmit power and withstand pressure of combustion. Piston pins are made hollow to reduce inertia load due to the reciprocating motion.

**Types of piston pins**

**Fully floating piston pin**

Fig 1

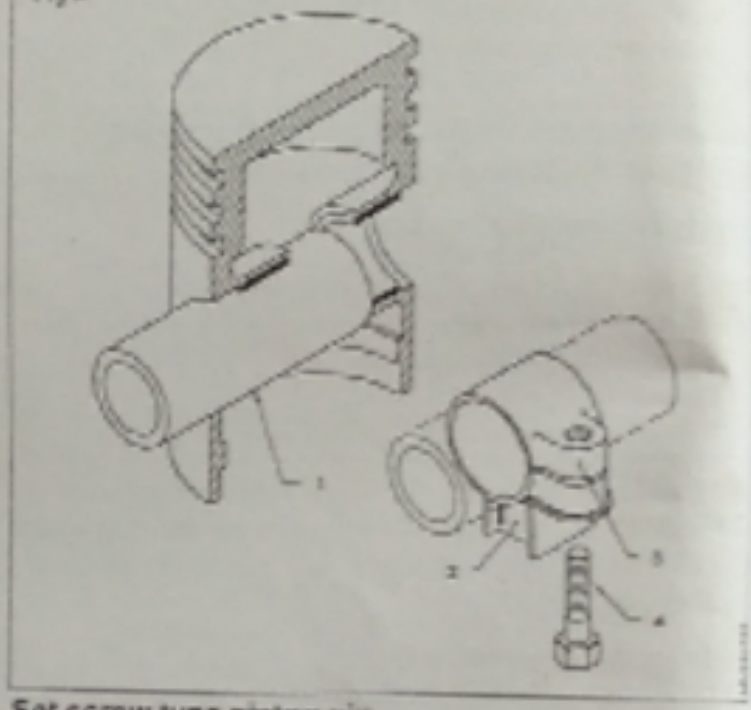



In this type (Fig 1) there are circlips (1) on either side of the piston pin (2). The pin (2) is free to rotate both in the piston (3) and the connecting rod. Circlips (1) are fitted into the grooves provided in the piston boss. This type of pins is used in engines which carry heavy loads. One gun metal or bronze bush is used between the small end of the connecting rod and the piston pin. Small two-stroke engines may have a needle bearing cage instead of a bush.

**Semi-floating piston pin**

The pin (1) is fastened to the connecting rod (2) with a clamp (3), screw (4) and nut. In this the piston boss forms the bearing. (Fig 2)

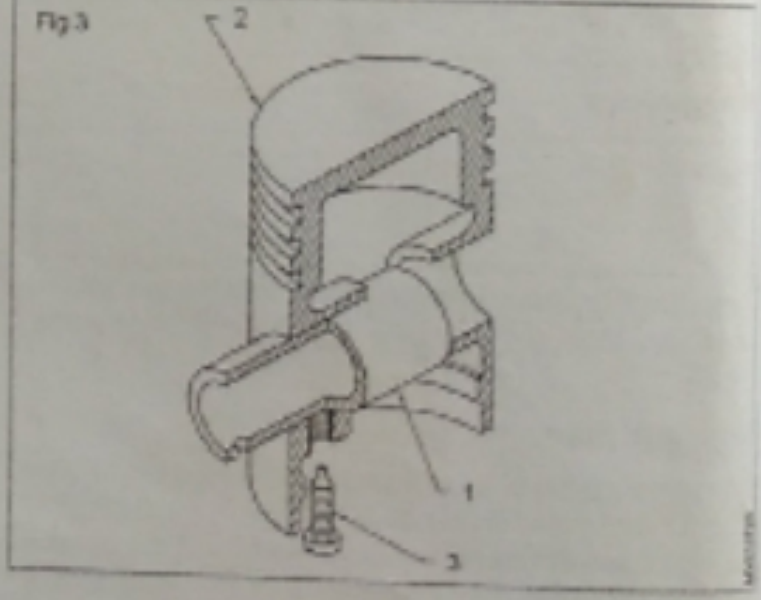
Fig 2




**Set screw type piston pin**

The pin (1) is fastened to the piston (2) by a set screw (3) through the piston boss and is provided with a bush in the small end of the connecting rod. (Fig 3)

Fig 3



### Material

The piston pins are made of nickel/chromium alloy steel. The outer surface is ground, chromium plated and case hardened.

### Connecting rod

#### Functions

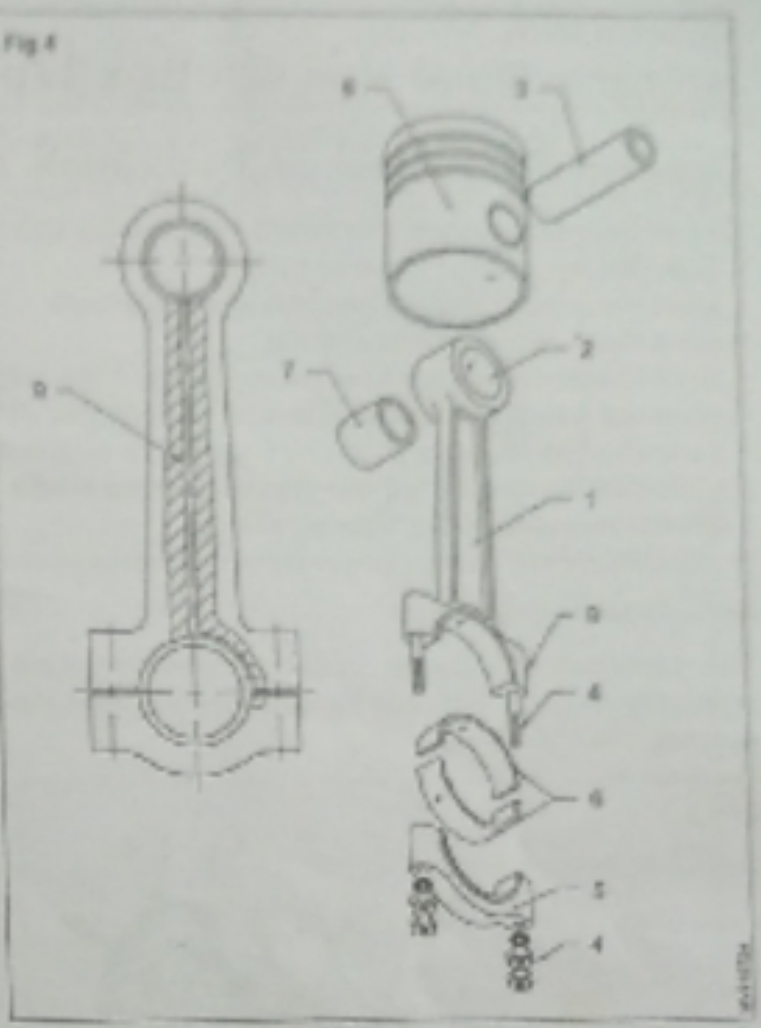
It is fitted in between the piston and crankshaft. It converts the reciprocating motion of the piston to the rotary motion in the crankshaft. It must be light and strong enough to withstand stress and twisting forces.

#### Construction

The connecting rod (1) (Fig 4) is made of high grade alloy steel. It is drop-forged to 'I' shape. In some engines aluminium alloy connecting rods are also used. The upper end of the connecting rod has a hole (2) for the piston pin (3). The lower end of the connecting rod (1) is split, so that the connecting rod can be installed on the crankshaft. The top and bottom halves (5) of the lower end of the connecting rod are bolted together on the big end journal of the crankshaft, by bolt and nut (4).

A large bearing area is provided to take the load, heat and wear. The split halves are usually fitted with babbitt bearings (6) or bearing lining steel-backed copper lead. In the upper end of the connecting rod a bronze bush (7) is fixed. The small end of the connecting rod is connected to the piston (8) by means of a piston pin (3).

Fig 4




In some engines a hole (9) is drilled in the connecting rods from the big end to the small end. It allows oil to flow from the big end to the small end bush.