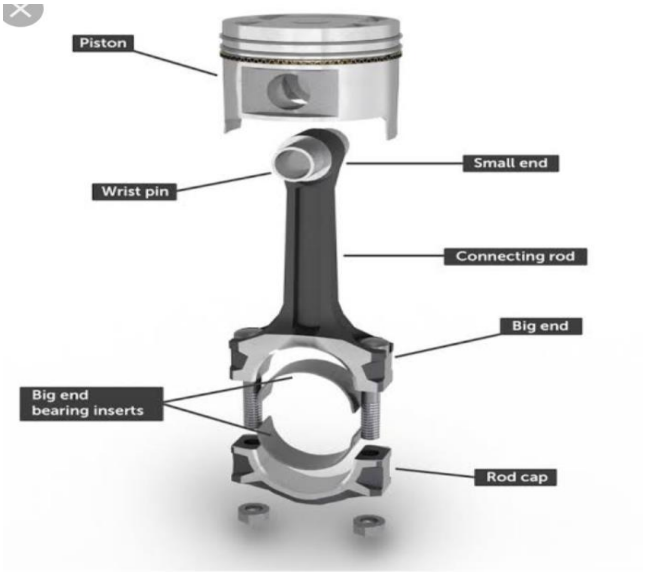
PISTON:

The engine piston serves several purposes viz.:

1. Transmission of explosion force to the crankshaft through the connecting rod.

2. Acts as a guide for the piston rings to seal the piston in the cylinder. 3. Acts as a guide for the upper end of the connecting rod.



Piston

A piston has to work under the most severe mechanical and thermal conditions. Therefore, it must satisfy the following requirements:

1. Maximum load carrying capacity with minimum weight.

2. Maximum heat withstanding quality with minimum expansion.

3. Maximum hardness with easy machinability.

4. Maximum hardness with maximum flexibility.

5. Quick dissipation of heat.

6. Resistance to corrosion and wear.

7. Minimum permanent deformation.

8. High durability 9. Low cost.

Materials for Piston:

Materials used for the manufacture of a piston are cast iron or semi-steel and aluminium. Their respective merits are given below:

Cast Iron or Semi-Steel:

This is preferred because it (i) is strong enough for the stresses imposed, (ii) has a melting point above the cylinder operating temperature and (iii) expands at the same rate as the cylinder and does not generate excessive friction when properly lubricated.

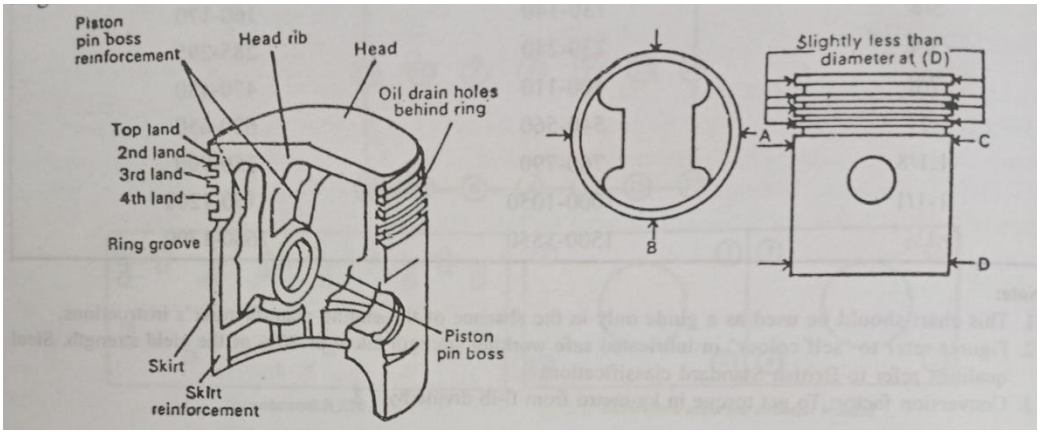
Aluminium Alloy:

This is lighter than cast iron, can be readily cast and machined and does not generate excessive friction. Due to less weight, the inertia of the moving parts reduces which ultimately adds to the higher speed of the Engine. As aluminium alloy pistons are subjected to more heat conductivity, the piston heat runs at a cooler temperature.

Piston Construction:

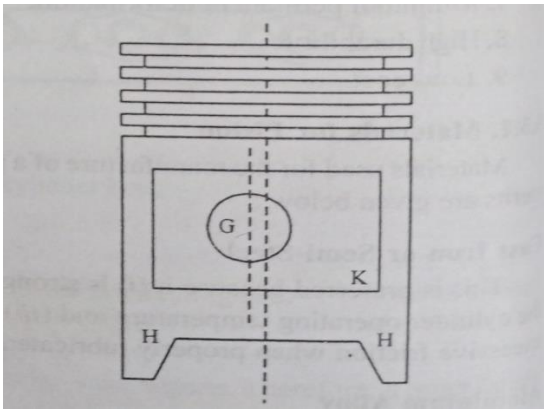
The main parts of a piston are the head, skirt, ring groove and lands. The head of the piston is the top surface where the combustible gases exert pressure. The piston head may be flat, concave or irregular. The different shapes of the piston head allow for more or less compression and swirling as needed for the different engines and fuels. Diesel engine pistons may also have a combustion chamber recessed in the head. Ribs inside the piston head reinforce it and enable it to carry away the heat from the head to the rings.

The skirt of the piston is the outside part below the ring grooves. It keeps the piston in alignment. This skirt forms a bearing area in contact with the cylinder wall which takes the thrust caused by the crankshaft. There is some thrust on both sides of the piston.



Piston parts

The major thrust, however, is on the side opposite the crank throw as the piston goes down on the power stroke. In some cases, the piston skirt is extended downward on the thrust sides lo increase the contact area on the thrust sides as shown in Figure. The piston pin may be off set to one side of the piston center line as shown at G It may or may not have a relief area as shown at K. The bottom of the skirt may be square or may be of the slipper type as shown at H.



Piston skirt extended downward

Some pistons are either fully or partially cut away around the piston pin holes. This is known as "relief" and is intended to provide additional clearance to avoid seizing in case the piston becomes overheated and expands excessively.

Ring Grooves:

Circular grooves around the piston which carry the piston rings are known as ring grooves. They are shaped to the proper design to match rings for good control of oil and blow-by. The lower groove has openings for oil collected by the oil control ring to flow back into the crankcase.

Piston Lands:

These are the areas between the ring grooves which hold and support the piston rings in their grooves.

Combustion Chamber:

A combustion chamber is the space where the combustion of fuel takes place. The design of a combustion chamber depends on a number of factors to achieve adequate mixing of the air and atomized fuel, which requires imparting a vigorous movement to the air. Among high speed diesel engines a variety of combustion chambers is available. In general they can be classified as open chamber or direct injection type and separate chamber type.

Direct Injection Chamber:

The clearance space that accommodates the compressed air charge is relatively simple in shape and often almost entirely due to a recess in the piston crown, the cylinder head being flat. The fuel is sprayed through two or three fine holes at a high velocity requiring an injection pressure of 2800 kg/cm² or more. The resulting hard jet enables the fuel to penetrate the dense air and find the necessary oxygen for combustion, aided in most cases by some residual swirl or turbulence set up during the suction stroke by the masking of the inlet valve.

This type of combustion chamber is available on engines with a compression ratio of 13:1 to 14:1 and requires no auxiliary starting devices.

Separate Combustion Chamber:

In this design a separate cell is available in which a part or the whole of the air during compression is forced through a restricted passage. Communication between the separate chamber and main cylinder is restricted in order to promote efficient combustion through the generation of powerful air or gas movements. The different types available under this category are known as pre-combustion chambers, air cell chambers and air swirl chambers.

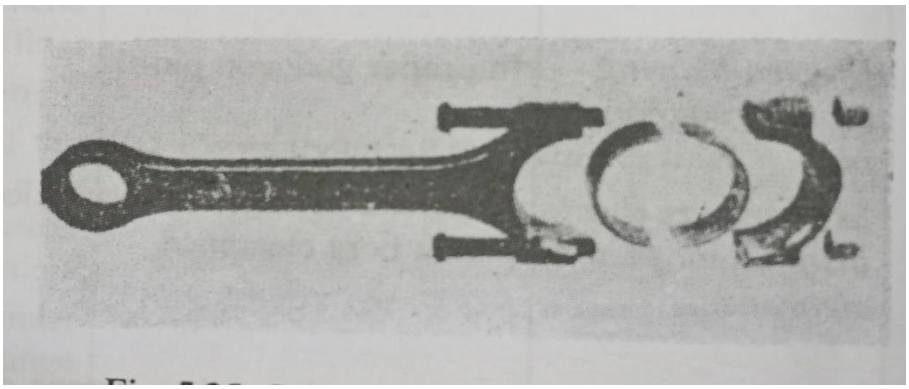
In a pre-combustion chamber, combustion is initiated in a separate cell in the cylinder head. The resulting increase in pressure causes a mixture of partially burnt fuel and air to issue through one or more passages communicating with the main cylinder, where there is an excess of air which completes the combustion.

In an air cell chamber, the air is again forced during the compression stroke into a separate cell normally in the cylinder head. Fuel is sprayed, usually from a single hole nozzle, in the direction of the mouth of the cell and across the main combustion chamber. As the piston begins to descend, the air from the cell rushes back into the main combustion chamber. This produces a thorough mixing of air and fuel, the principle being somewhat similar to that of a blow lamp.

An air swirl chamber differs from those described above in that the air is forced into a separate chamber where it is given a definite rotational motion. Fuel is injected directly into the chamber and mixes well with the swirling mass of air.

CONNECTING ROD:

The connecting rod is attached at one end to a crankpin on the crankshaft and at the other end to a piston through a piston pin or wrist pin. The lower part of the connecting rod is split to permit its being clamped around the crankshaft. The split head known as the big end usually incorporates a babbit bearing. A bearing lining. of either steel backed copper lead or steel backed cadmium silver is also used.



Connecting rod

The connecting rod must combine great strength with light weight. It must be strong enough to maintain rigidity when carrying the thrust of the piston during the power stroke. At the same time it must be as light as possible so that the centrifugal and inertia loads on the bearings will be no greater than necessary. Usually it is drop forged from alloy steel and is made with an I-beam cross-section.

To provide lubrication of the piston pin, an oil passage hole is often drilled along the entire length of the connecting rod from the crankpin journal bearing to the piston pin bearing. A hole in the big end upper half feeds the oil to the

connecting rod oil passage from the oil line drilled in the crankshaft. The oil circulates through the connecting rod oil passage to the piston pin bearing.

Types of Connecting Rod:

In addition to the normal design the following types of connecting rods are also used in some tractors:

(a) Split at an angle: Some engines, viz. Escort 335, have the connecting rod split at an angle to make assembly and disassembly easier and to permit the passage of the rod end through the cylinder bore.

(b) Offset from shank: On some engines, the big end of the connecting rod end bearing is offset to one side of the rod shank. Offset connecting rods are employed on engines where, due to the design of the engine, the cylinders are not exactly centred over the crankpins on the crankshaft.

Inspection and Repair:

Procedure When the connecting rod is removed from the engine, it should be tested for alignment. This is done in a piece of equipment called connecting rod aligner. Bent or twisted rods may be straightened in the aligner with a bent piece of iron. Bent or twisted rods cause rapid bearing of the cylinder, ring, piston and pin wear. This is a result of their tendency to oppose the vertical travel of the pistons in the cylinders.

Inspecting Bearing Clearance:

Connecting rod bearings that are worn, pitted, scored, corroded or show signs for fatigue should be replaced. Bearing failure due to fatigue results from the breakdown of the bearing metal after long application of intermittent and heavy loads at fairly high temperatures. The bearing surface is usually covered with fine cracks that extend through to the backing. If portions of the bearing show such signs of fatigue, all the engine bearings should be replaced.

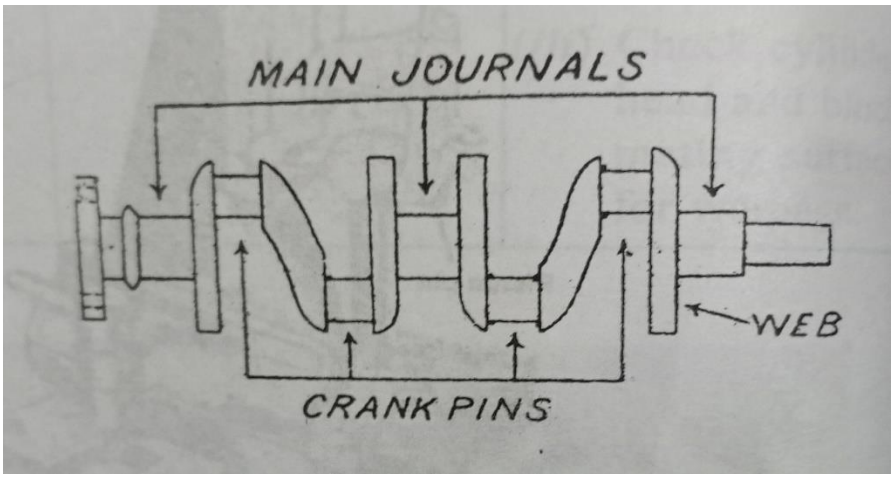
Side Clearance:

The connecting rod end bearing must have a side clearance to ensure that the sides of the connecting red bearing do not bind on the fillets at the end of the crankpins.

The side clearance is measured with a feeler gauge. On an in line engine, the side clearance should be from 0.1 to 0.25 mm. The connecting rod should be replaced if the side clearance exceeds 0.25 mm. On a V-type engine with side by side connecting rod, the side clearance if from 0.2 to 0.3 mm.

CRANKSHAFT:

The crankshaft is a one piece casting or forging of heat treated alloy steel that is of considerable mechanical strength. The crankshaft takes the downward thrust of the piston during the power stroke. The pressure exerted by the pistons through the connecting rods against the crankpins on the crankshaft causes the shaft to rotate. The crankshaft generally has drilled oil passages through which oil can flow from the main to the connecting rod bearings.



Crankshaft

In the assembled engine, the front end of the crankshaft carries a gear or sprocket that drives the camshaft. Some automobile engines have the crankshaft fitted with a device known as torsional vibration damper which combats torsional vibration in the crankshaft. As part of the vibration damper, there is a pulley with one or more grooves. A V-belt fits these grooves and drives the engine fan and water pump. The rear end of the crankshaft carries the flywheel. Its purpose is to smoothen power impulses so that the engine moves smoothly.

Parts of Crankshaft:

The main parts of the crankshaft are:

(a) Main bearing journal: Bearing surfaces for support on main bearings.

(b) Crankpins: Bearing surfaces connected to big end of connecting rods.

(c) Crank arms on throws: Offsets which help provide leverage to rotate the crankshaft.

(d) Counter-weights: Balancing weight opposite the rod journals.

Arrangement of Crankshaft Throws:

There are a number of factors which affect the design of a crankshaft. The arrangement of the crank arms is one of them. The firing order of the engine depends on the arrangement of the arm.

The arrangement of the crankshaft throws affects: (i) the balance of the engine, (ii) vibration from turning of the shaft, (ii) loads on the main bearing and (iv) firing order of the engine.

Balance of Crankshaft:

Due to the forces acting on the flywheel and crankshaft and the speed at which they revolve, it is necessary to balance them with great care. They are first balanced statistically and then dynamically. To obtain static balance, the weight must be equal in all directions from the centre when the crankshaft is at rest. Dynamic balance means balance while the crankshaft is rotating. Dynamic balance is attained when the centrifugal forces of rotation are equal in all directions at any point. The balancing operation requires a special machine and involves the removal of metal from the heavy points.

In order to obtain rotating balance, the crankshaft is equipped with counter-weights which are usually forged integrally with it. But in some cases the counter-weights are rigidly bolted to the crankshaft. These counter-weights are located on the opposite side of the crank-shaft from the connecting rod so as to balance the weight of the rod.

To balance the crankshaft proper, the entire rotating assembly is balanced dynamically. This includes the fan pulley, vibration damper, timing gears, and crankshaft, flywheel and clutch or corrector parts attached to it. Moreover, the connecting rods and pistons are all very carefully balanced one with another so that the rotating mass has as little vibration as possible.