AI 3401 TRACTORS AND ENGINE SYSTEMS

UNIT I NOTES

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.

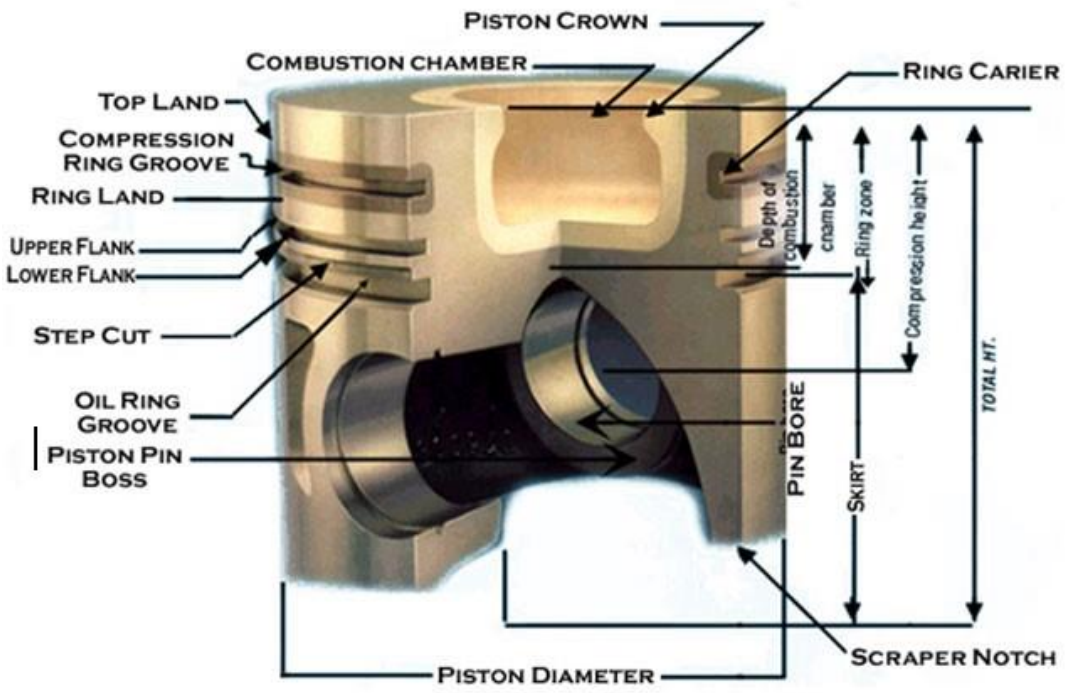
Aluminium Alloy:

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.

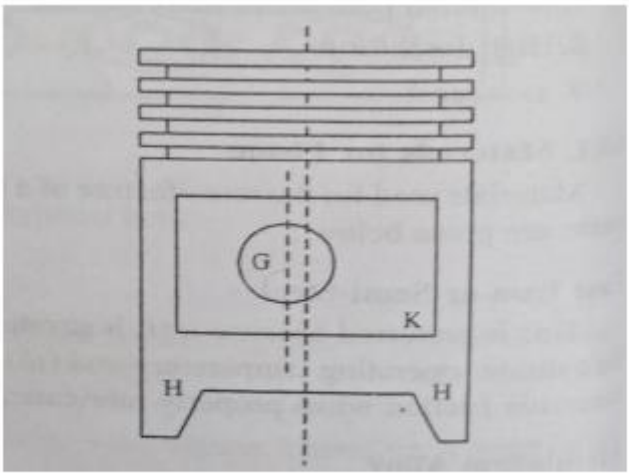
Piston Construction:

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.



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/cm^2 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.