

PISTONS

5

1. definition

use

design



1. Definition

- A **cylindrical metal component** which reciprocates in the cylinder under gas pressure. It is connected to the piston rod or to the connecting rod.

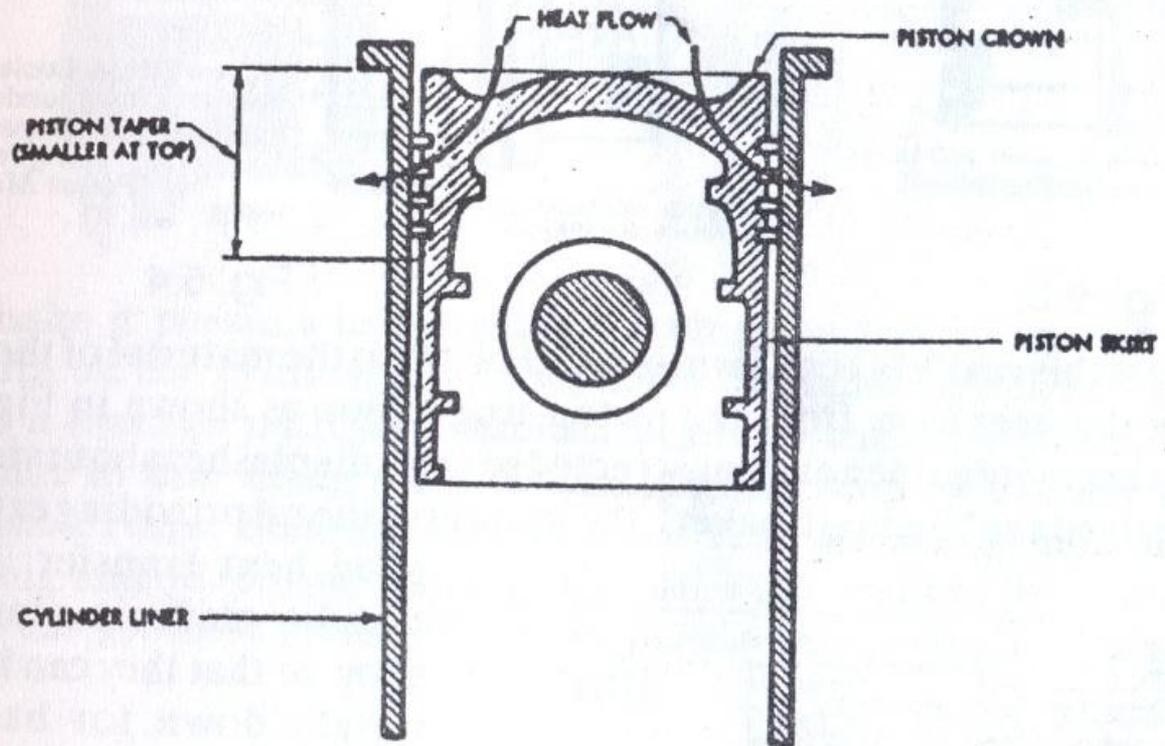


Fig 5.1.

Of the piston. Part 1:

Pair work: Based on your previous knowledge, discuss the following with your partner

- **Piston crown**
- **Piston skirt**

2. PISTON parts

- **Piston crown** is a cylindrical part which tapers to a thinner section.
- **Piston skirt** is a cylindrical part of the piston below the pressure rings, keeping the piston in alignment with the cylinder. It can contain a scraper ring.
 - diminish or reduce in thickness towards one end.

3. Piston classification & design

- Trunk
- ?

3. CLASSIFICATION & DESIGN

Marine diesel engine pistons may be classified as:

- **Trunk pistons** (small diesel engines) are cast in one-piece.
- **Pistons with crosshead** (longer than the previous and used in medium-speed and high-cylinder power engines) are termed two-piece pistons with detachable crown / composite pistons (light metal base and steel crown).

4. PISTON RINGS

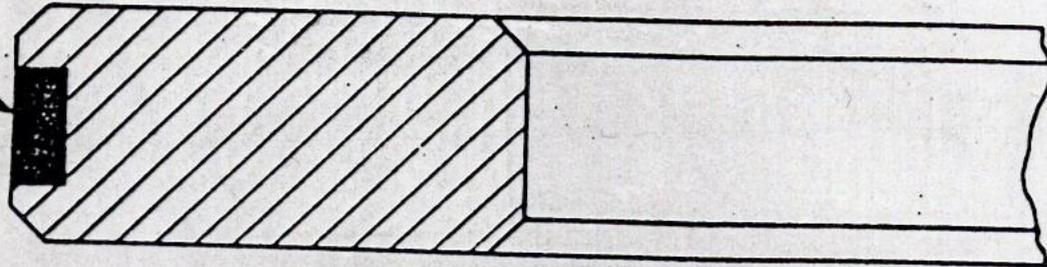
- A **piston ring** is a **spring tensioned** ring set in **grooves** in the circumference of a piston that push out against the walls of the cylinder forming a **gas tight seal**.
 - **Scraper ring** is a form of a piston ring fitted to the **crankcase end** of the piston designed to remove **excess lubricating oil** from the cylinder **walls** and return it to the crankcase.
 - **Piston groove** is a channel cut in the piston skirt to accomodate a ring. It is made up of the **upper surface / groove ceiling** and the **groove floor / land of the groove / lower surface**.

Piston rings

- Shape
- Purpose

- Scrapper ring
- piston groove

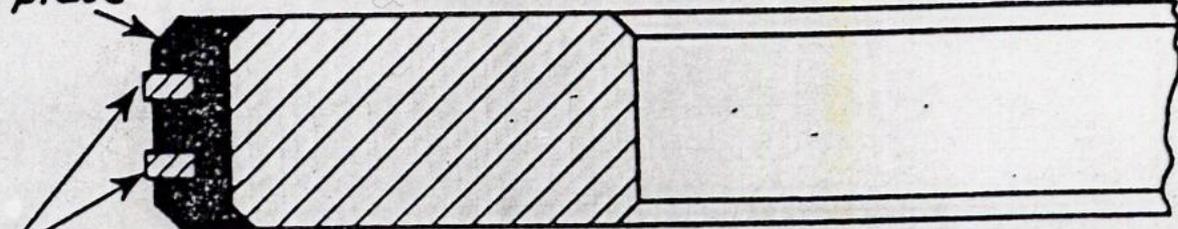
Chromium plate



Inlaid ring type

Chromium plate

Bronze inserts



Ring with bronze inserts.

8. PISTON RING FUNCTION

To give a **gas-tight sealing** of the **clearance** between the piston and the liner.

9. PISTON RING TYPES*

- **Single edged ring,**
- **Hooked scraper ring**
- **Spring backed oil control ring,**

10. PISTON RING MATERIAL

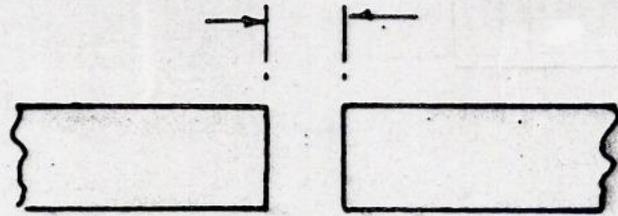
Pistons are made of cast iron and their surfaces are **chromium plated**. They may be either of **inlaid ring type** (with chromium plate inserts) or **ring with bronze inserts**.

11. PISTON RING CLEARANCES

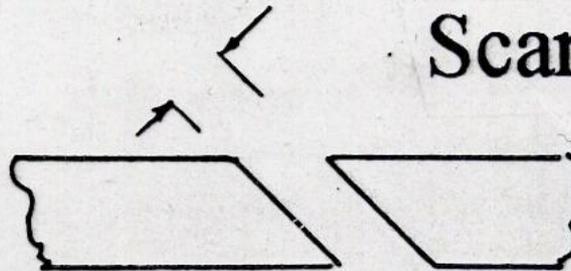
Ring gaps or clearances may be of:

- **butt type,**
- **scarfed type or**
- **lap type**

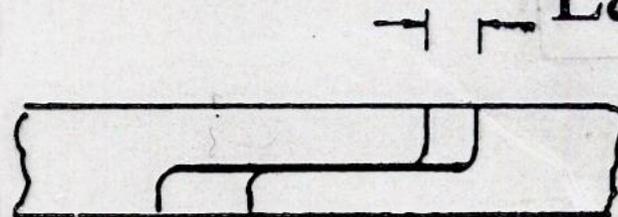
Butt type



Scarfed type



Lap type.



4. MATERIAL

- Iron or aluminium alloy (small engines).
- Wear resisting alloy steel + chromium & molybdenum.

5. LOADS & MATERIAL PROPERTIES

5.1 LOADS

Heavy mechanical and thermal loads due to operating conditions.

5.2 MATERIAL PROPERTIES

High strength, high resistance to corrosion and wear.

mp 'Iɪbdɪnəm

6. PISTON COOLING

- The piston is oil cooled. Different oil cooling arrangements may exist:
 - splash cooled
 - spray cooled
 - chamber cooled
 - coil cooled

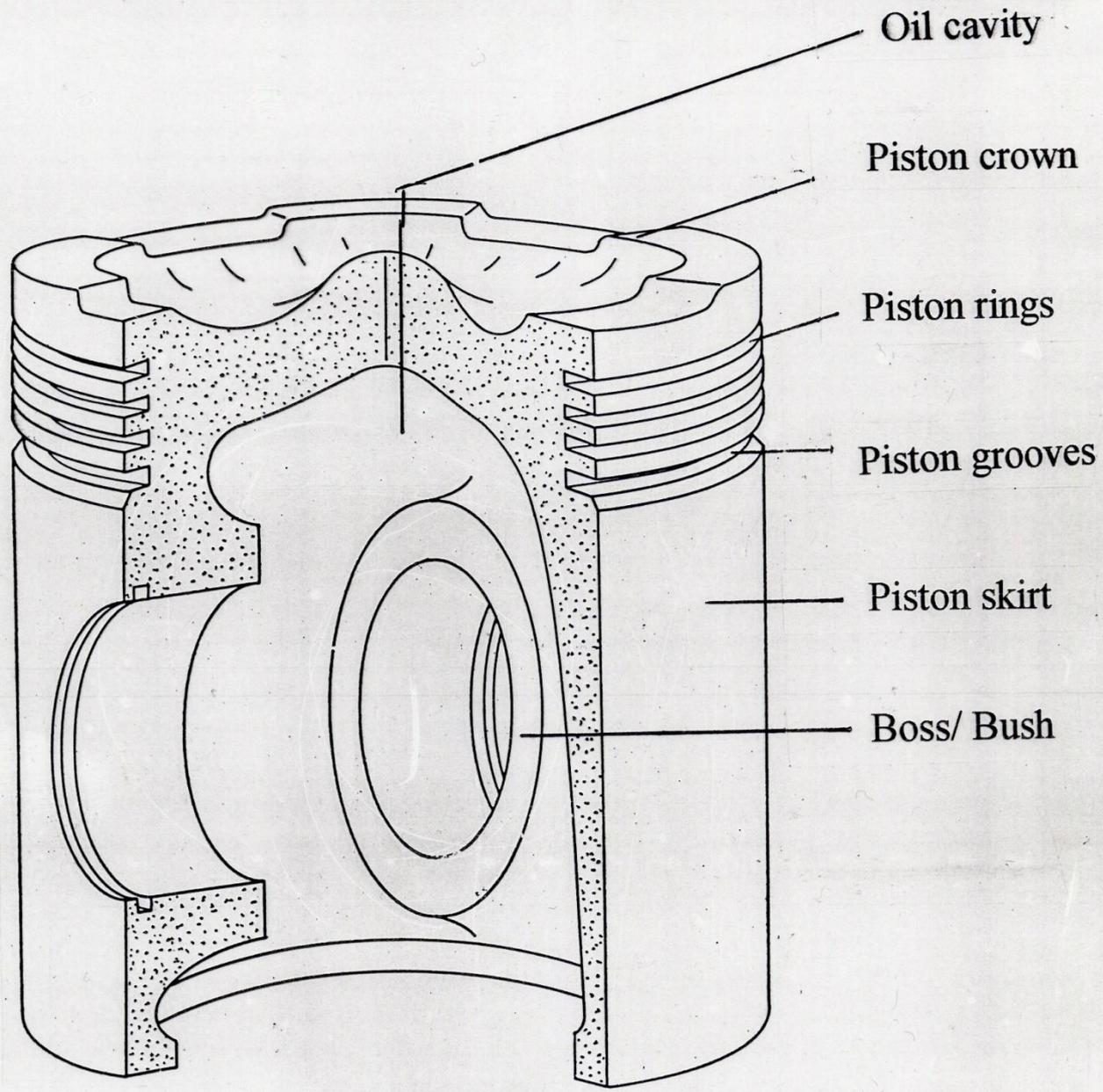
5. SEALING

- The **seal** is brought about by the gas pressure above and behind the ring, forcing it downwards against the **groove land** and outwards against the **liner wall**.
- To optimise the sealing:
 - **rings, grooves and liner** are to be of the **unit size**;
 - rings are to move freely / rings must float;
 - **adequate lubrication** should exist.

Complete the missing words (guessing new words):

passages, thinner, shaped, contain, shown, carried

The piston is a pot shaped component as _____ in Fig.5.1. The crown is fairly thick with the cylindrical parts tapering to a _____ section. The combustion chamber is _____ between the cylinder head and the piston and the most of it contained in the top of the piston. For this purpose the top surface of the piston crown may be bowl shaped or toroidal _____ (Fig.5.2.). The rim of the piston may _____ cutout portions to accommodate the valves when they open. The cooling of the piston is _____ out by circulating lubricating oil or water across the underside of the crown and inside the ring belt or through specially shaped _____.



Reading 1

- ▶ The piston is a pot shaped component as shown in Fig.5.1. The **crown** is fairly thick with the cylindrical parts *tapering* to a thinner section. The **combustion chamber** is enclosed between the **cylinder head** and the piston and the most of it contained in the top of the piston.
- ▶ For this purpose the top surface of the piston crown may be **bowl** shaped or **toroidal** shaped (Fig.5.2.). The **rim** of the piston may contain cutout portions to *accommodate* the **valves** when they open. The **cooling** of the piston is carried out by circulating lubricating oil or water across the underside of the crown and inside the **ring belt** or through specially shaped passages.
- ▶ Toroid: a surface generated by rotating a closed plane curve about a coplanar line that does not intersect the curve

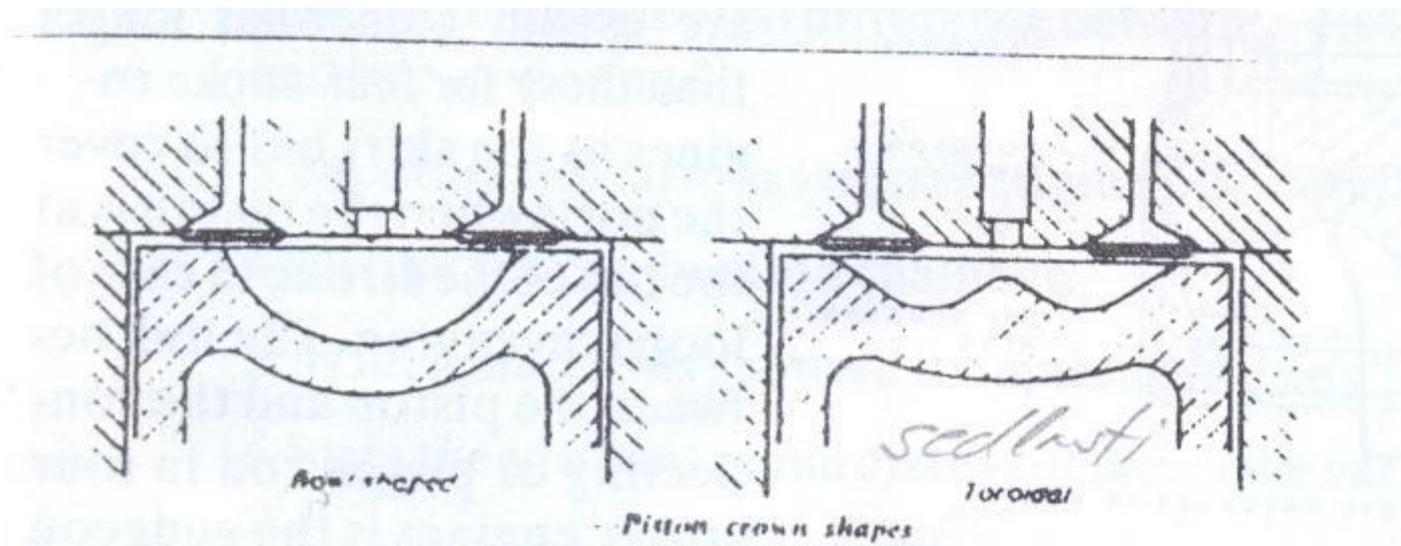


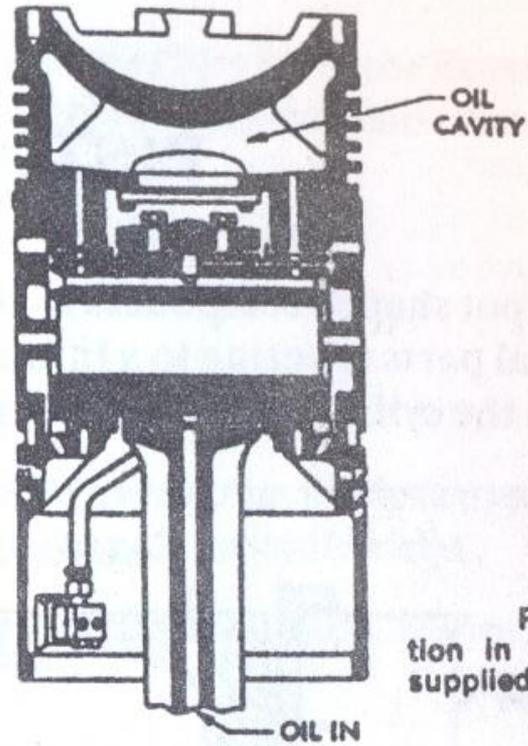
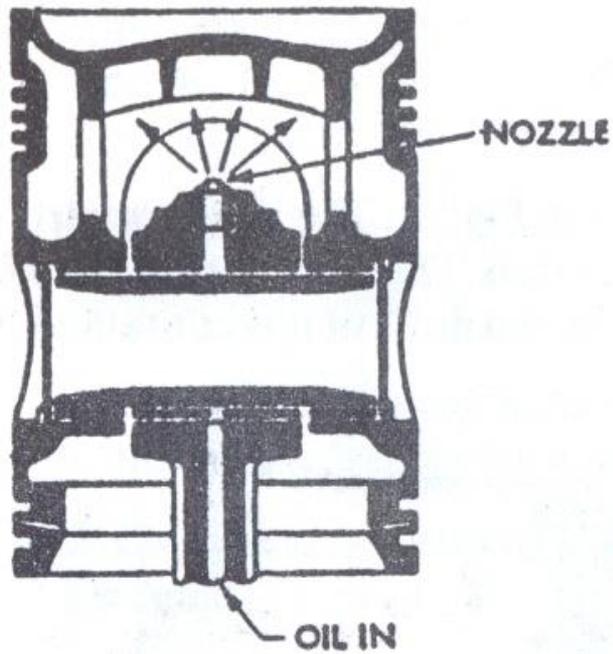
Fig 5.2.

Supply the missing info

- ▶ The piston is a as shown in Fig.5.1.
- ▶ The **crown** is fairly thick with the cylindrical parts *tapering* to
- ▶ The **combustion chamber** is enclosed between the **cylinder head** and the piston and the most of it contained
- ▶ For this purpose the top surface of the piston crown may be or **toroidal** shaped (Fig.5.2.).
- ▶ The **rim** of the piston may contain cutout portions to *accommodate* the **valves**
- ▶ The **cooling** of the piston is carried out by l or water across the underside of the crown and inside the **ring belt** or through specially

Reading 2

- The simplest means of carrying out the cooling is by splashing or spraying oil on the underside of the piston crown like in Fig.5.3. A more complex design has a cavity specially constructed for the oil to circulate through (Fig.5.4.).
- In some designs this cavity takes a form of a coil cast into the material of the piston and conducting the heat away from the piston ring region as shown in Fig5.5. In another design the cavity is open and constructed so that oil splashes about violently.



Piston Cooled by Oil
tion in Cavity under Crown
supplied through passage in
ing rod.
(Power Magazine)

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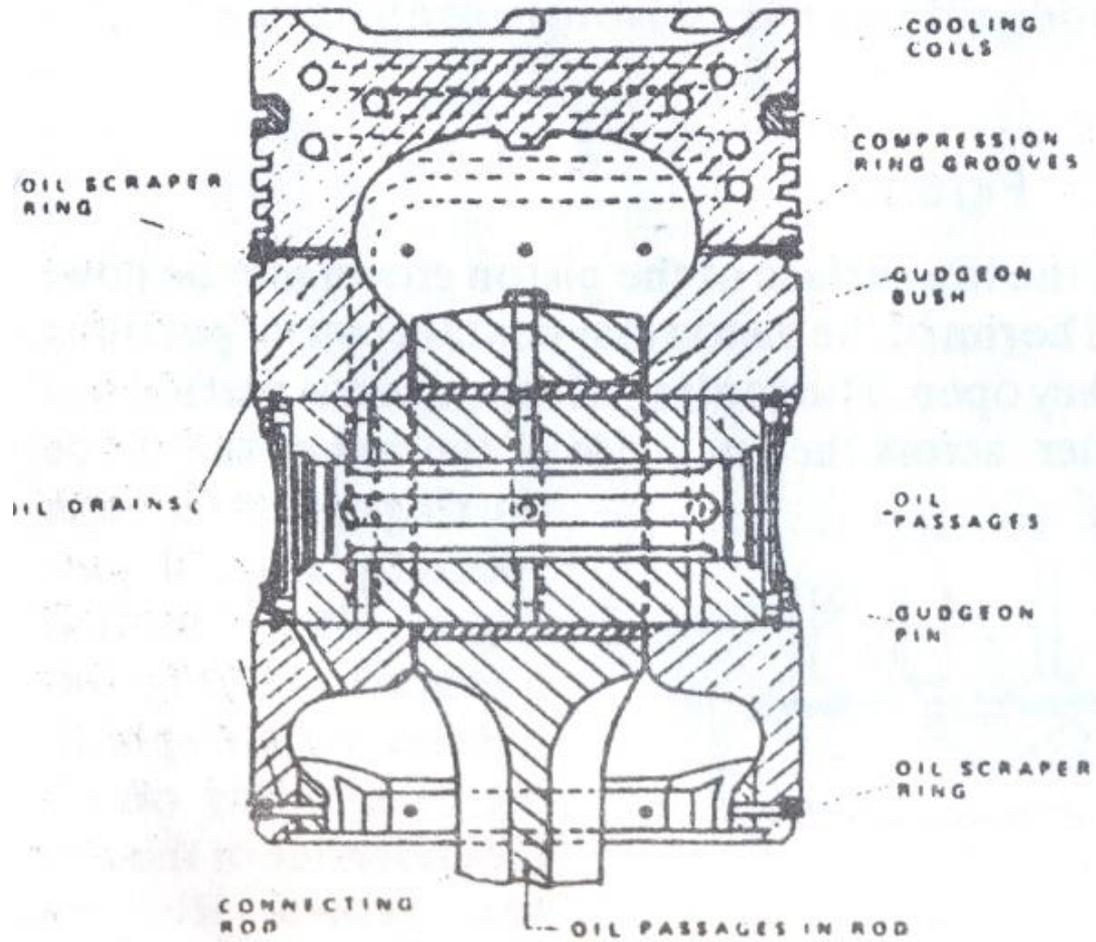


Fig 5.5.

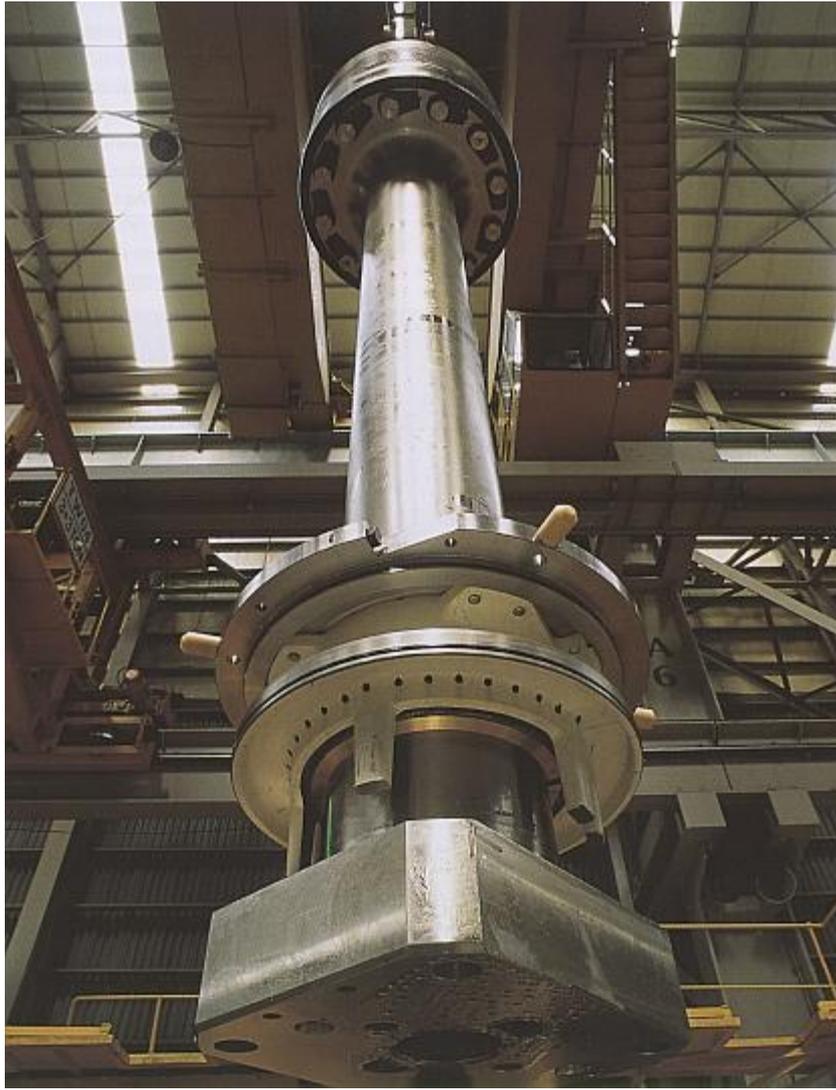
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- This design is termed the “cocktailshaker”, the motion of the oil providing extremely good heat transfer. Pistons may be made in aluminium alloy so that they can keep the weight down for balancing purposes at high speed. In other designs, where the necessity for the light weight is not important, they are made wholly of cast iron or cast steel.

Reading 3

- This design is termed the “ cocktailshaker”, the motion of the oil providing extremely good **heat transfer**. Pistons may be made in **aluminium alloy** so that they can keep the weight down for balancing purposes at high speed. In other designs, where the necessity for the light weight is not important, they are made wholly of **cast iron** or **cast steel**.

- This design is termed the “ _____”, the motion of the oil providing extremely good _____.
- Pistons may be made in _____ so that they can keep the weight down for _____ at high speed.
- In other designs, where the necessity for the light weight is not important, they are made wholly of _____ or _____.



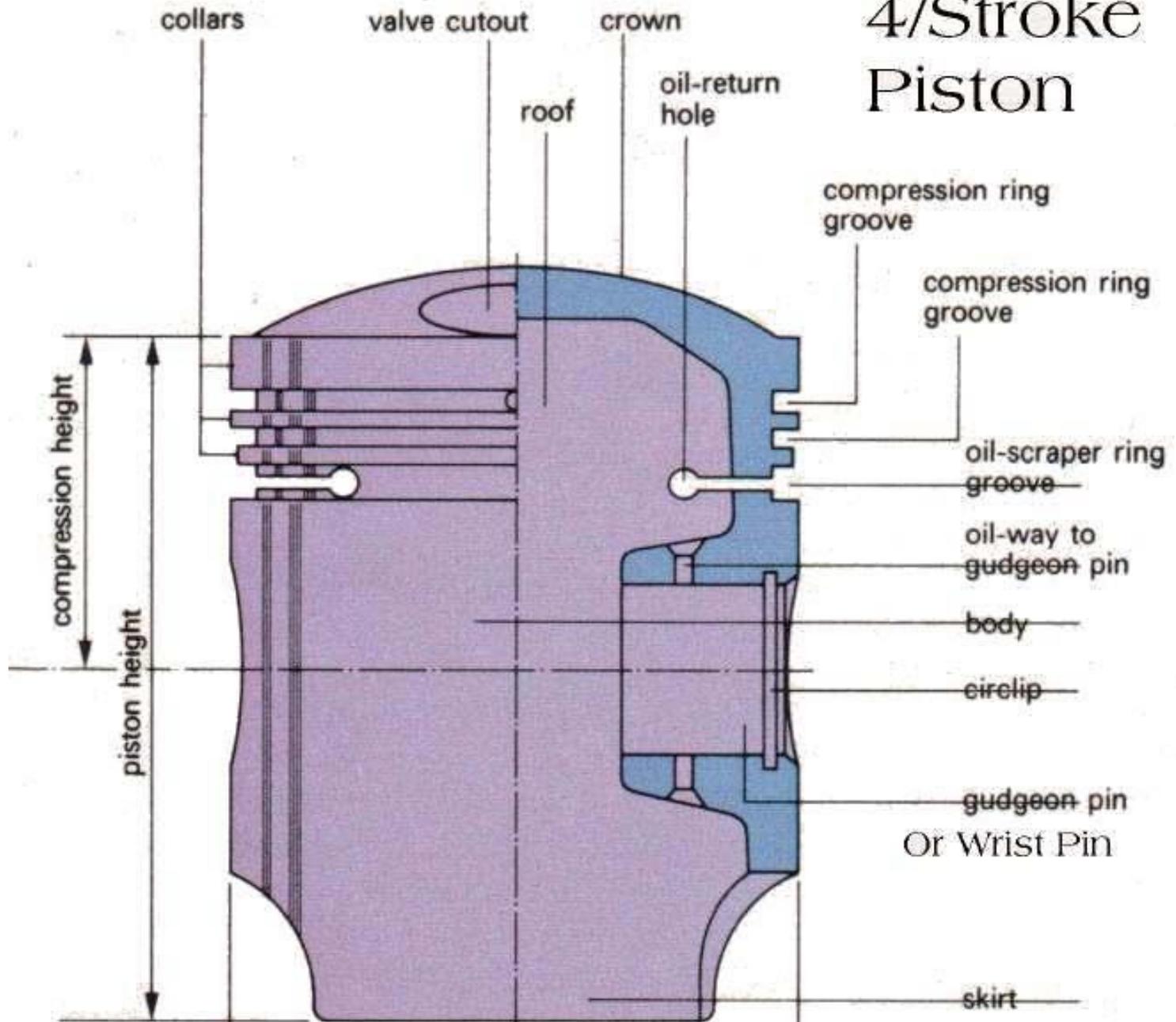
Reading 4

- Pistons for the two-stroke engines are usually somewhat longer than those for the four-stroke engines as the **skirt** has to cover the ports when the piston is at the top of the stroke in case of loop scavenging.
- The link between the piston and the connecting or piston rod in four-stroke engines is the **gudgeon pin**, sometimes referred to as the wrist pin which is carried in bosses in the piston skirt.

- _____ for the two-stroke engines are usually somewhat longer than those for the four-stroke engines as the _____ has to cover the ports when the piston is at the top of the stroke in case of loop scavenging.
- The link between the piston and the connecting or _____ in four-stroke engines is the _____ , sometimes referred to as the _____ which is carried in _____ in the piston _____ .

- Pistons for the two-stroke engines are usually somewhat longer than as the skirt has to cover the ports when the piston is at the top of the stroke in case of
- The link between or piston rod in four-stroke engines is the gudgeon pin, sometimes referred to as the wrist pin which is carried

4/Stroke Piston



Reading 5

- Generally the gudgeon pin is fully floating both in connecting rod small end and the piston bosses. In order to seal the gases in the top of the cylinder and prevent their leakage down the sides of the piston, piston rings are fitted in grooves turned in the piston crown. The action by which the ring seals the gas in the cylinder is shown in Fig.5.6.

- Generally the _____ pin is fully floating both in connecting rod small _____ and the piston _____. In order to _____ the gases in the top of the cylinder and prevent their _____ down the sides of the piston, piston rings are _____ in grooves turned in the piston _____. The action by which the ring _____ the gas in the cylinder is shown in Fig.5.6.

Jumbled chunks: Put the chunks below into the correct order:

- **Generally**

connecting rod small end the gudgeon pin is both in and the piston
bosses fully floating.

- **In order to**

seal the gases in the top of the cylinder, piston rings are fitted in grooves.
turned in the piston crown piston,

- **In order to**

prevent turned in the piston crown in grooves down the sides of the piston
their leakage , piston rings are fitted.

Reading 6

- ▶ The pressure of the gas in the clearance spaces forces the ring down on the side of the groove and out on the cylinder wall. Contact between these surfaces must be gas tight demanding smooth mating faces all the way round the ring.
- ▶ To make it possible to assemble the rings on the piston and enable them to conform on the cylinder bore they have a split or gap. This gap provides a leakage path for the combustion gas so that one piston ring alone is insufficient to seal adequately.

- ▶ The pressure of the gas in the _____ spaces forces the ring down on the side of the _____ and out on the cylinder _____ .
- ▶ Contact between these surfaces must be gas _____ demanding smooth _____ faces all the way round the ring.
- ▶ To make it possible to _____ the rings on the piston and enable them to _____ on the cylinder bore they have familiar _____ or gap.
- ▶ This gap provides a _____ path for the combustion gas so that one piston ring alone is insufficient to _____ adequately.

- Diesel engines employ usually four or more compression rings. Sometimes the lowest ring performs the dual function of gas sealing and oil control. The top ring bears the brunt of the sealing tasks, it sees the greatest pressure and it is hottest at highest temperature.

Reading 7

- Diesel engines employ usually four or more compression rings. Sometimes the lowest ring performs the dual function of gas sealing and oil control. The top ring bears the brunt of the sealing tasks, it sustains the greatest pressure and it is operated at highest temperature.

Questions and Discussion

1. Describe the shape and the functions of a piston.
2. What is the essential difference between a piston for a four-cycle engine and the two-cycle one ?
3. Mention the various stresses engine pistons are subjected to.
4. Define the combustion chamber.
5. Which materials are used for making the pistons ?
6. State the advantages and disadvantages of the various materials employed.
7. How is the piston shaped at the cylindrical part of the crown ? Give reasons for it.
8. What is the gudgeon (or wrist) pin ? In what ways may the connection be effected ?



- Diesel engines employ usually four
- Sometimes the lowest ring performs the dual function of and
- The top ring bears the brunt of the, it sustains and it is operated at

I. Label the parts of the piston in Fig.5.7. against the letters a, b, c, d, e.

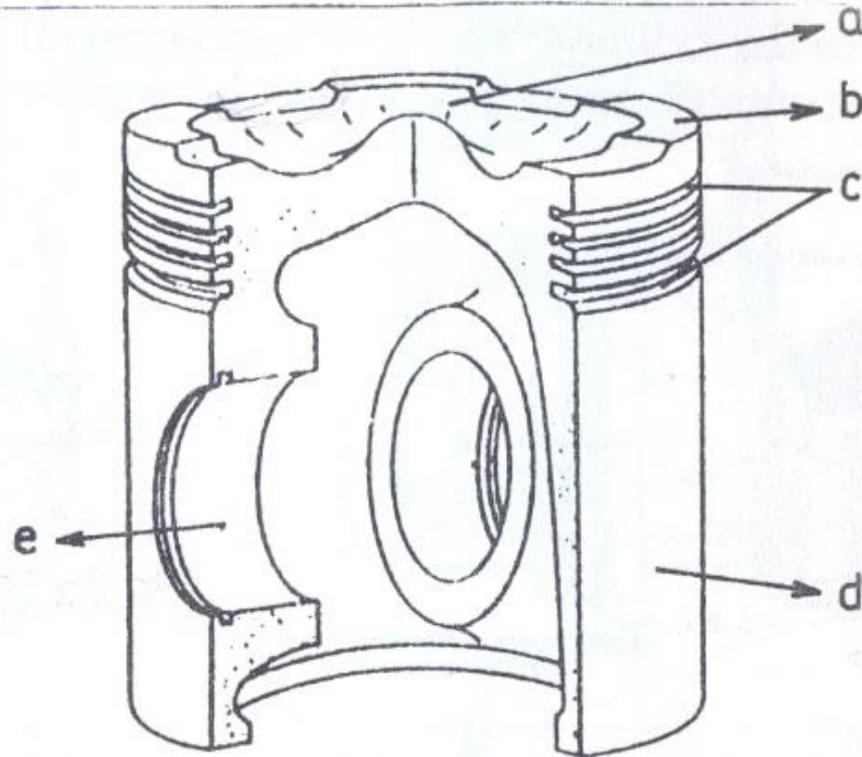


Fig 5.7.

II. Examine the previous sketch of the piston and answer the following questions

1. How is the top of the crown shaped ? What is another possible shape ?
2. State why the surfaces of piston crowns are shaped in this particular manner.
3. Is the crown section thick or thin ? Give reasons for it.
4. Is the rim of the crown evenly edged ?
5. Why are there grooves cut in the piston crown ?
6. Is the thickness of the piston wall the same throughout its length ? Give reasons for it.
7. What are piston bosses ?

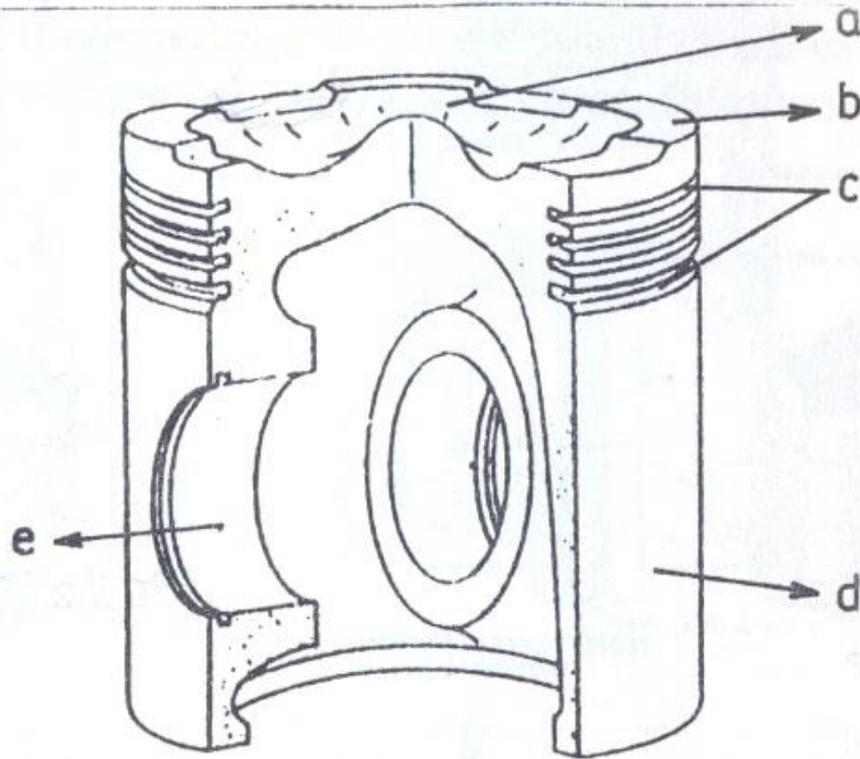


Fig 5.7.

III. Describe how the piston is cooled by observing the illustrations given in Fig.5.8.

III Describe how the piston is cooled by observing the illustrations given in Fig.5.8.

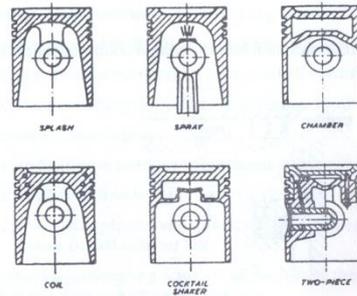
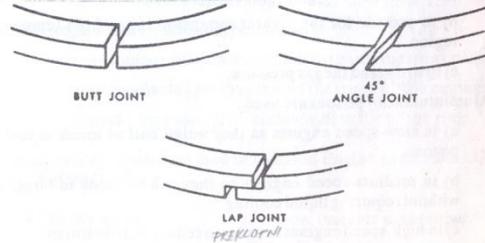


Fig 5.8.

IV Fig.5.9 shows three types of ring joint.



LAP JOINT
Compression Rings with Simple Joints
(Sealed Power Corp.)

Fig 5.9.

Now answer the questions.

1. Why is there a gap in the rings ?
2. What is the function of the piston rings ?

IV. Fig.5.9. shows three types of ring joint. Now answer the questions below

- 1. Why is there a gap in the rings ?*
- 2. What is the function of the piston rings ?*
- 3. When should piston rings be replaced ? Are all piston rings normally replaced at the same time ?*
- 4. What happens when the ring lubrication is too poor or excessive ?*
- 5. What is the difference between the compression rings and the oil control rings ?*

VI. Complete the following statements by choosing the correct endings

The crown of the piston is shaped on a slight taper

- to reduce the weight of the piston.
- to provide for the greater expansion in the high temperature region.
- to withstand the gas pressure.

Aluminium alloy pistons are used

- in slow-speed engines as they weight half as much as cast iron pistons.
- in medium-speed engines so they can be made in larger sizes without requiring liquid cooling.
- in high-speed engines in order to reduce inertia forces.

The main advantage of aluminium alloy pistons is:

- they expand considerably when heated.
- they transfer heat about three times as cast iron pistons.
- they require more clearance in the cylinder when the piston is cold.

Alloy cast iron pistons are widely used in slow-speed engines

- as they offer greater heat resistance and better wearing qualities.
- because of their heat transfer ability.
- because of their weight.

A gudgeon pin is said to be “ fully floating “ when

- it is secured in the piston and the bearing is held in the rod end.
 - it is free and the bearings are in both the piston and rod.
- it is fastened to the rod and the bearing is part of the piston.

The compression rings are designed

- to distribute and control lubricating oil in the cylinder wall.
- to transmit heat from the piston to the water-cooled cylinder liner.
- to seal the cylinder and transfer heat from the piston to the water-cooled cylinder liner.

Choose the correct answer

To provide a good sealing between the piston and the liner reducing the friction and wear to a minimum the rings

- must be tightly fixed in the grooves.
- should float freely within the whole depth of the grooves.
- should have a lap (or step) joint.

The piston of crosshead type engines is

- with minor differences, similar to that of the trunk piston engines.
- somewhat longer than that of the trunk piston engines.
- made long enough to accommodate the piston rings.

*VII . Some other prepositions used in technical English to indicate **LOCATION** and **DIRECTION** are:*

ACROSS meaning (1) “ from one side to the other”
“ on “ or “ at the opposite side of “

ALONG meaning (1) “ by the length of “

THROUGH meaning (1) “ in at one side and out at the opposite side ”
“ over the whole surface of “
“ by the way of “
“ by means of “ or “ by the help of “



Fill the blanks in the following sentences using a correct prepositions. Give reasons for using them

The damaged ship was sailing _____ the coast at a speed of 5 knots.

Fast liners sail _____ the Atlantic in few days.

Doors are provided on the cylinder casing _____ which the water spaces may be cleaned and inspected.

There is a Lash ship _____ the river at the deepwater terminal.

Cylinder liners for the two stroke engines have ports about midway _____ their length for admission and exhaust gases.

The air is drawn from the engine-room atmosphere _____ inlet filters which may be removed for cleaning.

The cooling of the piston is carried out by the circulating oil _____ the underside of the crown or _____ specially shaped passages.

Tie rod pass _____ all the separate components of the engine structure, thus maintaining them in compression.

He got this job _____ his uncle who has served the Company as Chief Engineer for twenty years.

NAMJERA, CILJ, SVRHA – II.

Purpose (2)



*Pistons may be made in aluminium alloy **so that** they can keep the weight down for the balancing purposes at high speed.*

*The rings have the familiar split or gap **so that** they can be easily assembled on the piston.*

*The wall pressure of simple ring is restricted by the radial depth of the ring, **in order that** it may be assembled in the groove.*

- Namjera ili cilj su u gornjim primjerima izraženi čitavom zavisnom rečenicom uvedenom sa SO THAT i IN ORDER THAT. Zavisna rečenica sadrži svršeni glagolski oblik (u određenom vremenu, licu i broju) kao što su “ they can ...” (1), (2) i “ it may ...” (3). Iza SO THAT obično slijede glagoli CAN ili WILL, a iza IN ORDER THAT glagol MAY, ukoliko je vrijeme u glavnoj rečenici sadašnje, a COULD ili WOULD odnosno MIGHT, ako je vrijeme prošlo. Na primjer:
 - A fan was fitted at the entrance so that ventilation could be facilitated.
 - The piston was removed in order that it might be inspected for wear and cracks.

GRAMMAR

Pored toga namjera se može izraziti i riječima ili skupovima riječi kao u navedenim primjerima:

- For this purpose the top of the piston crown may be bowl or toroidal shaped.
- Pistons may be in alluminium alloy so that they can keep weight down for balancing purposes at high speed.
- For propulsion purposes, close governing is not essential and stability is more important.
- The purpose (aim, object) of this report is to ensure the basic safety in the engine room.
- What is the purpose of supercharging ?
- The object of this design is to maintain more accurately the axial dimensions of the ring.
- The number of developments are aimed at providing rings to run in quickly. (i.e. the purpose or aim of these developments is to provide ...)
- For obtaining the best results it is necessary that rings are allowed some time for the running in. (i.e. To obtain the best results ...)

1. Join the following pairs of sentences introducing the purpose clause by *SO THAT* and *IN ORDER THAT*

Example

Liners are always made of special cast iron. This enables them to resist the abrasive action of piston rings.

- ▶ Cylinder liners are always made of special cast iron so that they can resist the abrasive action of the piston rings.
- ▶ Cylinder liners are always made of special cast iron in order that they may resist the abrasive action of the piston rings.

1a. Join the following pairs of sentences introducing the purpose clause by *SO THAT* and *IN ORDER THAT*

- ▶ Piston rings are used in grooves turned in piston. Their purpose is to seal the gases in the top of the cylinder and prevent their leakage down the sides of the piston.
- ▶ The engineers worked hard for two days. Their intention was to repair damage before sailing.
- ▶ In the fuel-supply system of larger vessels remote-operated valves are included. So, the fuel is turned off in the accidental occurrence of dangerous leaks, fires or other hazards.
- ▶ In addition to special portable power tools much improved workshop machinery is now provided. This enables a wider spectrum of repair work to be undertaken on board.
- ▶ In the first port the newly-arrived rating bought a small camera. His purpose was to take as many snapshots as possible during the voyage.
- ▶ The lower end of the cylinder liner is fitted with rubber rings. Their purpose is to provide seal for the bottom of the water space.
- ▶ I sent my proposal to the Department Manager a week ago. I wanted him to consider them long enough before our meeting.
- ▶ Scraper ring are generally fitted near the bottom of the trunk pistons. The oil thrown by revolving cranks is scraped off the cylinder wall on the down stroke.
- ▶ A distant piece is interposed between the foot and the box. It permits piston to be moved nearer to or farther from the cylinder head at the top dead centre.

IV. Translate into English:

- ▶ U svrhu montiranja (assembly) na klip, prstenovi imaju uobičajeni zazor ili zračnost.
- ▶ Da bi se prsten što bolje prilagodio (conform to) provrtu cilindra, zračnost prstenova mora biti što manja.
- ▶ Klipni prstenovi moraju biti otporni na trenje prilikom kretanja u cilindru. U tu svrhu oni su izvedeni od lijevanog željeza (alloy) manganom i kromom.
- ▶ Za postizanje (obtain) potrebne jačine prstenova u njihovoj izradi upotrebljava se do 1 % molibdena.
- ▶ Da bi lagano klizio u košuljici klip treba imati stalono i dovoljno podmazivanje.
- ▶ Što je uloga uljnih prstenova ?