STCW - TABLE A-III/2 - FUNCTION 1 - MARINE ENGINEERING AT THE MANAGEMENT LEVEL

MODULE 1 - MANAGE THE OPERATION OF PROPULSION PLANT OF MACHINERY

LEARNING OBJECTIVES

AT THE END OF THIS MODULE THE TRAINEES SHALL BE ABLE TO DESIGN FEATURES AND OPERATIVE MECHANISM OF THE FOLLOWING MACHINERY AND ASSOCIATED AUXILIARIES:

1. Marine Diesel Engine
2. Marine Steam Turbine
3. Marine Gas Turbine
4. Marine Steam Boiler

COMPETENCE

Manage the operation of propulsion plant machinery.

1.1 MARINE DIESEL ENGINE

- Reviews the Essential Engine Components: Bedplate, Crankshaft, Bearings, Liners, Pistons and Rings
- Analyzes the safe operation, maintenance and repair
- Discuss faults and repair procedures and processes employed

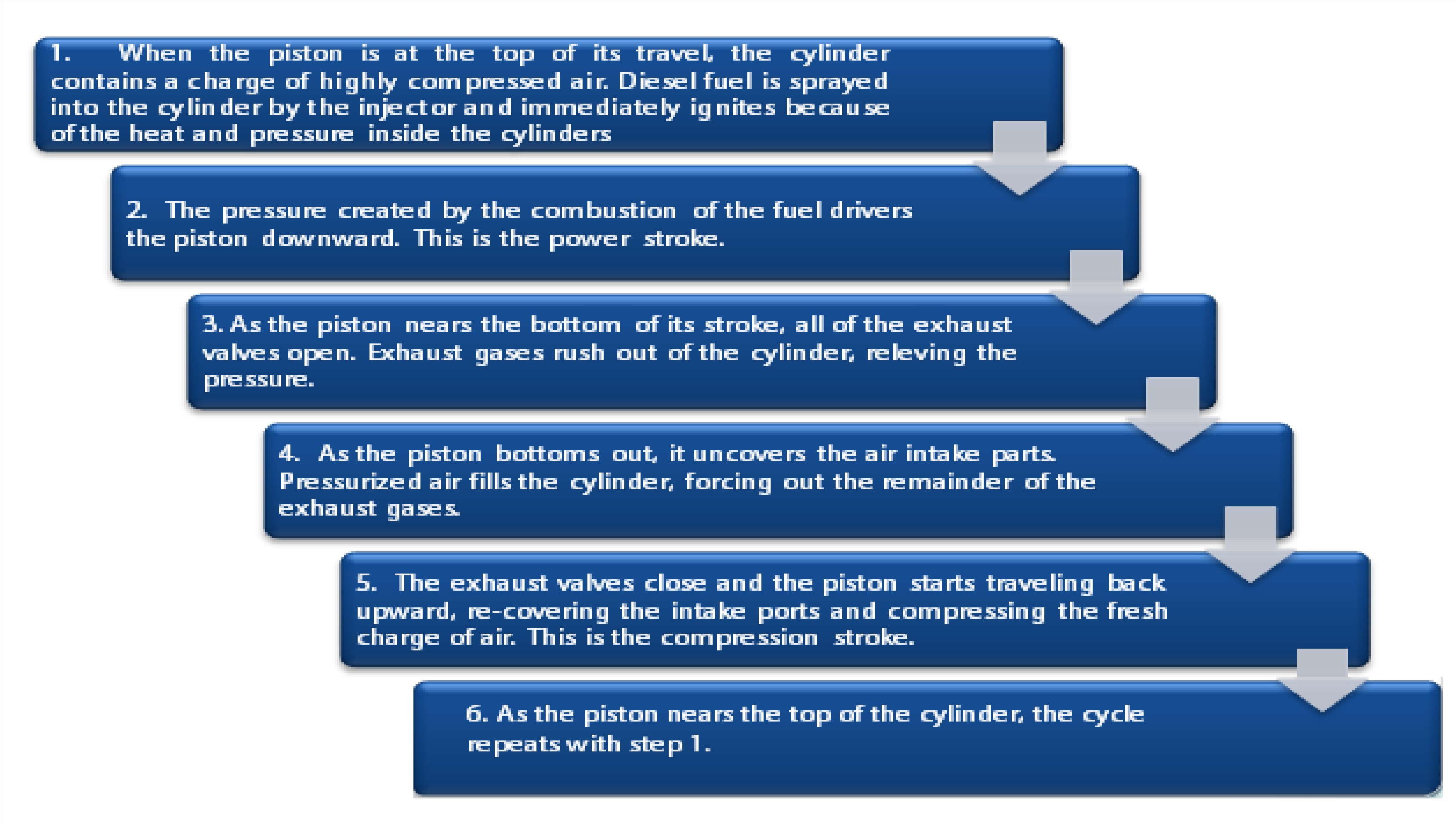
1.1. MARINE DIESEL ENGINE

A diesel engine converts the energy stored in the fuel into mechanical energy by burning the fuel. The chemical reaction of burning the fuel liberates heat, which causes the combustion gases to expand, forcing the piston to move downwards and cause the rotation of the crankshaft.

Diesel Cycle Terms

- Stroke - single up or down motion of the piston
- Top dead center (TDC) - highest point of travel by piston
- Bottom dead center (BDC) - lowest point of travel by the piston
- Cycle - number of strokes combined to complete the process

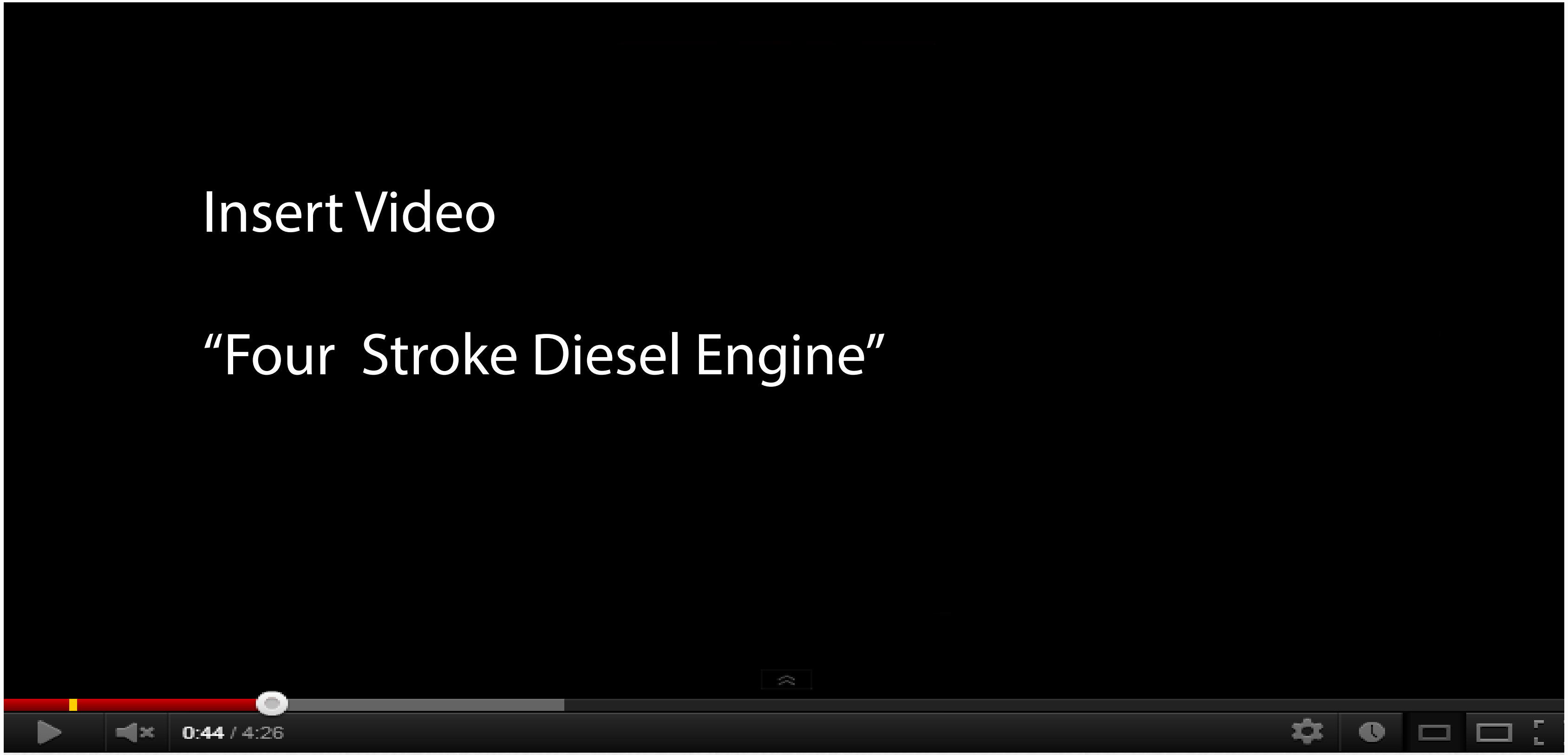
Two Stroke Diesel Engine



Four Stroke Diesel Engine

- INTAKE STROKE - Airl inlet valve opens and air enters the cylinder as the piston moves down from TDC
- COMPRESSION STROKE - Intake valves close and the piston rises, compressing the air trapped in the cylinder increasing its pressure and temperature
- POWER STROKE - Fuel is injected into the cylinder and ignites due to high temperature created by compression. Fuel rapidly burns, expanding gases force the piston down.
- EXHAUST STROKE - Exhaust valves open, piston rises and pushes exhaust gases out of the cylinder

Four Stroke Diesel Engine



Four Stroke Diesel Engine - cycle

The cycle begins at top dead center (TDC), when the piston is farthest away from the axis of the crankshaft. On the intake or induction stroke of the piston, the piston descends from the top of the cylinder, reducing the pressure inside the cylinder. A mixture of fuel and air is forced (by atmospheric or greater pressure) into the cylinder through the intake (inlet) port. The intake (inlet) valve (or valves) then close(s), and the compression stroke compresses the fuel–air mixture.

The air–fuel mixture is then ignited near the end of the compression stroke, usually by a spark plug (for a gasoline or Otto cycle engine) or by the heat and pressure ofcompression (for a Diesel cycle or compression ignition engine). The resulting pressure of burning gases pushes the piston through the power stroke. In the exhaust stroke, the piston pushes the products of combustion from the cylinder through an exhaust valve or valves.

Four Stroke Diesel Engine - cycle

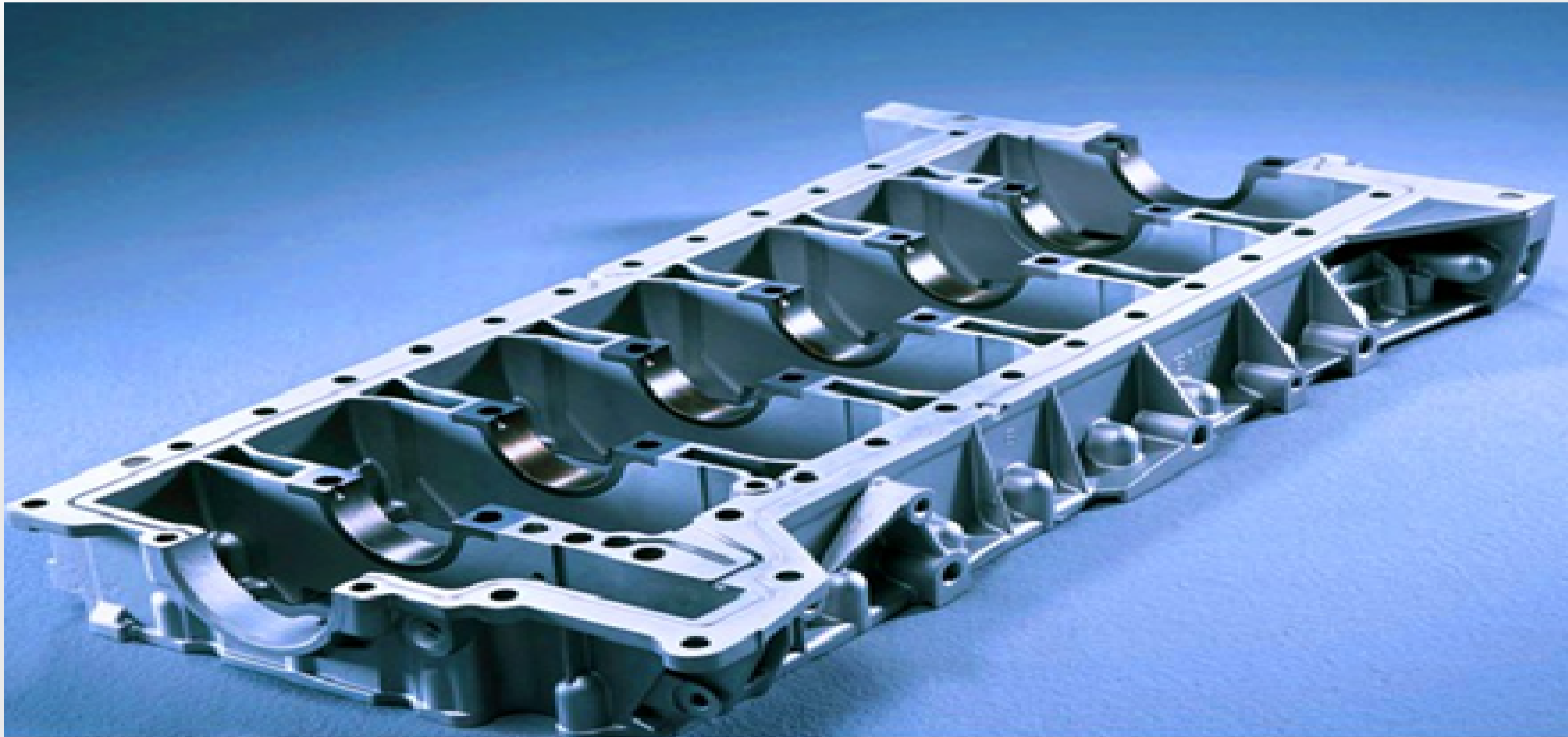
Bedplate

A one piece structure that may be of cast iron, prefabricated steel, cast steel, or a hybrid arrangement of cast steel and prefabricated steel.

For many years however, cast iron was the preferred material since it gave a stress free, easily machined and at times a cheap structure.

When welding techniques and methods of inspection improved and larger furnaces became available for annealing, the switch to prefabricated steel structure with its saving in weight and cost was made.

Bedplate



Crankshaft

It is the backbone of the reciprocating diesel engine. It must be extremely reliable as the cost of replacement would be high, and to say nothing of the dangerous situation that may arise on the high seas if it failed.

Types:

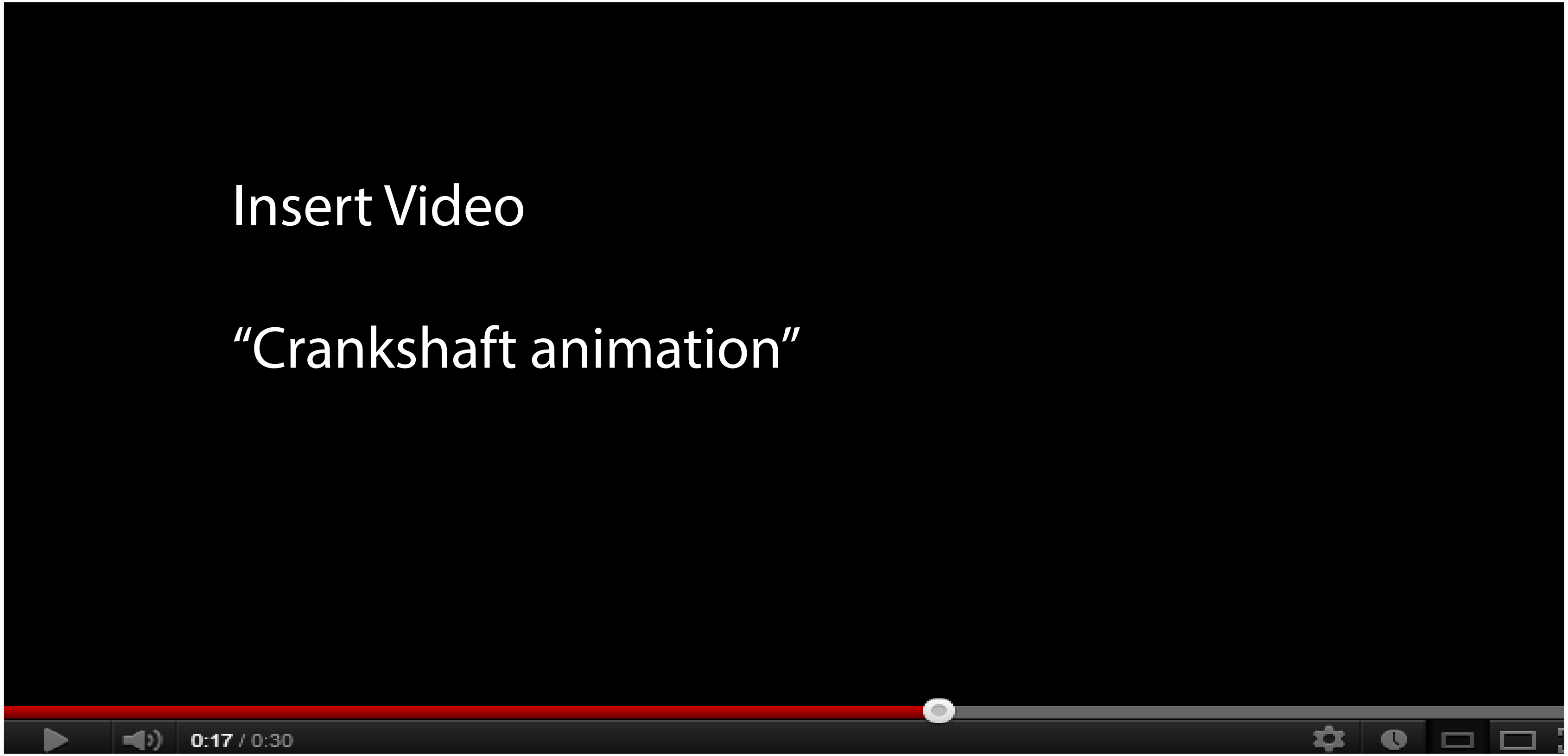
Fully built-up - webs are shrunk on to the journals and crank pins.
Semi built-up - webs and crankpin as one unit shrunk on to the journals.
One piece - one piece of material either cast or forged.

Uses:

Large marine diesel engines : fully built or semi-built crankshafts.
Medium speed diesel engines: semi-built.
High speed diesel engines: one piece construction.

Crankshaft

Crankshaft animation



Crankshaft defects and their causes

Worn main bearings – caused by incorrect bearing adjustment, choked lubricating oil supply pipe causing lubrication starvation, contaminated lubricating oil, and vibration forces.

Excessive bending of engine framework – caused by incorrect cargo distribution but is unlikely, more probable cause would be grounding of the vessel.

Vibration - can be caused by:

1. Incorrect power balance,
2. Prolonged running at or near critical speeds,
3. Slipped crank webs on journals,
4. Light ship conditions leading to impulsive forces from the propeller (e.g. forcing frequency four times the revs. for a four bladed propeller), the near presence of running machinery.

Bearing Clearances and Shaft Misalignment

1. Bearing clearances can be checked in a variety of ways, a rough check is to observe the discharge of oil, in the warm condition, from the ends of the bearings.

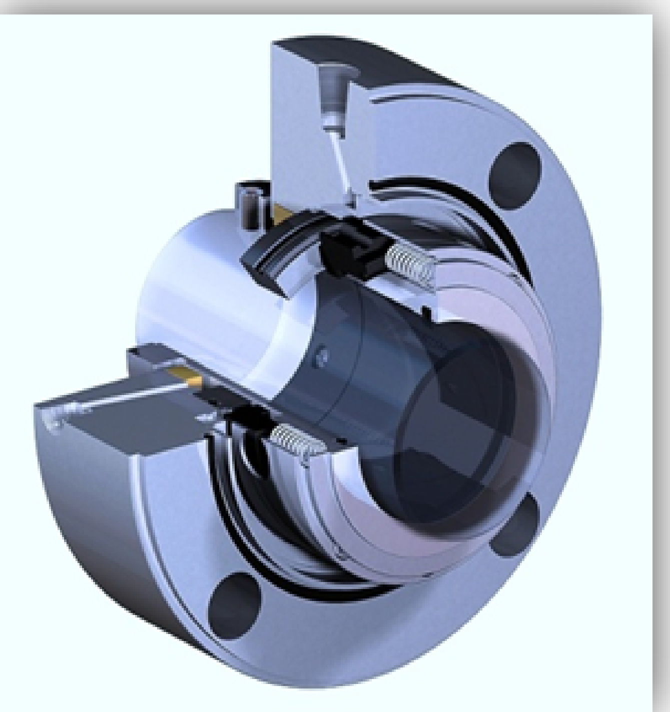
2. **Feeler gauge** can be used, but for some of the bearings they can be difficult to maneuver into position in order to obtain readings.

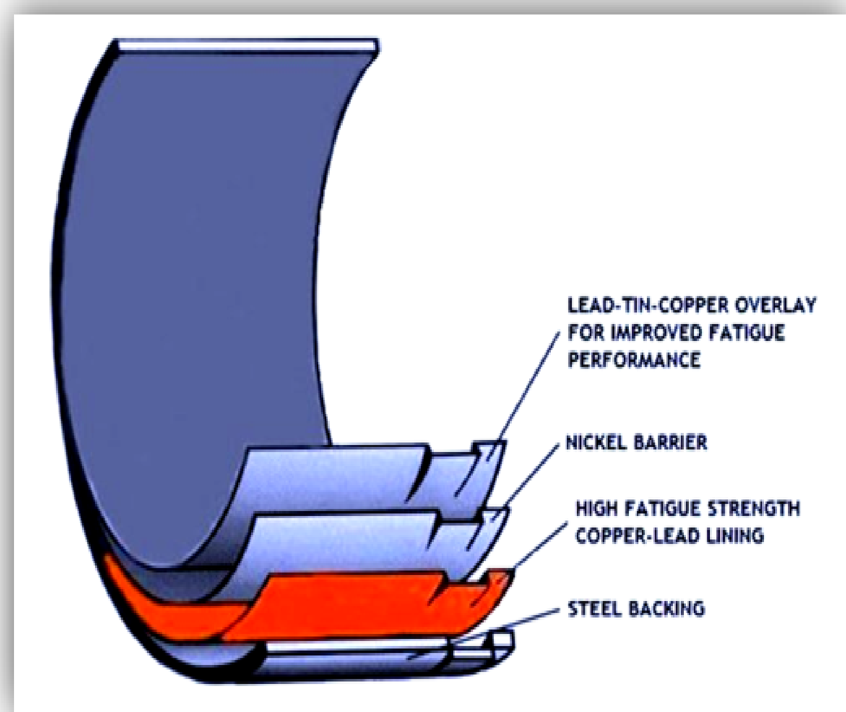
3. **Clock gauges** can very effective and accurate providing the necessary relative movement can be achieved, this can prove to be very difficult in larger types of engines.

Main bearing clearances, should be zero at the bottom, if not, then the crankshaft is out of alignment. Obviously, if the main bearing clearance is not zero at the bottom the adjacent bearing or bearings are high by comparison and the shaft is out of alignment.

Crankshaft alignment can be checked by taking deflections that is the relative movement of the distance between the crank webs when rotating the shaft one revolution. A clock gauge arranged horizontally between the webs opposite the crankpin is used to measure the change in distance.

Bearings




LEAD-TIN-COPPER OVERLAY FOR IMPROVED FATIGUE PERFORMANCE
NICKEL BARRIER
HIGH FATIGUE STRENGTH COPPER-LEAD LINING
STEEL BACKING

Cylinder Liners

Upper and lower liners are made thin to give good heat transfer and have the supporting ribs for strength and cooling water passage.

Steel rings are shrunk on to the supporting ribs to give additional strength to withstand combustion loads.
The lower water jacket, exhaust and combustion belts are bolted together.

Main advantages:

1. Liners are simple, short, hard wearing iron castings which can be relatively easily manufactured.
2. Each half (top or bottom) of the liners can be separately replaced if necessary.
3. Strong cast steel can be used for the combustion belt whose wearing properties does not have to match up to the cylinder liners.

A main disadvantage is the spigot copper joints, with some arrangements of cylinders there are no joints, or possibly one.

Cylinder Liners

Cylinder Liner Wear

1. With correct cylinder lubrication,
2. Correctly fitted piston rings and
3. Warming through of the diesel engine before starting,
4. Together with good combustion, and
5. Properly timed fuel injection, cylinder liner wear can be kept to a minimum.

Cylinder Lubrication

1. To separate sliding surfaces with an unbroken oil film.
2. To form an effective seal between piston rings and cylinder liner surface to prevent blow-by.
3. To neutralize corrosive combustion products and thus protect cylinder liner, piston and rings from corrosive attack.
4. To soften deposits and thus prevent wear due to abrasion.
5. To cool hot surfaces without burning.
6. To remove, dissipate and cause the loss of deposits to exhaust, hence preventing seizure of piston rings and keeping engine clean.