1.0 ENGINE

An internal combustion engine is a part of a vehicle that generates the motive force that propels the vehicle by burning its fuel internally.

Reciprocating internal combustion engines is a type of internal combustion engines used as prime movers for most transport vehicles which ply on roads and power generating units used domestically. The combustion of its fuel takes place within the cylinder and the energy in the combustion chamber is transferred to the crankshaft of the engine via the piston and connecting rod. An internal combustion engine in which the energy from the combustion chamber is transferred to the crankshaft by the reciprocating motion of the piston is known as a reciprocating internal combustion engine.

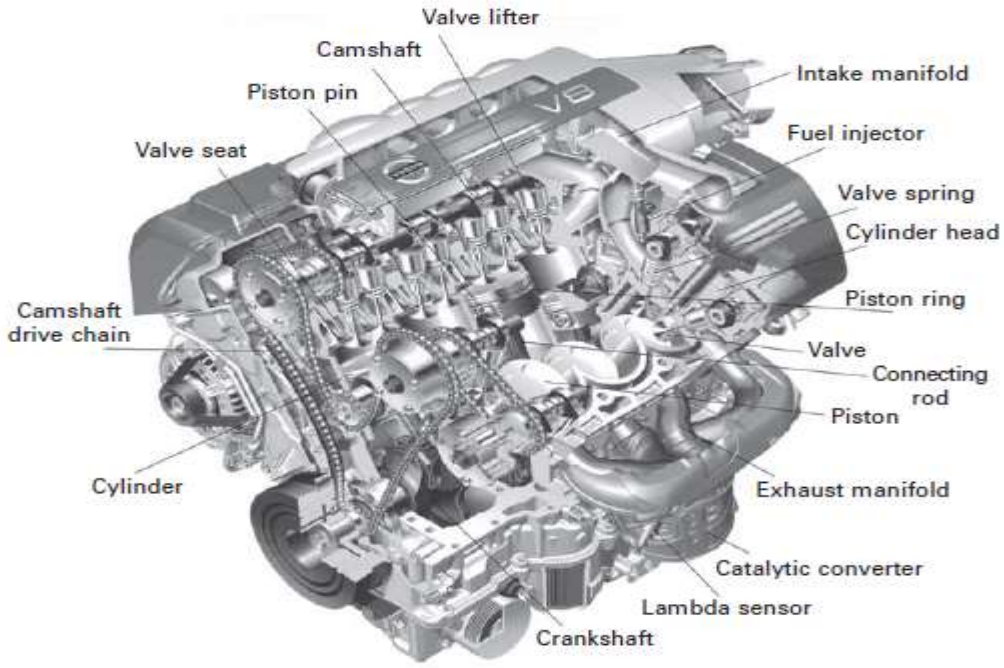

Figure 1: The Picture of the Cutaway of a four-stroke cycle petrol engine

Reciprocating internal combustion engines can be classified as two-stroke or four-stroke cycle depending on its cycle of operation and could also be broadly classified as a compression ignition (CI) or a spark ignition engine depending on the mode of combustion of the air-fuel mixture in the combustion chamber.

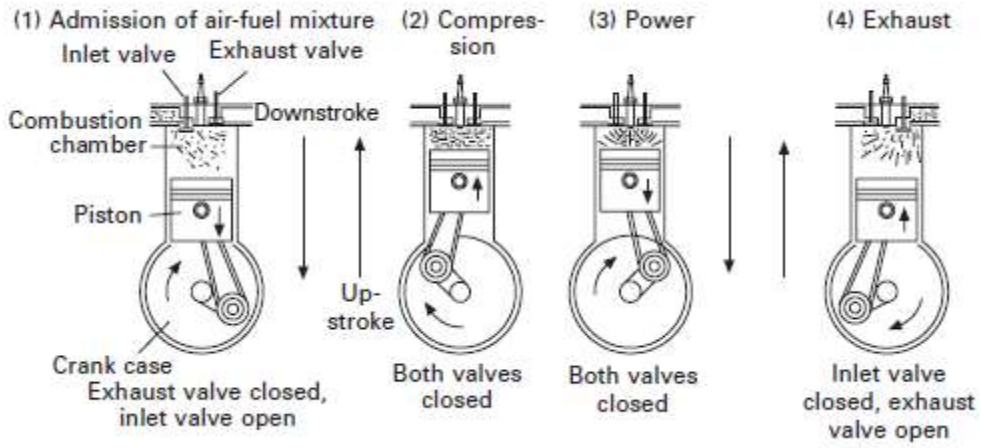

Figure 2: The Basic Operation of a Four-Stroke Cycle Engine

Piston is the reciprocating component of a cylinder bore with the main purpose of transferring the force from the expanding combusting gases to the crankshaft through the connecting rod or con rod as it is also referred to. The piston and its piston rings, form the combustion chamber with the cylinder head, sealing and preventing the combusting/combusted gases from escaping into the crankcase. At ignition of the air-fuel mixture, the combusting gases expand exerting pressure on the piston crown which is transferred to the rotating crankshaft through the piston pin and the connecting rod. In a two-stroke engine, the piston plays the role of a gas exchange control mechanism (valve).

1.1 MATERIALS FOR ENGINE PARTS

Table 1: Materials for Engine Parts

Part Name	Material
Cylinder block	Gray cast iron, compact graphite cast iron, cast Al alloy Al-Si-Cu-Mg alloy or cast iron with metals for better strength and wear resistance like Mo, Cr, Ni etc.
Piston	Gray cast iron, cast steel, spheroidized graphite cast iron, alloy cast iron, Aluminium alloy etc.
Piston ring	Spring steel and stainless steel, Chilled cast iron, Cr-Mo steel,
Camshaft	iron base sintered metal
Valve	Heat-resistive steel, Ti alloy, SiC ceramics
Valve seat	Iron base sintered metal, cast iron
Valve spring	Spring steel, music wire

Piston pin	Nodular cast iron, Si-Cr steel, stainless steel
Connecting rod	Carbon steel, iron base sintered metal, micro-alloyed steel, spheroidized graphite cast iron
Turbo charger	Niresist cast iron, cast stainless steel, superalloy
Exhaust manifold	High-Si cast iron, niresist cast iron, cast stainless steel, stainless steel tube and sheet
Plain bearing	Al-Si-Sn and Cu-Pb alloys
Catalyst	Pt-Pd-Rh alloy

2.0 CYLINDER BLOCK

The engine cylinder block is the main framework of a vehicle's engine which supports and holds other engine components. The cylinder block could come detached from the crankcase (assembled) (as seen in air- cooled engines) or integrated with the crankcase (integral) (as seen in water cooled engines) as shown in figures (3a) and (3b) respectively.

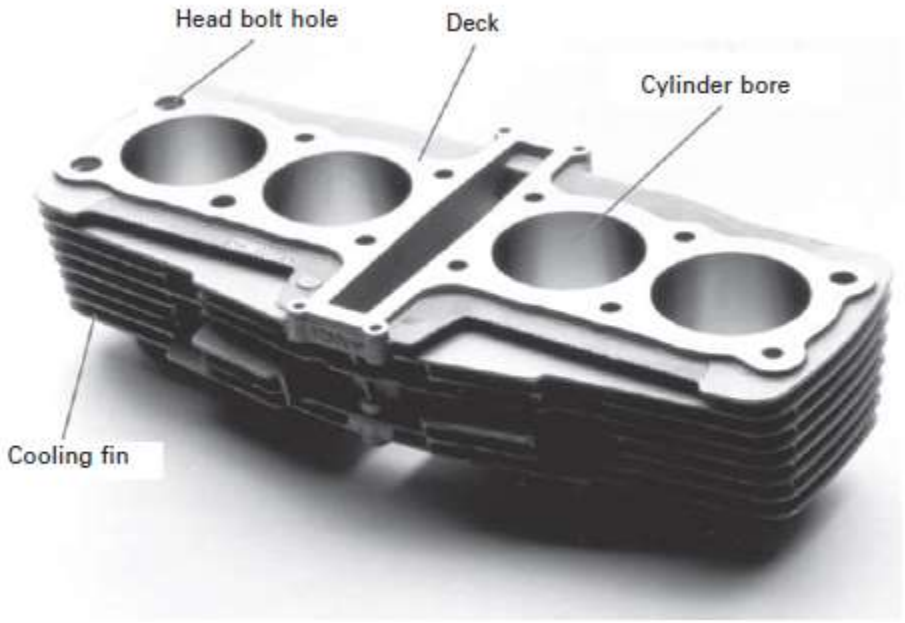

Figure 3(a):Air-cooled engine block

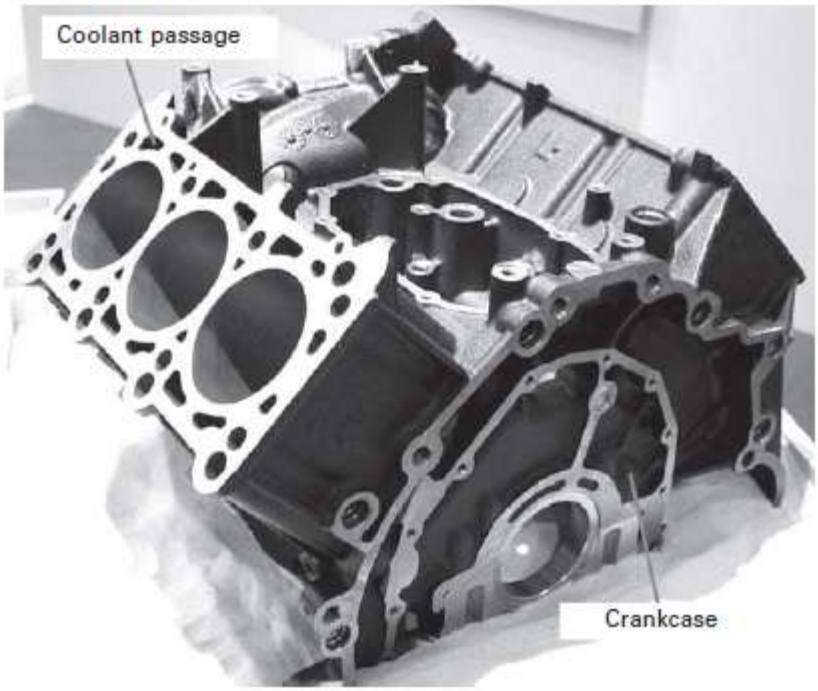

Figure 3(b): A cast iron cylinder block integrated with the crankcase

2.1 THE FUNCTION OF A CYLINDER BLOCK

The function and operation of an engine cylinder is summarized with the chart in figure 4.

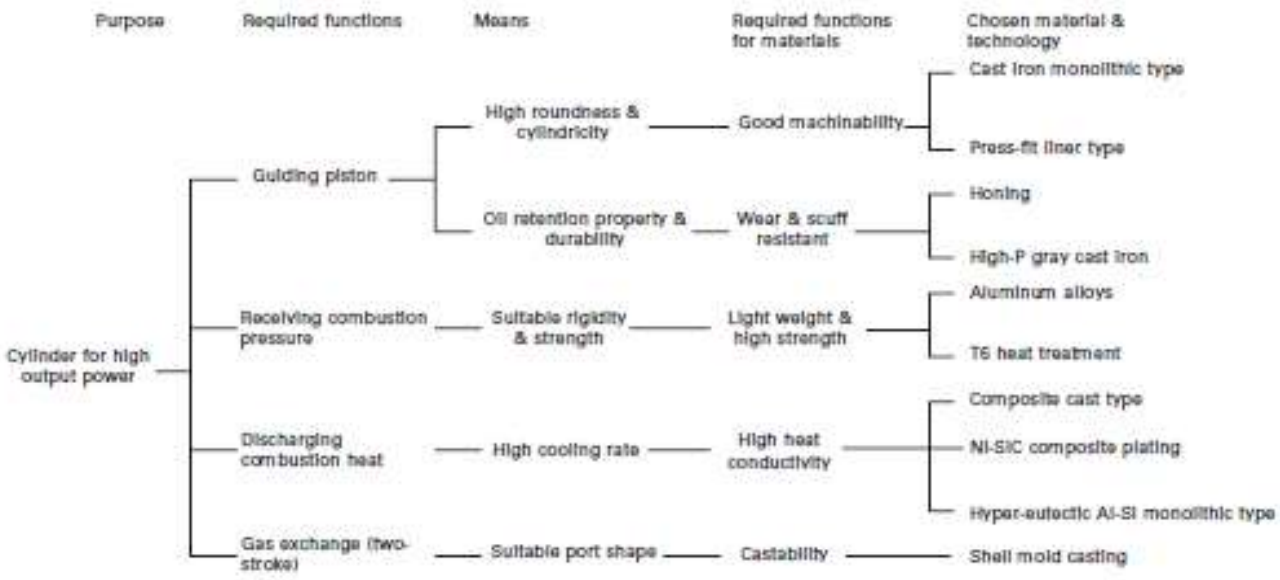

Figure 4: Functions of an engine cylinder

To minimize the wear at the top-dead-center region of the cylinder (which is as a result of insufficient oil film at the point), and scratch along the direction of travel of the piston, the engine cylinder is required to maintain accurate roundness and straightness in a tolerance order of micro-meters (μm) during operation. The wear on the cylinder walls as a result of the scratch along the direction of piston travel leads to increased blow-by and oil consumption.

Generation of higher power output from an engine translates to generation of more heat in the engine and this requires a higher cooling unit/system compared to a lower power output engine. While the cooling of an engine could be done with air or water, the air cooled engines come with simpler designs compared to the water cooled engines due to the absence of water passages in the engine block.

The use of air-cooled engines in automotive engines have been observed to be less efficient with increase in engine power output requirement and this has resulted in the switch of most automotive engines to water cooled engines. In summary, it could be said that the required cooling level of an engine determines the structure of its cylinder.

The chart in figure 5 shows the different types of cylinder block structures.

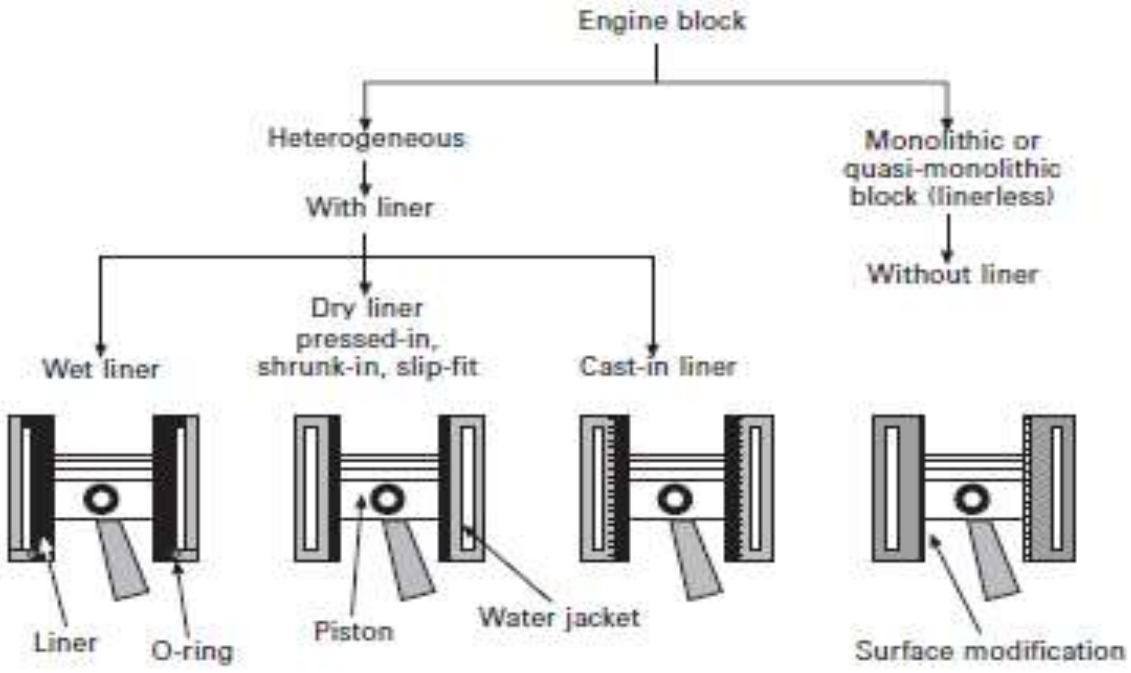

Figure 5: Bore design in engine blocks

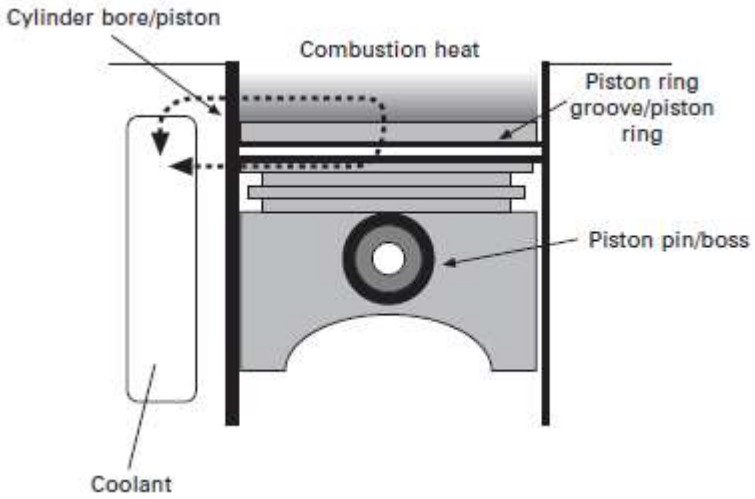

Figure 6: The Tribological System around a Cylinder Bore (black portions)

The monolithic or quasi-monolithic block are blocks made of one material. They are also known as a linerless block because they don't have liners. The walls of the cylinder bore are either made of the same material as the block or a modified surface such as plating to improve the wear resistance of the surface. The linerless designs in multi-bore engines make the engines more compact by decreasing inter-bore spacing. The heterogeneous block are engines blocks with liners and a liner is also known as or called a **sleeve**. A **wet liner** is directly exposed to coolant at its outer surface and the heat on the engine cylinder wall is dissipated directly into the coolant. The wet liner normally has a flange at the top and the clamping action of the cylinder head presses the liner into position. A rubber or a copper O-ring is used at the bottom and on some occasions, at the top of a wet liner to prevent the leakage of the coolant into the crankcase. Compared to the dry liner, the wet liner is made thicker because of its requirement to withstand combustion pressure and heat without the added support of the engine block. The dry liner presses or shrinks into a cylinder that has already been bored. The dry liner is thinner compared to the wet liner and has no direct contact with the coolant. In the cast-in liner design, the cast is introduced and encloses the liner during the casting process of the entire cylinder block.

Cylinder blocks are basically made of cast iron or aluminium alloy. Aluminium engine blocks are much lighter compared to cast iron blocks.