Overview of Engine Classification & Construction

- Combustion refers to the process of burning fuel.
- Engines are machines using combustion as the source of energy to produce power.
- Motors do not use combustion as an energy source.
- Typically a motor may use electricity vacuum or air for an energy source
- Two basic types of engines are the internal and external combustion.
- With few exceptions (ie Wankel – Rotary) all automotive production engines are reciprocating engines.
- Reciprocating engines refer to the up and down or back and forth movement of a piston in a cylinder. This linear movement is changed to rotational movement by the crankshaft.
**Reciprocating Engines:**
Convert the force of combustion expansion pressure into the up and down movement of the pistons. The reciprocating action of pistons is converted into rotational movement by the crankshaft.

**Engine Classification**
Reciprocating engines can be classified in endless number of ways: by cylinder arrangement, construction, operating cycle, fuel systems, ignition systems, manufacturers etc.. A fundamental type of classification is the type of combustion system.

All gasoline-fueled engines are referred to spark ignition combustion. Spark ignition may also be used to begin the combustion process in natural gas, propane and other alternate fuels.

Diesel engines are more correctly referred to as compression ignition combustion. Many distinctions can be made among Spark Ignition (SI) and Compression Ignition (CI) systems. However, between SI and CI engines basic operational characteristics exist. Diesel engines are more popular choice than gasoline SI engines for heavy duty engines for the following reasons:
Higher torque output for the same engine displacement.
Lower fuel consumption to produce the same horsepower
Flatter torque rise profile than gasoline (– more lower end torque)
Longer engine life
Fewer maintenance requirements – less aggravation level with simplified fuel/ignition system
Historically, diesels operated on cheaper fuel than gasoline

Many of the above operational characteristics are due to the higher compression ratio and energy content of diesel fuel. Higher compression ratios create a greater expansion forces during combustion and result in higher cylinder pressures during power stroke. Higher compression ratios require longer strokes having greater crank throw distances. The leverage on the crank throw in turn creates greater crankshaft leverage and consequently higher torque. Slower diesel engine speed and the lubricating properties of diesel fuel minimize cylinder wall wear. This adds to the longevity of diesel engine service.
Above: Diesel engines have typically flatter torque rise (greater low-end torque) and lower top engine RPM limit.

Cylinder pressures are higher in a diesel engine which generate greater torque.
**Major Engine Components**
The following parts are common to a typical reciprocating internal combustion engines.

Valve Cover
A valve cover is typically a stamped sheet metal casing that prevents dirt and contamination from entering the engine. Oil, which splashes around beneath the valve cover is prevented from escaping by the valve cover and gasket. Valve covers are necessary to provide access to valve train mechanism and or fuel system when servicing is required. (ie a valve and injector adjustment)
Cylinder Head

A cylinder head is usually a heavy metal casting that seals the “top” of the engines combustion chamber. Due to the high combustion chamber pressures of a diesel engine, many more cylinder head bolts are required to clamp and maintain the seal between the head and cylinder block. In addition to the valve mechanisms, injectors and nozzles, intake and exhaust manifolds are bolted to the cylinder head and are located in a diesel engine. Spark plugs are also located in gasoline engine cylinder heads. Intake and exhaust manifolds are bolted to the head.

Cross section of and overhead cam cylinder head

Cylinder heads contain valve train mechanism and passageways for intake & exhaust gases, coolant, oil and fuel.
A gasket between the cylinder head and block is necessary to seal the compression gases
**Camshaft**

To operate the valves in correct sequence a camshaft is used. Eccentric lobes on the camshaft actuate valves through the valve train. The valve train may consist of valve lifters, pushrods, rocker levers and bridges. L-head engines have the camshaft located in the engine block. Overhead camshafts have the camshaft located in the cylinder head.

**Valves & Ports**

Valves are used to control the movement of gases into and out of the cylinder. Ports are passageways through the head through which intake and exhaust gases flow.
Intake and exhaust manifold carry fresh air and fuel (some gasoline engines only) and combustion gases to and from the engine through ports and passageways.
Valve/Gear Train Mechanism
To co-ordinate the movement of the crankshaft with the camshaft and the valves, a gear train or valve timing mechanism is used. The gear train may also operate fuel injection apparatus, lubrication, power steering and coolant pumps, accessory drive mechanisms and even PTO pumps. Belts chains or gears are typical components used to transfer power in the gear train.
Cylinder Block
Most engines are built upon a cylinder block, or engine block. The block is usually an iron or aluminium casting that contains the engine cylinders as well as passages for coolant and oil circulation. The top of the block is covered by the cylinder head, which has more coolant passages and forms most of the combustion chamber in gasoline fuelled engines. The bottom of the block is covered with an oil pan, or an oil sump.
Premium diesel engines and many in heavy-duty applications use replaceable cylinder liners.

**Crankcase**
The crankcase is the lower portion of the engine containing the crankshaft. It is usually bounded by the area below the cylinders and contains the oil pan/sump.
Within the crankcase is the crankshaft. The crankshaft converts the reciprocating action of the pistons to a rotational movement. The crankshaft revolves inside the crankcase portion of the engine block. Main bearing caps bolt to the block and hold the crankshaft in place. Large shell bearings, called main bearings, are used between the crankshaft and caps.

**Cylinder Components**

The piston is attached to one end of a connecting rod by a pin called a piston pin, or a wrist pin. The other end of the rod is attached to the crankshaft. Rod bearings, similar to the main bearings, are used between the connecting rod and the crankshaft.

As the piston strokes in the cylinder, it rotates the crankshaft. The rotary motion of the crankshaft can be used to turn the wheels of a vehicle, rotate the blades of a lawnmower, or turn the propeller of an airplane.

It is important to understand the relationship between the revolving crankshaft and the stroking piston. The piston always makes two strokes for each revolution of the crankshaft. The complete four-stroke cycle requires two crankshaft revolutions. Because only one of the four strokes is a power stroke, the crankshaft must coast for one and one-half
Flywheel
The flywheel is a heavy round casting bolted to the end of the crankshaft. The heavy mass of the flywheel develops considerable inertia that is used to “smooth out” the impulses of the firing strokes. The flywheel keeps the engine turning because it also resists a decrease in speed.

The ring gear is a gear attached to the outside diameter of the flywheel engaged by the starting motor to crank the engine during starting.

When an automatic transmission is used, a torque converter is bolted to the flywheel. Because the torque converter is heavy, the flywheel can be much lighter. The flywheel used with a torque converter is often called a "flex plate." The total weight of torque converter and flex plate equals the weight of the flywheel and clutch on a manual transmission engine.
Flywheel & Harmonic Balancer of Large Bore Diesel (Volvo)

The harmonic balancer dampens out torsional and harmonic vibrations at the front of the crankshaft while the flywheel accomplishes a similar function at the rear of the engine. Torsional vibration is more severe in diesel engines due to combustion characteristics.