# INTERNAL COMBUSTION ENGINE TERMINOLOGY AND ABBREVIATIONS

The following terms and abbreviations are commonly used in engine technology literature.

**Internal Combustion** (Ie)

**Spark Ignition** (81) An engine in which the combustion process in each cycle is started by use of a spark plug.

**Compression Ignition** (CI) An engine in which the combustion process starts when the air-fuel mixture self-ignites due to high temperature in the combustion chamber caused by high compression. CI engines are often called **Diesel** engines, especially in the non-technical community.

**Top-Dead-Center** (TDC) Position of the piston when it stops at the furthest point away from the crankshaft. *Top* because this position is at the top of most engines (not always), and *dead* because the piston stops at this point. Because in some engines top-de ad-center is not at the top of the engine (e.g., horizontally opposed engines, radial engines, etc.), some Sources call this position

**Head-End-Dead-Center** (HEDC). Some sources call this position **Top-Center** (TC). When an occurrence in a cycle happens before TDC, it is often abbreviated bTDC or bTe. When the occurrence happens after TDC, it will be abbreviated aTDC or aTe. When the piston is at TDC, the volume in the cylinder is a minimum called the *clearance volume.*

**Bottom-Dead-Center** (BDC) Position of the piston when it stops at the point closest to the crankshaft. Some sources call this **Crank-End-Dead-Center** (CEDC) because it is not always at the bottom of the engine. Some sources call this point **Bottom-Center** (BC). During an engine cycle things can happen before abBotet.om-dead-center, bBDC or bBC, and after bottom-de ad-center, aBDC or **Direct Injection** (DI) Fuel injection into the main combustion chamber of an engine. Engines have either one main combustion chamber (open chamber)

**Indirect Injection** (IDI) Fuel injection into the secondary chamber of an engine with a divided combustion chamber.

**Bore** Diameter of the cylinder or diameter of the piston face, which is the same minus a very small clearance.

**Stroke** Movement distance of the piston from one extreme position to the other: TDC to BDC or BDC to TDC.

**Clearance Volume** Minimum volume in the combustion chamber with piston at TDC.

**Displacement or Displacement Volume** Volume displaced by the piston as it travels through one stroke. Displacement can be given for one cylinder or for the entire engine (one cylinder times number of cylinders). Some literature calls this *swept volume.*

**Smart Engine** Engine with computer controls that regulate operating characteristics such as air-fuel ratio, ignition timing, valve timing, exhaust control, intake tuning, etc. Computer inputs come from electronic, mechanical, thermal, and chemical sensors located throughout the engine. Computers in some automobiles are even programmed to adjust engine operation for things like valve wear and combustion chamber deposit buildup as the engine ages. In automobiles the same computers are used to make *smart cars* by controlling the steering, brakes, exhaust system, suspension, seats, anti-theft systems, sound-entertainment systems, shifting, doors, repair analysis, navigation, noise suppression, environment, comfort, etc. On some systems engine speed is adjusted at the instant when the transmission shifts gears, resulting in a smoother shifting process. At least one automobile model even adjusts this process for transmission fluid temperature to assure smooth shifting at cold startup.

**Air-Fuel Ratio** (AF) Ratio of mass of air to mass of fuel input into engine.

**Fuel-Air Ratio** (FA) Ratio of mass of fuel to mass of air input into engine.

**Brake Maximum Torque** (BMT) Speed at which maximum torque occurs.

**Overhead Valve** (ORV) Valves mounted in engine head.

**Overhead Cam** (aRC) Camshaft mounted in engine head, giving more direct control of valves which are also mounted in engine head.

**Fuel Injected** (FI)

**Block** Body of engine containing the cylinders, made of cast iron or aluminum. **In** many older engines, the valves and valve ports were contained in the block. The block of water-cooled engines includes a water jacket cast around the cylinders. On air-cooled engines, the exterior surface of the block has cooling fins.

**Camshaft** Rotating shaft used to push open valves at the proper time in the engine cycle, either directly or through mechanical or hydraulic linkage (push rods,

**Figure 1-15** Cross-section of four-stroke cycle S1 engine showing engine components;

(A) block, (B) camshaft, (C) combustion chamber, (D) connecting rod, (E) crankcase, (F) crankshaft, (G) cylinder, (H) exhaust manifold, (I) head, (J) intake manifold, (K) oil pan, (L) piston, (M) piston rings, (N) push rod, (0) spark plug, (P) valve, (Q) water jacket. rocker arms, tappets). Most modern automobile engines have one or more camshafts mounted in the engine head (overhead cam). Most older engines had camshafts in the crankcase. Camshafts are generally made of forged steel or cast iron and are driven off the crankshaft by means of a belt or chain (timing chain).

**Carburetor** Venturi flow device which meters the proper amount of fuel into the air flow by means of a pressure differential. For many decades it was the basic fuel metering system on all automobile (and other) engines. It is still used on low cost small engines like lawn mowers, but is uncommon on new automobiles.

**Catalytic converter** Chamber mounted in exhaust flow containing catalytic material that promotes reduction of emissions by chemical reaction.

**Combustion chamber** The end of the cylinder between the head and the piston face where combustion occurs. The size of the combustion chamber continuously changes from a minimum volume when the piston is at TDC to a maximum when the piston is at BDC. The term "cylinder" is sometimes synonymous with "combustion chamber" (e.g., "the engine was firing on all cylinders"). Some engines have *open* combustion chambers which consist of one chamber for each cylinder. Other engines have *divided* chambers which consist of dual chambers on each cylinder connected by an orifice passage.

**Connecting rod** Rod connecting the piston with the rotating crankshaft, usually made of steel or alloy forging in most engines but may be aluminum in some small engines.

**Connecting rod bearing** Bearing where connecting rod fastens to crankshaft.

**Cooling fins** Metal fins on the outside surfaces of cylinders and head of an aircooled engine. These extended surfaces cool the cylinders by conduction and convection.

**Crankcase** Part of the engine block surrounding the rotating crankshaft. In many engines, the oil pan makes up part of the crankcase housing.

**Crankshaft** Rotating shaft through which engine work output is supplied to external systems. The crankshaft is connected to the engine block with the *main bearings.* It is rotated by the reciprocating pistons through connecting rods connected to the crankshaft, offset from the axis of rotation. This offset is sometimes called *crank throw* or *crank radius.* Most crankshafts are made of forged steel, while some are made of cast iron.

**Cylinders** The circular cylinders in the engine block in which the pistons reciprocate back and forth. The walls of the cylinder have highly polished hard surfaces. Cylinders may be machined directly in the engine block, or a hard metal (drawn steel) sleeve may be pressed into the softer metal block. Sleeves may be dry sleeves, which do not contact the liquid in the water jacket, or wet sleeves, which form part of the water jacket. In a few engines, the cylinder walls are given a knurled surface to help hold a lubricant film on the walls. In some very rare cases, the cross section of the cylinder is not round.

**Exhaust manifold** Piping system which carries exhaust gases away from the engine cylinders, usually made of cast iron.

**Exhaust** system Flow system for removing exhaust gases from the cylinders, treating them, and exhausting them to the surroundings. It consists of an exhaust manifold which carries the exhaust gases away from the engine, a thermal or catalytic converter to reduce emissions, a muffler to reduce engine noise, and a tailpipe to carry the exhaust gases away from the passenger compartment.

**Fan** Most engines have an engine-driven fan to increase air flow through the radiator and through the engine compartment, which increases waste heat removal from the engine. Fans can be driven mechanically or electrically, and can run continuously or be used only when needed.

**Flywheel** Rotating mass with a large moment of inertia connected to the crankshaft of the engine. The purpose of the flywheel is to store energy and furnish a large angular momentum that keeps the engine rotating between power strokes and smooths out engine operation. On some aircraft engines the propeller serves as the flywheel, as does the rotating blade on many lawn mowers.

**Fuel injector** A pressurized nozzle that sprays fuel into the incoming air on SI engines or into the cylinder on CI engines. On SI engines, fuel injectors are located at the intake valve ports on multipoint port injector systems and upstream at the intake manifold inlet on throttle body injector systems. In a few SI engines, injectors spray directly into the combustion chamber.

**Fuel pump** Electrically or mechanically driven pump to supply fuel from the fuel tank (reservoir) to the engine. Many modern automobiles have an electric fuel pump mounted submerged in the fuel tank. Some small engines and early automobiles had no fuel pump, relying on gravity feed.

**Glow plug** Small electrical resistance heater mounted inside the combustion chamber of many CI engines, used to preheat the chamber enough so that combustion will occur when first starting a cold engine. The glow plug is turned off after the engine is started.

**Head** The piece which closes the end of the cylinders, usually containing part of the clearance volume of the combustion chamber. The head is usually cast iron or aluminum, and bolts to the engine block. In some less common engines, the head is one piece with the block. The head contains the spark plugs in SI engines and the fuel injectors in CI engines and some SI engines. Most modern engines have the valves in the head, and many have the camshaft(s) positioned there also (overhead valves and overhead cam).

**Head gasket** Gasket which serves as a sealant between the engine block and head where they bolt together. They are usually made in sandwich construction of metal and composite materials. Some engines use liquid head gaskets.

**Intake manifold** Piping system which delivers incoming air to the cylinders, usually made of cast metal, plastic, or composite material. In most SI engines, fuel is added to the air in the intake manifold system either by fuel injectors or with a carburetor. Some intake manifolds are heated to enhance fuel evaporation.

The individual pipe to a single cylinder is called a *runner*.

**Main bearing** The bearings connected to the engine block in which the crankshaftrotates. The maximum number of main bearings would be equal to the number of pistons plus one, or one between each set of pistons plus the two ends. On some less powerful engines, the number of main bearings is less than this maximum.

**Oil pan** Oil reservoir usually bolted to the bottom of the engine block, making up part of the crankcase. Acts as the oil sump for most engines.

**Oil pump** Pump used to distribute oil from the oil sump to required lubrication points. The oil pump can be electrically driven, but is most commonly mechanically driven by the engine. Some small engines do not have an oil pump and are lubricated by splash distribution.

**Oil sump** Reservoir for the oil system of the engine, commonly part of the crankcase. Some engines (aircraft) have a separate closed reservoir called a *dry sump.*

**Piston** The cylindrical-shaped mass that reciprocates back and forth in the cylinder, transmitting the pressure forces in the combustion chamber to the rotating crankshaft. The top of the piston is called the *crown* and the sides are called the *skirt.* The face on the crown makes up one wall of the combustion chamber and may be a flat or highly contoured surface. Some pistons contain an indented bowl in the crown, which makes up a large percent of the clearance volume. Pistons are made of cast iron, steel, or aluminum. Iron and steel pistons can have sharper corners because of their higher strength. They also have lower thermal expansion, which allows for tighter tolerances and less crevice volume. Aluminum pistons are lighter and have less mass inertia. Sometimes synthetic or composite materials are used for the body of the piston, with only the crown made of metal. Some pistons have a ceramic coating on the face.

**Piston rings** Metal rings that fit into circumferential grooves around the piston and form a sliding surface against the cylinder walls. Near the top of the piston are



usually two or more compression rings made of highly polished hard chrome steel. The purpose of these is to form a seal between the piston and cylinder walls and to restrict the high-pressure gases in the combustion chamber from leaking past the piston into the crankcase (blowby). Below the compression rings on the piston is at least one oil ring, which assists in lubricating the cylinder walls and scrapes away excess oil to reduce oil consumption.

**Push rods** Mechanical linkage between the camshaft and valves on overhead valve engines with the camshaft in the crankcase. Many push rods have oil passages through their length as part of a pressurized lubrication system.

**Radiator** Liquid-to-air heat exchanger of honeycomb construction used to remove heat from the engine coolant after the engine has been cooled. The radiator is usually mounted in front of the engine in the flow of air as the automobile moves forward. An engine-driven fan is often used to increase air flow through the radiator.

**Spark plug** Electrical device used to initiate combustion in an SI engine by creating

a high-voltage discharge across an electrode gap. Spark plugs are usually made of metal surrounded with ceramic insulation. Some modern spark plugs have built-in pressure sensors which supply one of the inputs into engine control.

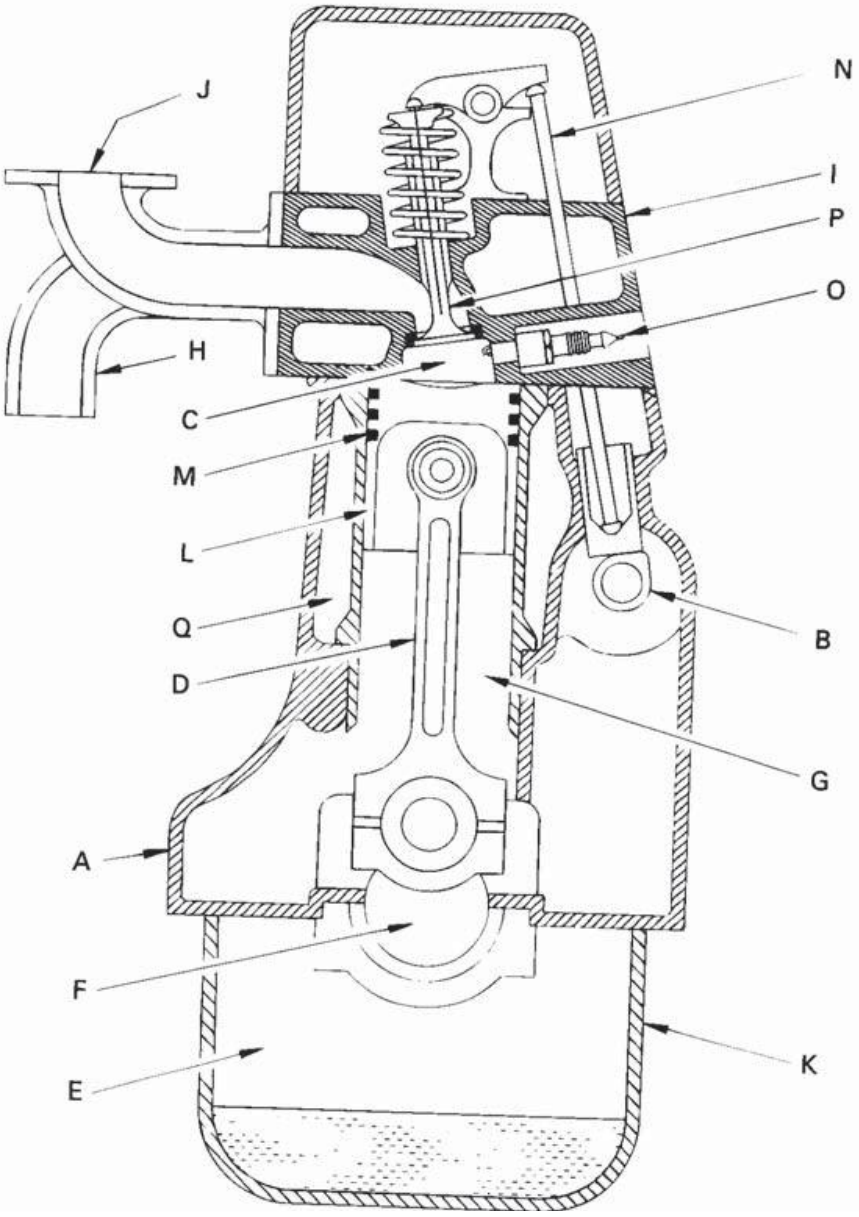
**Speed control-cruise control** Automatic electric-mechanical control system that keeps the automobile operating at a constant speed by controlling engine speed.

**Starter** Several methods are used to start IC engines. Most are started by use of an electric motor (starter) geared to the engine flywheel. Energy is supplied from an electric battery.

On some very large engines, such as those found in large tractors and construction equipment, electric starters have inadequate power, and small IC engines are used as starters for the large IC engines. First the small engine is started with the normal electric motor, and then the small engine engages gearing on the flywheel of the large engine, turning it until the large engine starts.

Early aircraft engines were often started by hand spinning the propeller, which also served as the engine flywheel. Many small engines on lawn mowers and similar equipment are hand started by pulling a rope wrapped around a pulley connected to the crankshaft.

Compressed air is used to start some large engines. Cylinder release valves are opened, which keeps the pressure from increasing in the compression strokes. Compressed air is then introduced into the cylinders, which rotates the engine in a *free-wheeling* mode. When rotating inertia is established, the release valves are closed and the engine is fired.

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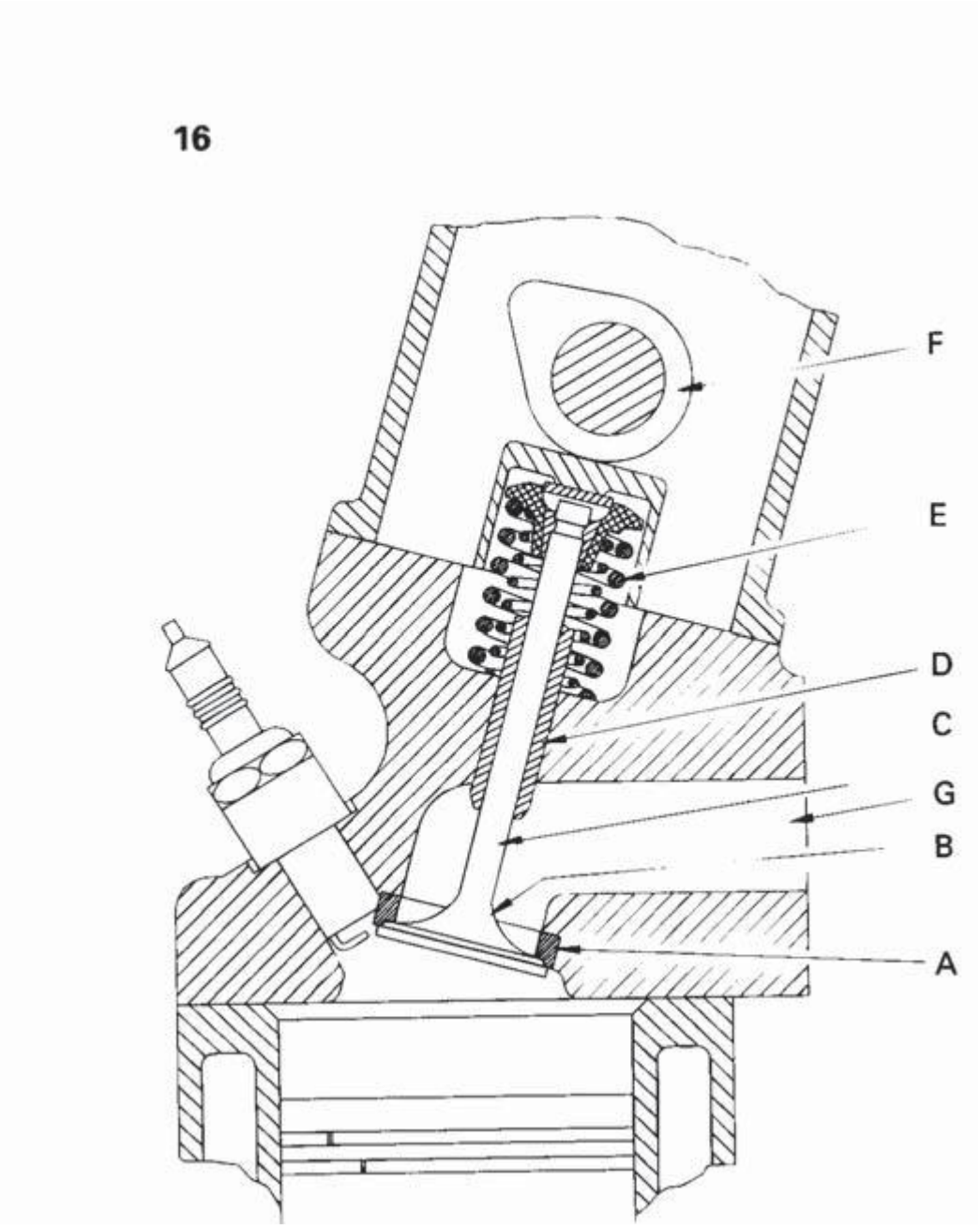


Poppet valve is spring loaded closed, and pushed open by cam action at proper time in cycle. Most automobile engines and other reciprocating engines use poppet valves. Much less common are sleeve valves and rotary valves. Components include: (A) valve seat, (B) head, (C) stem, (D) guide, (E) spring, (F) camshaft, (G) manifold