

Introduction to Automotive Service

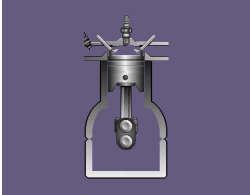
Engine Systems

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Brookhaven College

Introduction to Automotive Service

Basic Engine Operation

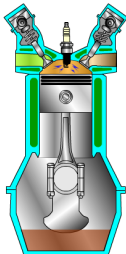
- The internal combustion process consists of:
 - admitting air and fuel into the cylinder
 - compressing the air and fuel mixture
 - igniting and burning the mixture
 - removing the burned gases from the cylinder



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Four Stroke Cycle

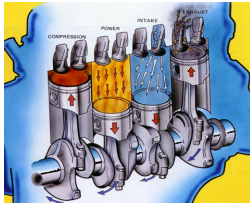
- Intake
 - intake valve open
- Compression
 - both valves closed
- Power
 - both valves closed
- Exhaust
 - exhaust valve open



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Firing Order


- TDC - top dead center
- BDC - bottom dead center
- Mate cylinders
- Each cylinder's air/fuel mixture must be ignited just prior to TDC during the compression stroke
- What speed does the camshaft rotate at in relation to the crankshaft?
- How many rotations of the crankshaft are required to fire all the cylinders in a modern V8 engine?



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Engine Design

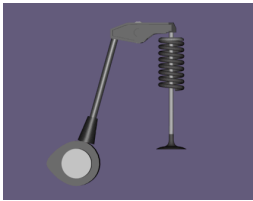
- Engines are commonly referred to by the engine's displacement in cubic inches or liters
- An engine's displacement is the volume of each of its cylinders multiplied by the engine's number of cylinders
- Engines are commonly referred to by the number of cylinders and the cylinders arrangement
 - inline 4 or 6
 - V 6, 8, 10 or 12
 - opposed 4 or 6



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Overhead Valves - OHV

- Valves located in the cylinder head
- Camshaft located in block
- Push rods and lifters are used to transfer cam lobe motion to the rocker arms



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Overhead Cam - OHC

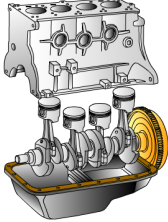
- Camshaft located in cylinder head
- Camshaft may operate the valves directly or use rocker arms
- SOHC use one camshaft for intake and exhaust valves
- DOHC engines use separate camshafts for the intake and exhaust valves



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Engine Component Jeopardy

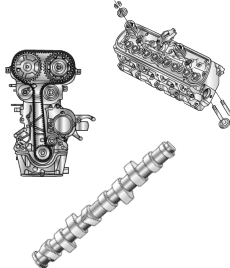
- Contains the pistons and crankshaft
- Moves up and down in the cylinder and compresses the air fuel mixture
- Connects the piston to the crankshaft
- Converts reciprocal motion of the piston and connecting rod into rotary motion



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Engine Component Jeopardy


- Bolts to the top of the block and contains the valves
- Open and close to admit fuel/air mixture and release exhaust gasses
- Uses egg shaped lobes to open the valves
- Closes the valves
- Used to drive the camshaft at one half crankshaft speed



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Engine Operation


- The piston moves downward as the air fuel mixture rapidly expands during combustion
- The piston rings seal the cylinder wall to the piston
- The connecting rod transfers the piston's motion to the crankshaft
- The crankshaft converts reciprocal motion into rotary motion



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Valve Train Operation

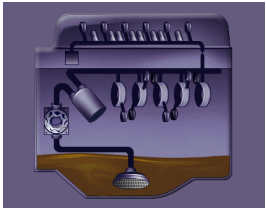
- The camshaft is driven by the crankshaft
- The camshaft rotates at one half crankshaft speed and controls valve operation
- OHV engines use lifters, push rods and rocker arms to transfer rotating cam lobe motion to the valves
- OHC engines may use lifter and rocker assemblies to operate the valve
- The valves are closed by valve springs



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Lubrication System Components

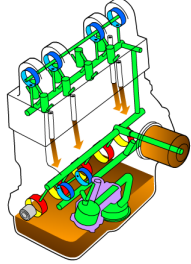
- Engine Oil
- Oil Reservoir
- Oil Pickup
- Oil Pump
- Oil Filter
- Oil Passages



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Lubrication System Operation

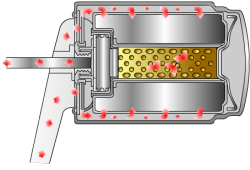
- Oil from the pan travels through the pickup tube to the oil pump
- Pump output is routed through the filter and to oil passages in the block cylinder head
- Oil passages are also present in the crankshaft and other engine components
- Moving engine components such as the pistons, crankshaft and camshaft, ride on a film of oil



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Oil Filter


- Full Flow Oil Filter**
 - all of the pump output flows through the filter
- Anti-drainback Valve**
 - keeps oil filter and lubrication passages primed when engine is off
- Bypass Valve**
 - allows oil to bypass filter element when the filter element is blocked



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Engine Oil Ratings

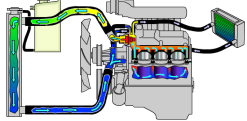
- Oil Performance**
 - API - American Petroleum Institute
 - SN is currently recommended for today's vehicles
- Viscosity Grade**
 - SAE - Society of Automotive Engineers
 - W - winter
- Energy Conservation Rating**



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Cooling System

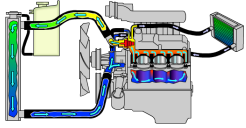
- Maintain an optimum operating temperature under all conditions
- Efficiently remove excess heat
- Bring engine to normal operating temperature as soon as possible



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Cooling System Operation


- Coolant flow:**
 - radiator
 - lower radiator hose
 - coolant pump
 - engine block coolant passages
 - cylinder head coolant passages
 - thermostat
 - upper radiator hose



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Engine Coolant


- A 50/50 mix of coolant and water provides optimum performance
- Raises boiling point and lowers the freezing point
- The cooling system is pressurized to further increase the coolant's boiling point
- Protects cooling system components from rust and corrosion



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Engine Coolant Types

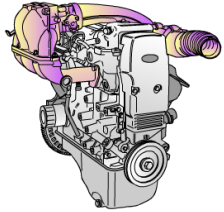
- The standard green coolant and orange coolant are both ethylene glycol based
 - green – silicate corrosion inhibitors
 - orange – organic acid corrosion inhibitors
- Do not mix or interchange coolant types



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Intake & Exhaust Manifolds


- Intake manifolds deliver air and fuel to the engine
 - commonly made of metal or plastic
- Exhaust manifolds carry spent exhaust gasses away
 - cast iron
 - tubular steel headers



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Engine Control Systems

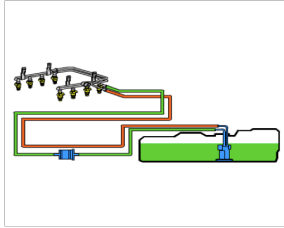
- The Powertrain Control Module (PCM) monitors engine and vehicle operating conditions with sensors and controls powertrain systems including:
 - fuel and air
 - ignition
 - emission
 - transmission



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Fuel System

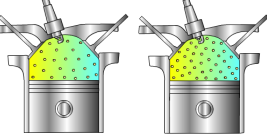
- Fuel Tank
- Fuel Pump
- Fuel lines
- Fuel Rail
- Fuel Pressure Regulator
- Fuel Injectors



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Air Fuel Ratios


- Ideal
 - 14.7 to 1
- Lean
 - 15 to 1 or greater
 - increased fuel economy
- Rich
 - 14 to 1 or less
 - reduced fuel economy



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Fuel Injectors


- Fuel injectors are turned on by the PCM
- A longer on-time provides a richer mixture
- The on time is referred to as pulse width and is measured in milliseconds



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Ignition System

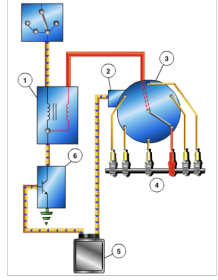
- Provides sufficient spark at the correct time to ignite the air fuel mixture
- Most of today's vehicles use distributorless ignition with computer controlled spark advance systems



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Ignition Operation

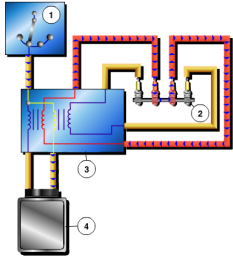
1. Ignition coil
2. Camshaft position sensor
3. Distributor
4. Spark plugs
5. Powertrain control module
6. Ignition module



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Distributor-less Ignition


1. Ignition switch
2. Spark plug
3. Coil pack
4. Powertrain control module



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Vehicle Emissions

- HC - hydrocarbons
 - fuel not burned during combustion
 - increases with misfires
- CO - carbon monoxide
 - a by product of incomplete combustion
 - increases with rich mixtures
- NOX - oxides of nitrogen
 - formed by heat and pressures in the combustion chambers
 - increases with lean mixtures

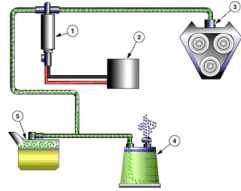


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Evaporative Emissions

- The evaporative emission systems stores evaporative HC emissions when the vehicle is not being operated

1. Purge valve
2. PCM
3. Intake
4. Charcoal canister
5. Fuel Tank

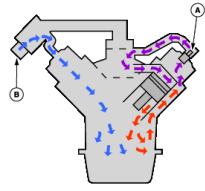


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PCV System

- The Positive Crankcase Ventilation (PCV) System recycles crankcase gases back through the engine where they are burned reducing HC and CO emissions

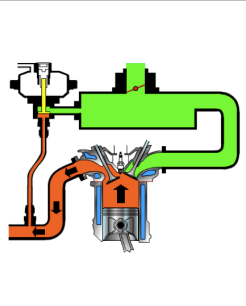
- A. PCV Valve
- B. Filtered Air inlet



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EGR System

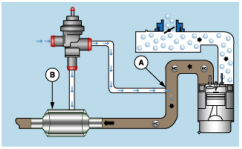
- The Exhaust Gas Recirculation (EGR) System is designed to reintroduce exhaust gas into the combustion cycle lowering combustion temperatures and reducing the formation of NOX



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Secondary AIR

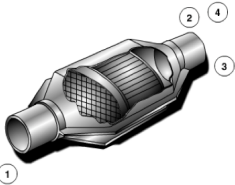
- Air is injected into the exhaust stream to continue the burning process and reduce HC and CO emissions
 - Air is delivered upstream during warm-up
 - Air is delivered downstream after warm-up



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Catalytic Converters

- Conventional Oxidation Catalysts are used to reduce HC and CO
- Three-Way Catalysts are used to reduce HC, CO and NOX



- HC, CO and NOX
- $HC + O_2 \Rightarrow CO_2 + H_2O$
- $CO + O_2 \Rightarrow CO_2$
- $NOX + H_2 \Rightarrow N_2 + H_2O$