## SEMINAR ON FOUR STROKE PETROL ENGINE

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**INTRODUCTION**

## FOUR STROKE PETROL ENGINE

A PETROL ENGINE IS AN [INTERNAL COMBUSTION ENGINE](http://en.wikipedia.org/wiki/Internal_combustion_engine) WITH [SPARK-IGNITION](http://en.wikipedia.org/wiki/Spark-ignition_engine), DESIGNED TO RUN ON PETROL ([GASOLINE](http://en.wikipedia.org/wiki/Gasoline)) AND SIMILAR VOLATILE FUELS.

IN MOST PETROL ENGINES, THE FUEL AND AIR ARE USUALLY PRE-MIXED BEFORE COMPRESSION (ALTHOUGH SOME MODERN PETROL ENGINES NOW USE CYLINDER-DIRECT PETROL INJECTION). THE PRE-MIXING WAS FORMERLY DONE IN A [CARBURETOR](http://en.wikipedia.org/wiki/Carburetor), BUT NOW IT IS DONE BY ELECTRONICALLY CONTROLLED [FUEL INJECTION](http://en.wikipedia.org/wiki/Fuel_injection), EXCEPT IN SMALL ENGINES WHERE THE COST/COMPLICATION OF ELECTRONICS DOES NOT JUSTIFY THE ADDED ENGINE EFFICIENCY. THE PROCESS DIFFERS FROM A [DIESEL ENGINE](http://en.wikipedia.org/wiki/Diesel_engine) IN THE METHOD OF MIXING THE FUEL AND AIR, AND IN USING [SPARK PLUGS](http://en.wikipedia.org/wiki/Spark_plug) TO INITIATE THE COMBUSTION PROCESS. IN A DIESEL ENGINE, ONLY AIR IS COMPRESSED (AND THEREFORE HEATED), AND THE FUEL IS INJECTED INTO VERY HOT AIR AT THE END OF THE COMPRESSION STROKE, AND SELF-IGNITES.

WITH BOTH AIR AND FUEL IN A CLOSED CYLINDER, COMPRESSING THE MIXTURE TOO MUCH POSES THE DANGER OF AUTO-IGNITION — OR BEHAVING LIKE A DIESEL ENGINE. BECAUSE OF THE DIFFERENCE IN BURN RATES BETWEEN THE TWO DIFFERENT FUELS, PETROL ENGINES ARE MECHANICALLY DESIGNED WITH DIFFERENT TIMING THAN DIESELS, SO TO AUTO-IGNITE A PETROL ENGINE CAUSES THE EXPANSION OF GAS INSIDE THE CYLINDER TO REACH ITS GREATEST POINT BEFORE THE CYLINDER HAS REACHED THE "TOP DEAD CENTER" (TDC) POSITION. A TYPICAL SPARK IGNITION OCCURS JUST A FEW DEGREES OF CRANKSHAFT ROTATION BEFORE THE PISTON REACHES TDC, WHICH ALLOWS TIME FOR THE GAS TO BEGIN TO EXPAND. THEN THE BULK OF THE EXPANSION OCCURS JUST AFTER THE PISTON HAS ROTATED BEYOND TDC. HIGHER OCTANE PETROL BURNS SLOWER, THEREFORE IT HAS A LOWER PROPENSITY TO AUTO-IGNITE AND ITS RATE OF EXPANSION IS LOWER. THUS, ENGINES DESIGNED TO RUN HIGH-OCTANE FUEL EXCLUSIVELY CAN ACHIEVE HIGHER COMPRESSION RATIOS.

PETROL ENGINES RUN AT HIGHER SPEEDS THAN DIESELS, PARTIALLY DUE TO THEIR LIGHTER PISTONS, CONNECTING RODS AND CRANKSHAFT (A DESIGN EFFICIENCY MADE POSSIBLE BY LOWER COMPRESSION RATIOS) AND DUE TO PETROL BURNING FASTER THAN DIESEL. HOWEVER THE LOWER COMPRESSION RATIOS OF A PETROL ENGINE GIVE A LOWER EFFICIENCY THAN A DIESEL ENGINE. TO GIVE AN EXAMPLE, A PETROL ENGINE IS LIKE OPERATING A BICYCLE IN ITS LOWEST GEAR WHERE EACH PUSH FROM YOUR FEET ADDS LITTLE ENERGY TO THE SYSTEM, BUT YOU STILL EXPEND ENERGY TO MOVE YOUR LEGS BACK TO THE TDC POSITION. A DIESEL ENGINE IS LIKE OPERATING THAT SAME BICYCLE IN ITS HIGHEST GEAR, WHERE EACH PUSH IMPARTS SUBSTANTIALLY MORE ENERGY TO THE SYSTEM THAN IN THE LOWER GEAR, BUT WITH THE SAME EFFORT BEING USED TO MOVE YOUR LEGS BACK TO TDC.

## APPLICATIONS

PETROL ENGINES HAVE MANY APPLICATIONS, INCLUDING:

* [MOTOR CARS](http://en.wikipedia.org/wiki/Automobile)
* [MOTORCYCLES](http://en.wikipedia.org/wiki/Motorcycle)
* [AIRCRAFT](http://en.wikipedia.org/wiki/Aircraft)
* [MOTORBOATS](http://en.wikipedia.org/wiki/Motorboat)
* [SMALL ENGINES](http://en.wikipedia.org/wiki/Small_engine), SUCH AS [LAWN MOWERS](http://en.wikipedia.org/wiki/Lawn_mower), [CHAINSAWS](http://en.wikipedia.org/wiki/Chainsaw) AND PORTABLE [ENGINE-GENERATORS](http://en.wikipedia.org/wiki/Engine-generator)

WORKING CYCLES

PETROL ENGINES MAY RUN ON THE FOUR-STROKE CYCLE OR THE TWO-STROKE CYCLE. FOR DETAILS OF WORKING CYCLES SEE:

* [FOUR-STROKE CYCLE](http://en.wikipedia.org/wiki/Four-stroke_cycle)
* [TWO-STROKE CYCLE](http://en.wikipedia.org/wiki/Two-stroke_cycle)

COOLING

PETROL ENGINES MAY BE [AIR-COOLED](http://en.wikipedia.org/wiki/Air-cooled_engine), WITH FINS (TO INCREASE THE SURFACE AREA ON THE CYLINDERS AND [CYLINDER HEAD](http://en.wikipedia.org/wiki/Cylinder_head)); OR LIQUID-COOLED, BY A [WATER JACKET](http://en.wikipedia.org/wiki/Water_jacket) AND [RADIATOR](http://en.wikipedia.org/wiki/Radiator_%28engine_cooling%29). THE [COOLANT](http://en.wikipedia.org/wiki/Antifreeze) WAS FORMERLY WATER, BUT IS NOW USUALLY A MIXTURE OF WATER AND EITHER [ETHYLENE GLYCOL](http://en.wikipedia.org/wiki/Ethylene_glycol) OR [PROPYLENE GLYCOL](http://en.wikipedia.org/wiki/Propylene_glycol). THESE MIXTURES HAVE LOWER FREEZING POINTS AND HIGHER BOILING POINTS THAN PURE WATER AND ALSO PREVENT CORROSION, WITH MODERN ANTIFREEZES ALSO CONTAINING LUBRICANTS AND OTHER ADDITIVES TO PROTECT [WATER PUMP](http://en.wikipedia.org/wiki/Water_pump) SEALS AND BEARINGS. THE COOLING SYSTEM IS USUALLY SLIGHTLY PRESSURIZED TO FURTHER RAISE THE [BOILING POINT](http://en.wikipedia.org/wiki/Boiling_point) OF THE COOLANT.

COMPRESSION RATIO

THE [COMPRESSION RATIO](http://en.wikipedia.org/wiki/Compression_ratio) IS THE RATIO BETWEEN THE TOTAL VOLUMES OF THE CYLINDER AND THE COMBUSTION CHAMBERS – AT THE BEGINNING, AND END OF THE COMPRESSION STROKE. BROADLY SPEAKING, THE HIGHER THE COMPRESSION RATIO, THE HIGHER THE EFFICIENCY OF THE ENGINE. HOWEVER, COMPRESSION RATIO HAS TO BE LIMITED TO AVOID PRE-IGNITION OF THE FUEL-AIR MIXTURE WHICH WOULD CAUSE [ENGINE KNOCKING](http://en.wikipedia.org/wiki/Engine_knocking) AND DAMAGE TO THE ENGINE. MODERN MOTOR-CAR ENGINE OVERALL HAVE COMPRESSION RATIOS OF BETWEEN 9:1 AND 10:1, BUT THIS CAN GO UP TO 11 OR 12:1 FOR HIGH-PERFORMANCE ENGINES THAT RUN ON HIGHER OCTANE FUEL

IGNITION

PETROL ENGINES USE [SPARK IGNITION](http://en.wikipedia.org/wiki/Spark_ignition) AND [HIGH VOLTAGE](http://en.wikipedia.org/wiki/High_voltage) CURRENT FOR THE SPARK MAY BE PROVIDED BY A [MAGNETO](http://en.wikipedia.org/wiki/Magneto_%28electrical%29) OR AN [IGNITION COIL](http://en.wikipedia.org/wiki/Ignition_coil). IN MODERN CAR ENGINES THE [IGNITION TIMING](http://en.wikipedia.org/wiki/Ignition_timing) IS MANAGED BY AN ELECTRONIC [ENGINE CONTROL UNIT](http://en.wikipedia.org/wiki/Engine_Control_Unit).

ENGINE

• AN ENGINE IS THE POWER HOUSE OF ANY VEHICLE
• AN ENGINE CONVERTS THE FUEL ENERGY IN TO KINETIC ENERGY USED TO PROPELL THE VEHICLE ON ROAD
• ENGINE IS ALSO PROVIDED WITH THE ACCESSORIES AND MOUNTINGS FOR EFFICIENT WORKING OF THE ENGINE
• ENGINE COMPONENTS

WORKING OF ENGINE

• THE ENGINE WORK IN FOUR DIFFERENT STROKES
• SUCTION
• COMPRESSION
• POWER
• EXHAUST

• TYPES OF WORKING CYCLES

• TWO STROKE:- IN THIS TWO WORKING STROKES ARE COMPLETED IN SINGLE STROKE
• FOUR STROKE:- EACH STROKE IS COMPLETED IN DIFFERENT STROKE

* MAIN COMPONENTS OF ENGINE
• ENGINE BLOCK
• ENGINE HEAD
• SUMP
• PISTON
• PISTON RINGS
• CRANK SHAFT
• CAM SHAFT
• CONNECTING ROD
• VALVE
• FLYWHEEL
• INTAKE MANIFOLD
• EXHAUST MANIFOLD
• TIMING CHAIN
• AIR FILTER
* ENGINE BLOCK

• ENGINE BLOCK IS THE MAIN PART IN THE ENGINE ASSEMBLY.
• IT COMPRISES THE MOVING PARTS.
• THE BLOCK IS PROVIDED WITH THE PROVISION FOR ACCESSORIES AND

MOUNTINGS.

• THE ENGINE BLOCK IS CASTED AS SINGLE IN SAND CASTING.
• THE POPULAR MATERIAL FOR THE ENGINE BLOCK IS CAST IRON, ALUMINUM ALLOY ETC
• THE ENGINE BLOCK IS PROVIDED WITH THE WATER JACKETS FOR CIRCULATING THE COOLANT AROUND THE CYLINDER BORE.
• THE LATEST ENGINE BLOCK MATERIALS CONTAINS ALUSIL & NIKASIL
CYLINDER HEAD
• CYLINDER HEAD IS THE TOP PORTION OF THE ENGINE IT COMPRISES THE VALVE TRAIN.
• THE CYLINDER HEAD CONTAINS THE POPPET VALVES AND THE SPARK PLUGS, ALONG WITH TRACTS OR 'PORTS' FOR THE INLET AND EXHAUST GASES
• THE CYLINDER HEAD ALSO SUPPORTS THE SPARK PLUGS AND FUEL INJECTORS.
• IT ALSO PROVIDED WITH THE WATER JACKETS.
• THE CYLINDER HEAD IS CASTED AS SINGLE PIECE IN CAST IRON CASTING OR ALUMINUM
• THE ALUMINUM IS THE MOST PREFERRED MATERIAL FOR THE CYLINDER HEAD AS IT IS THE LIGHTEST, CORROSION RESISTANT

CRANK SHAFT

• CRANK SHAFT IS THE ROTATING MEMBER IN THE ENGINE ASSEMBLY
• THE RECIPROCATING MOTION OF THE PISTON IS TRANSMITTED INTO THE ROTARY MOTION WITH THE HELP OF CRANK SHAFT.
• CRANK SHAFT IS ROLL FORGED OR CASTED, BUT THE ROLL FORGED CRANK SHAFT IS MOST POPULAR IN COMMERCIAL VEHICLES.
• THE CRANK SHAFT IS PROVIDED WITH JOURNALS
• IT ALSO PROVIDED WITH THE OIL HOLES FOR SUPPLYING OIL
GENERAL WORKING OF CRANK SHAFT

PISTON ASSEMBLY

• PISTON IS THE RECIPROCATING PART INSIDE THE CYLINDER BORE
• PISTON IS RESPONSIBLE FOR THE SUCTION AND COMPRESSION OF THE CHARGE INSIDE THE CYLINDER CAVITY
• PISTONS ARE DIE CASTED WITH ALUMINUM ALLOY AND SOMETIMES WITH CAST IRON.
• PISTONS ARE PROVIDED WITH THE PISTON RINGS USUALLY THREE IN NOS. VIZ TWO COMPRESSION AND ONE OIL CONTROL RING
• FOR IMPROVING THE LIFE OF PISTONS THEY ARE COATED WITH TIN, GRAPHITE

CONNECTING ROD

• THE CONNECTING ROD IS THE CONNECTING MEMBER BETWEEN PISTON AND CRANK SHAFT
• THE CONNECTING RODS ARE MOST USUALLY FORGED OF STEEL FOR PRODUCTION ENGINES CAST IRON FOR APPLICATIONS SUCH AS MOTOR SCOOTERS, ALUMINUM ALLOYS
• THEY ARE NOT RIGIDLY FIXED AT EITHER END, SO THAT THE ANGLE BETWEEN THE CONNECTING ROD AND THE PISTON CAN CHANGE AS THE ROD MOVES UP AND DOWN AND ROTATES AROUND THE CRANKSHAFT.
• THE JOURNAL BEARINGS ARE PROVIDED AT CRANK END AND OTHER END IS CONNECTED WITH PISTON WITH THE HELP OF GUDGEON PIN.

CAM SHAFT

• THE CAM SHAFT IS THE ROTARY COMPONENT RESPONSIBLE FOR OPENING AND CLOSING OF THE INLET AND EXHAUST VALVES
• THE CAM SHAFT IS ROTATED WITH THE HELP OF TIMING CHAIN OR

TIMING GEAR

• THE CAM SHAFT IS PROVIDED WITH THE CAM LOBES WHICH CAUSES THE WORKING OF THE VALVES
• THE NORMAL MATERIAL FOR CAM SHAFT IS CHILLED IRON CASTINGS, BILLET STEEL
• THE TIMING OF CRANK SHAFT AND CAM SHAFT IS SO ADJUSTED THAT THE VALVES OPENS AND CLOSES AT CORRECT TIME

VALVES

• VALVES ARE THE GATEWAYS FOR THE INTAKE CHARGE AND EXHAUST GASES
• THE VALVES ARE OPERATED WITH THE HELP OF CAM SHAFT AND CAM LOBES
• THE OPENING AND CLOSING OF THE VALVE IS DONE WITH THE HELP OF TIMING GEAR OR TIMING CHAIN
• THE VALVES ARE COOLED WITH COOLANT
• THE SODIUM COOLED VALVES ARE SELF COOLED USED FOR EXHAUST
• VALVE SEATS MADE OF IMPROVED ALLOYS SUCH AS STELLITE

SPARK PLUG

• SPARK PLUG IS USED TO IGNITE THE CHARGE INSIDE THE ENGINE
• SPARK PLUGS ARE THE ELECTRICAL COMPONENT IN THE ENGINE ASSEMBLY
• THE SPARK PLUG PRODUCES THE SPARK OF ABOUT 10-15 THOUSAND VOLTS WHICH PRODUCES 500-600̊ DEGREE TEMPERATURE
• THE SPARK IS PRODUCED IN EACH CYLINDER DURING POWER STROKE WHICH IS DISTRIBUTED WITH DISTRIBUTOR ACCORDING TO FIRING ORDER

FUEL INJECTORS

• FUEL INJECTORS ARE USED TO INJECT THE METERED AMOUNT OF FUEL INSIDE THE CYLINDER DURING POWER STROKE
• THE FUEL IS SPRAYED INSIDE THE CYLINDER IN THE FORM OF LITTLE DROPLETS FORMED DUE TO PRESSURIZED FUEL SUPPLY
• THE INJECTOR IS CONNECTED WITH THE FUEL PUMP

EXHAUST MANIFOLD

• THE GOAL OF PERFORMANCE EXHAUST HEADERS IS MAINLY TO DECREASE FLOW RESISTANCE (BACK PRESSURE), AND TO INCREASE THE VOLUMETRIC EFFICIENCY OF AN ENGINE, RESULTING IN A GAIN IN POWER OUTPUT
• AN EXHAUST MANIFOLD OR HEADER COLLECTS THE EXHAUST GASES FROM MULTIPLE CYLINDERS INTO ONE PIPE AND DELIVERS IT INTO AIR
• EXHAUST MANIFOLDS ARE GENERALLY SIMPLE CAST IRON OR STAINLESS STEEL
• THE EXHAUST GASES COMING OUT FROM THE EXHAUST MANIFOLD WITH HIGH VELOCITY THEREBY DECREASING THE TEMPERATURE

INTAKE MANIFOLD

• AN INTAKE MANIFOLD OR INLET MANIFOLD IS THE PART OF AN ENGINE THAT SUPPLIES THE FUEL/AIR MIXTURE TO THE CYLINDERS
• THE PRIMARY FUNCTION OF THE INTAKE MANIFOLD IS TO EVENLY DISTRIBUTE THE COMBUSTION MIXTURE
• INTAKE MANIFOLD IS INCORPORATED WITH THE CARBURETOR
• INTAKE MANIFOLD IS GENERALLY FITTED WITH AIR FILTERS
• THE INTAKE MANIFOLDS ARE MANUFACTURED WITH VENTURI EFFECT.

 TRANSMISSION

* ***THE TRANSMISSION IS MADE UP OF A SET OF GEARS THAT CONVERT THE ROTATIONAL SPEED OF THE CRANKSHAFT INTO TORQUE. THE TRANSMISSION IS ENGAGED BY THE CLUTCH AND CAUSES THE ENGINE SPROCKET TO SPIN AT THE CONVERTED RATIO, PULLING THE DRIVE CHAIN AND ULTIMATELY CAUSING THE REAR WHEEL TO SPIN AS THE CHAIN PULLS THE REAR SPROCKET.***

## FOUR STROKE ENGINE

THE FOUR STROKES OF THE CYCLE ARE INTAKE, COMPRESSION, POWER, AND EXHAUST. EACH CORRESPONDS TO ONE FULL STROKE OF THE PISTON; THEREFORE, THE COMPLETE CYCLE REQUIRES TWO REVOLUTIONS OF THE CRANKSHAFT TO COMPLETE.



### INTAKE

DURING THE INTAKE STROKE, THE PISTON MOVES DOWNWARD, DRAWING A FRESH CHARGE OF VAPORIZED FUEL/AIR MIXTURE. THE ILLUSTRATED ENGINE FEATURES A POPPET INTAKE VALVE WHICH IS DRAWN OPEN BY THE VACUUM PRODUCED BY THE INTAKE STROKE. SOME EARLY ENGINES WORKED THIS WAY; HOWEVER, MOST MODERN ENGINES INCORPORATE AN EXTRA CAM/LIFTER ARRANGEMENT AS SEEN ON THE EXHAUST VALVE. THE EXHAUST VALVE IS HELD SHUT BY A SPRING (NOT ILLUSTRATED HERE)



COMPRESSION

AS THE PISTON RISES, THE POPPET VALVE IS FORCED SHUT BY THE INCREASED CYLINDER PRESSURE. FLYWHEEL MOMENTUM DRIVES THE PISTON UPWARD, COMPRESSING THE FUEL/AIR MIXTURE.



POWER

AT THE TOP OF THE COMPRESSION STROKE, THE SPARK PLUG FIRES, IGNITING THE COMPRESSED FUEL. AS THE FUEL BURNS IT EXPANDS, DRIVING THE PISTON DOWNWARD.



### EXHAUST

AT THE BOTTOM OF THE POWER STROKE, THE EXHAUST VALVE IS OPENED BY THE CAM/LIFTER MECHANISM. THE UPWARD STROKE OF THE PISTON DRIVES THE EXHAUSTED FUEL OUT OF THE CYLINDER.

### IGNITION SYSTEM

THIS ANIMATION ALSO ILLUSTRATES A SIMPLE IGNITION SYSTEM USING BREAKER POINTS, COIL, CONDENSER, AND BATTERY.

A NUMBER OF VISITORS HAVE WRITTEN TO POINT OUT A PROBLEM WITH THE BREAKER POINTS IN MY ILLUSTRATION. IN THIS STYLE IGNITION CIRCUIT, THE SPARK PLUG WILL FIRE JUST AS THE BREAKER POINTS OPEN. THE ILLUSTRATION APPEARS TO HAVE THIS BACKWARDS.

IN FACT, THE ILLUSTRATION IS CORRECT; IT JUST MOVES SO FAST IT’S DIFFICULT TO SEE! HERE’S A CLOSE-UP OF THE FRAMES JUST AT THE POINT THE PLUG FIRES:



MY ORIGINAL INTENT WAS TO ACCURATELY SHOW THAT THE POINTS NEED TO REMAIN CLOSED FOR ONLY A FRACTION OF A SECOND, CALLED THE DWELL. BY ILLUSTRATING THIS, I INADVERTENTLY OBSCURED THE OVERALL OPERATION OF THE CIRCUIT. PERHAPS SOMEDAY I’LL PREPARE A MORE DETAILED ILLUSTRATION OF THE IGNITION SYSTEM ALONE.

LARGER FOUR STROKE ENGINES USUALLY INCLUDE MORE THAN ONE CYLINDER, HAVE VARIOUS ARRANGEMENTS FOR THE CAMSHAFT (DUAL, OVERHEAD, ETC.), SOMETIMES FEATURE FUEL INJECTION, TURBOCHARGERS, MULTIPLE VALVES, ETC. NONE OF THESE ENHANCEMENTS CHANGES THE BASIC OPERATION OF THE ENGINE.







