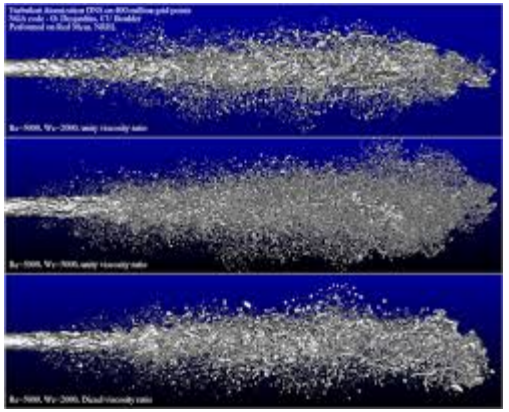
Principles of Engine Operation, 2 & 4 Stroke Engines

Chapter #5

23% of mowers are sold in May…

30% snow throwers are sold in December

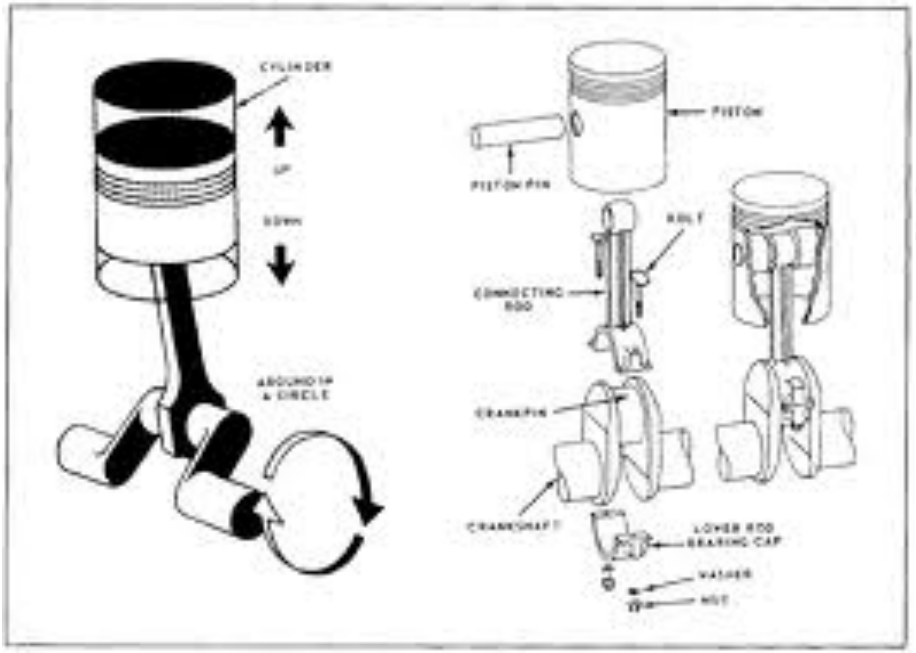
Gasoline Must Be Atomized

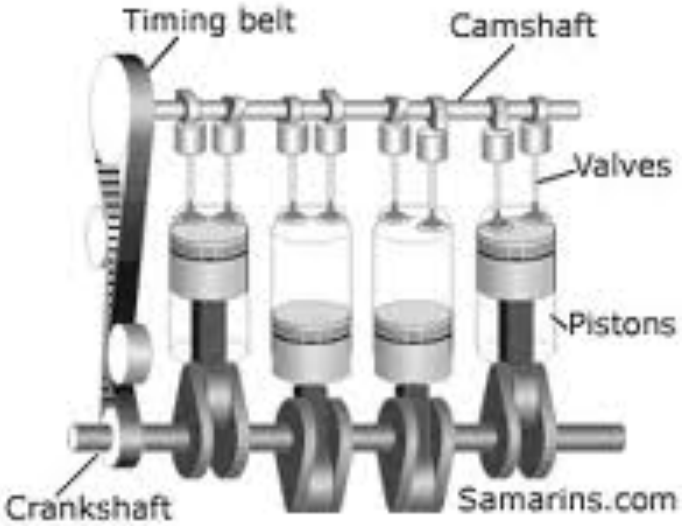


Combustion Force Must Be Contained

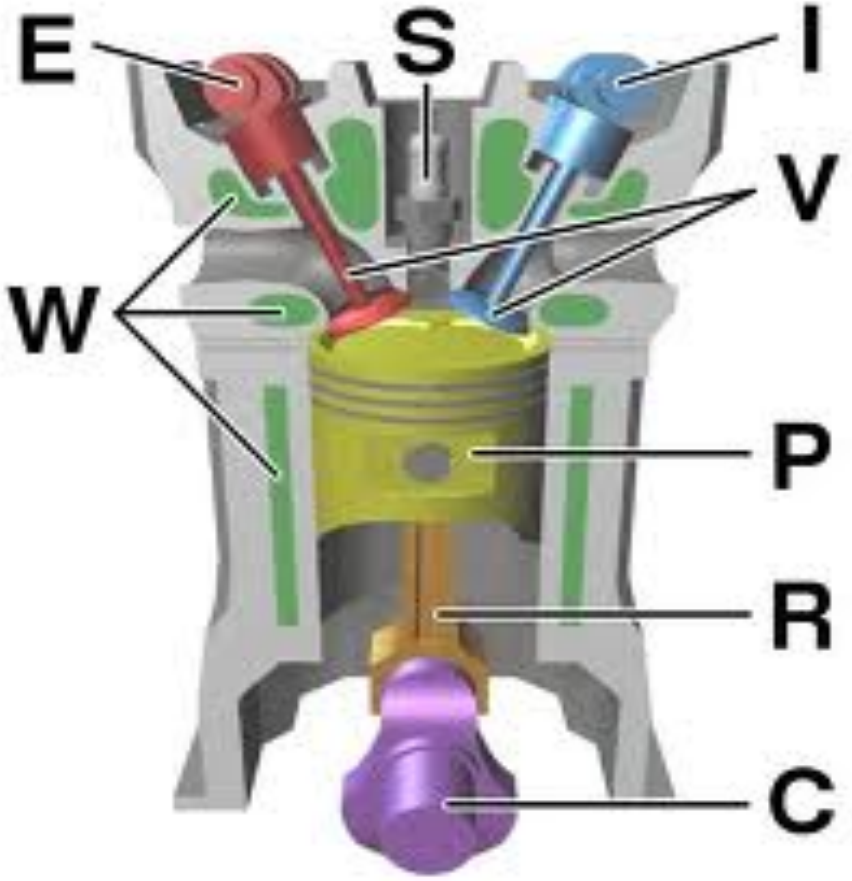
- Gas + oxygen + nitrogen in atmosphere + carbon dioxide = water + nitrogen to atmosphere (air-fuel mixture -> exhaust gases)

Simple engine

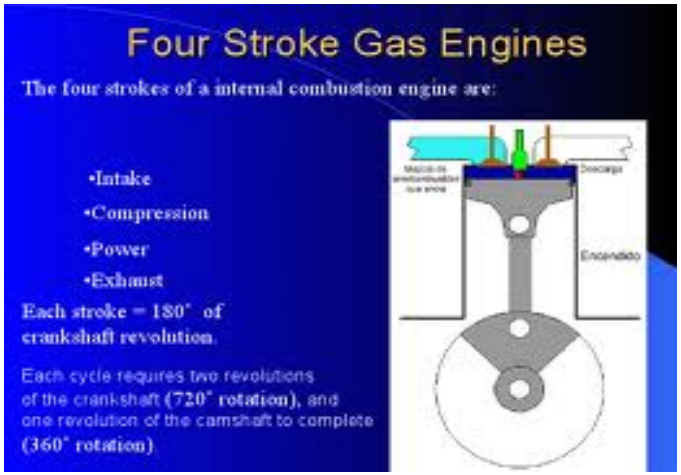


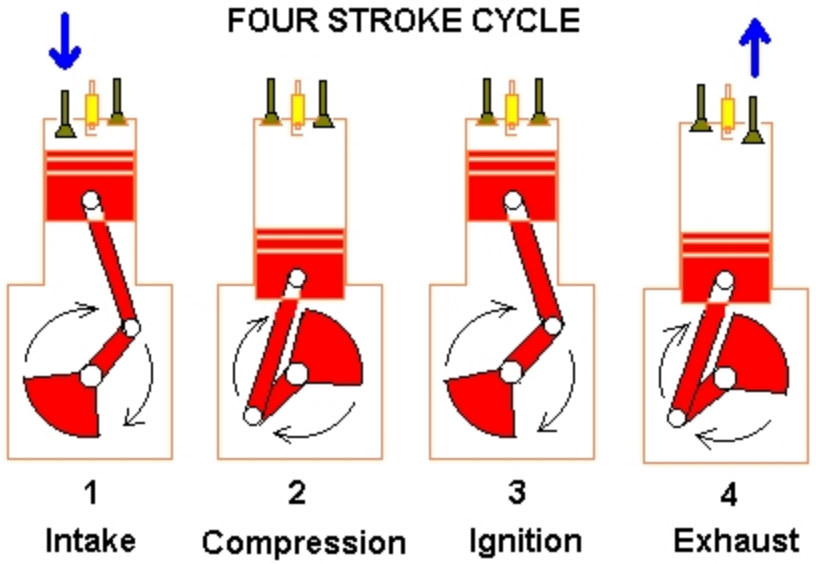


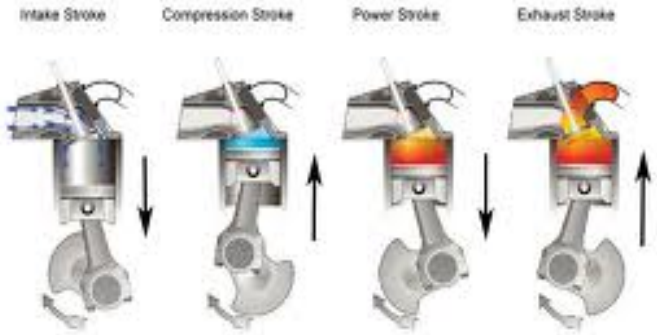
Simple Engine Operation



Four-Stroke Engine

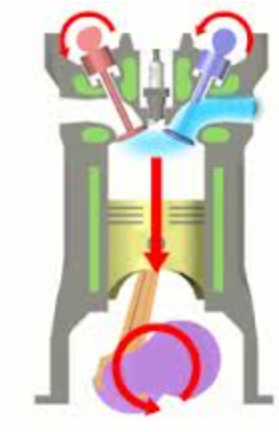


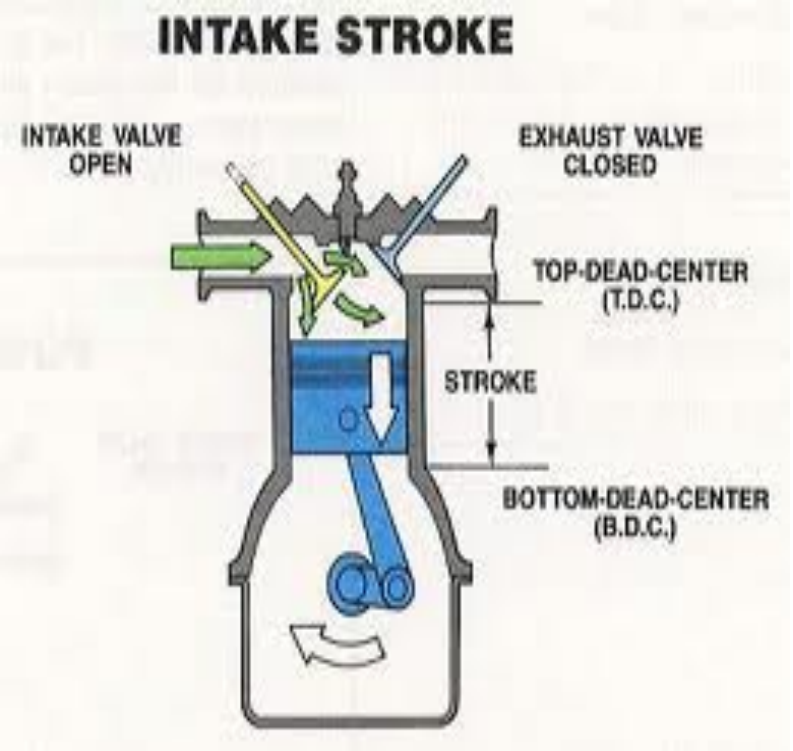




Four-Stroke Engine

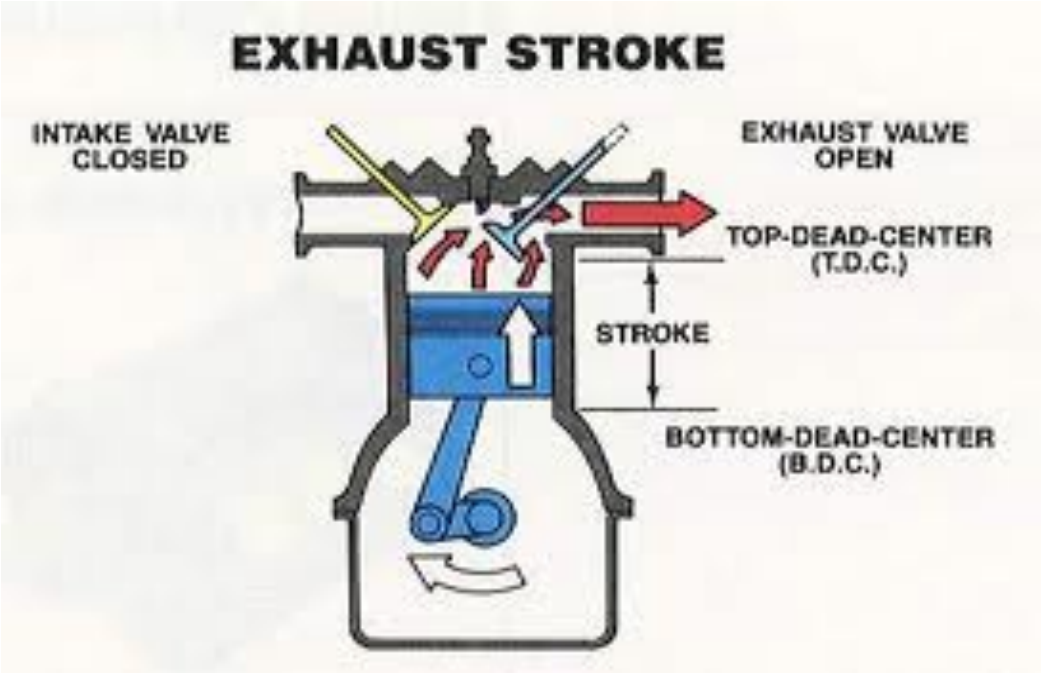
- Intake Stroke





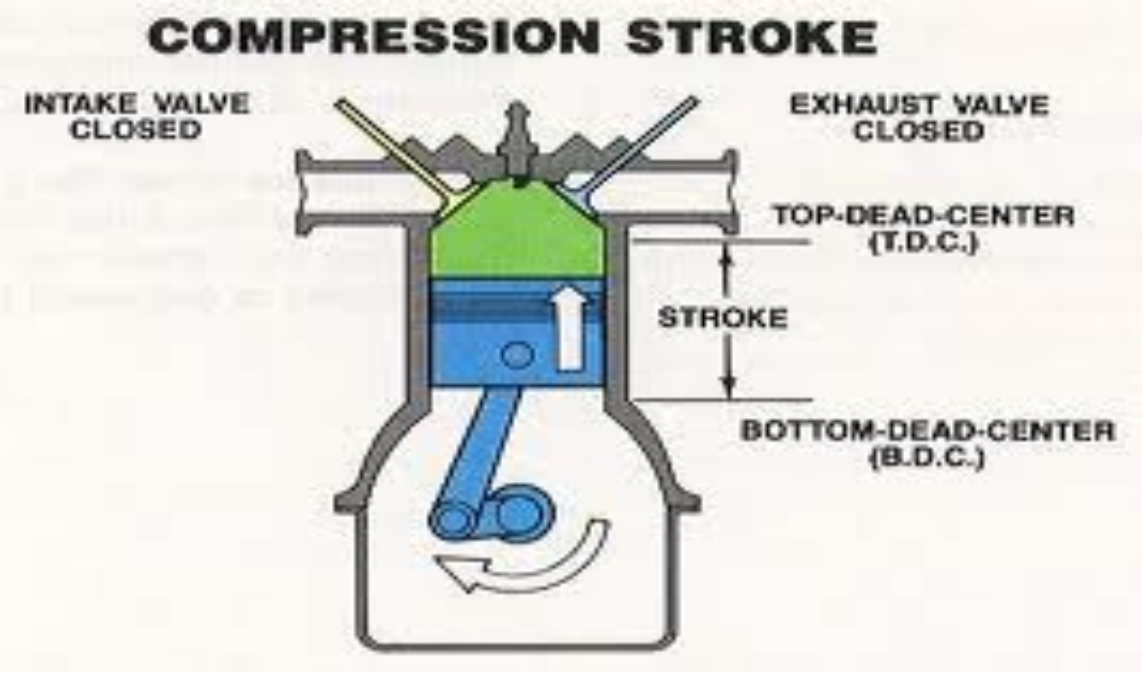
Four-Stroke Engine

- Exhaust Stroke



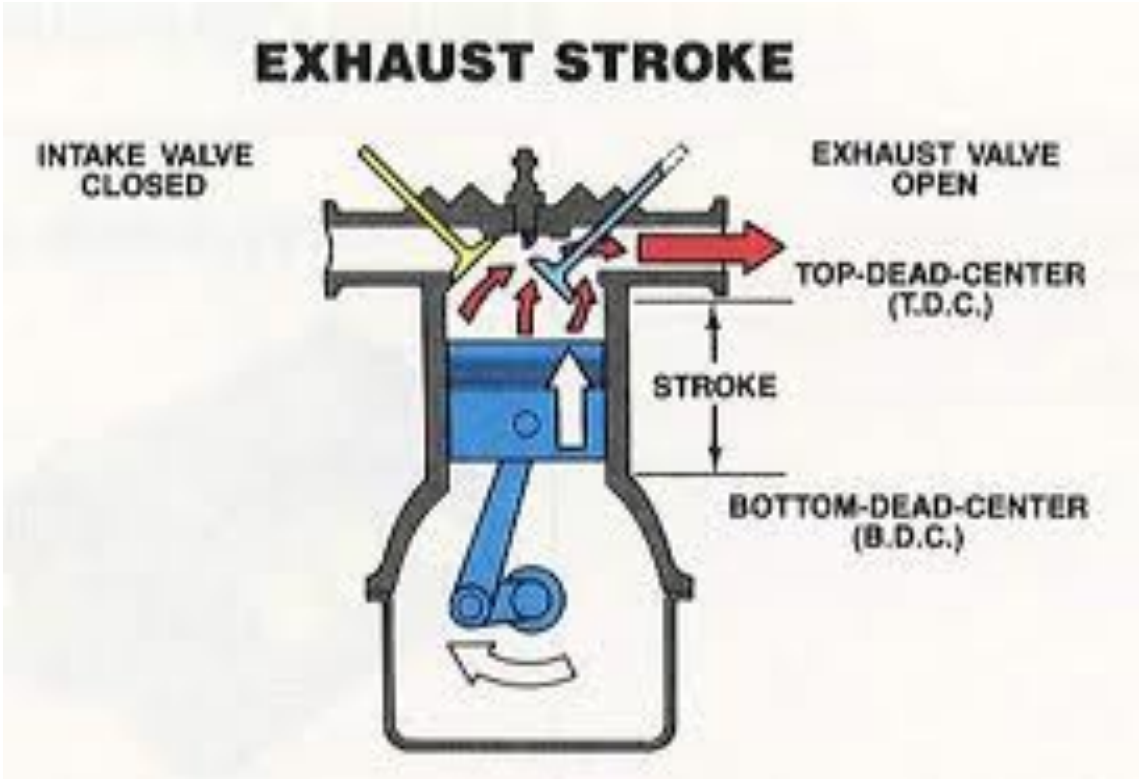
Four-Stroke Engine

- Compression



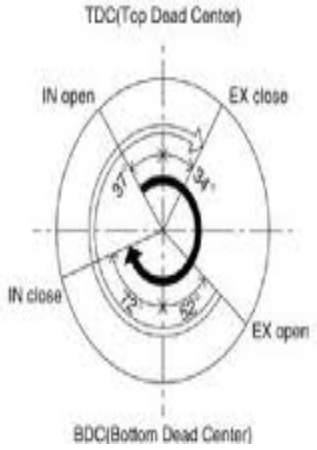
Four-Stroke Engine

- Power Stroke



Four-Stroke Engine

- Valve Timing



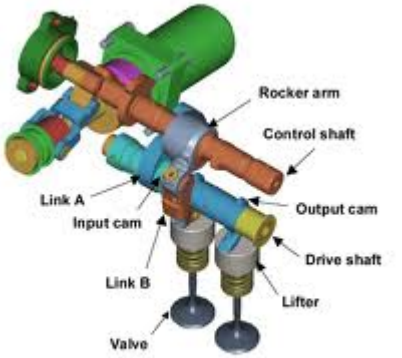
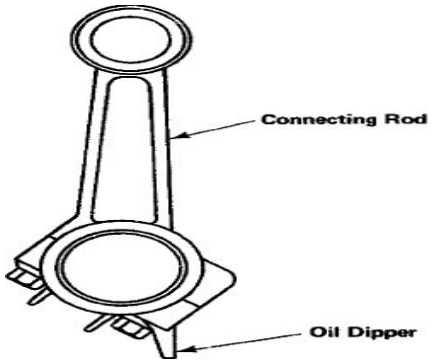
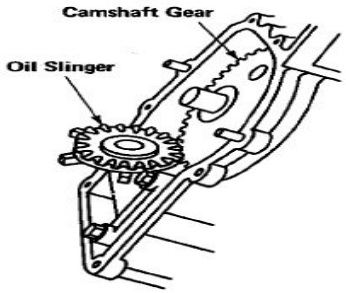


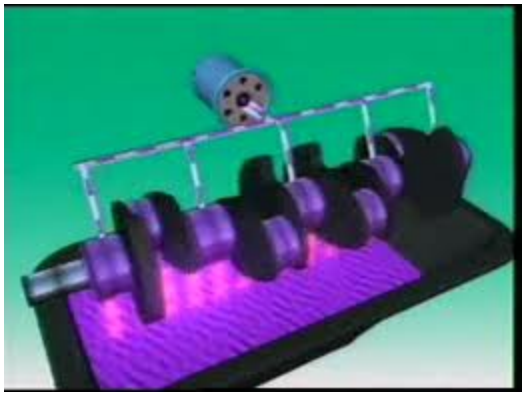
Fig. 1 Mechanical valve train system of the VVEL (from the paper 'New PM Parts for VVEL (Variable Valve Event and Lift System)', K Kawase, Diamet Corp., Japan. Courtesy EPMA)

Four-Stroke Engine

- Lubrication







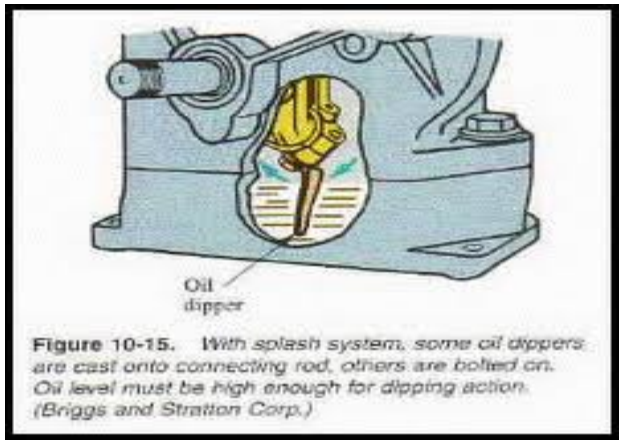
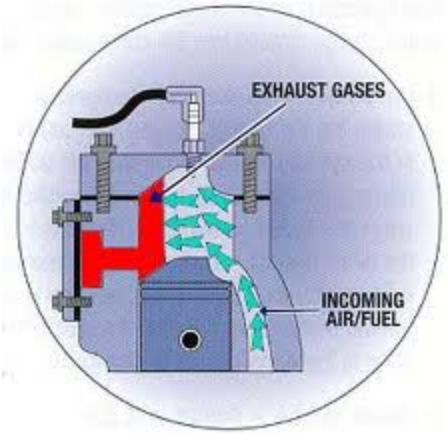
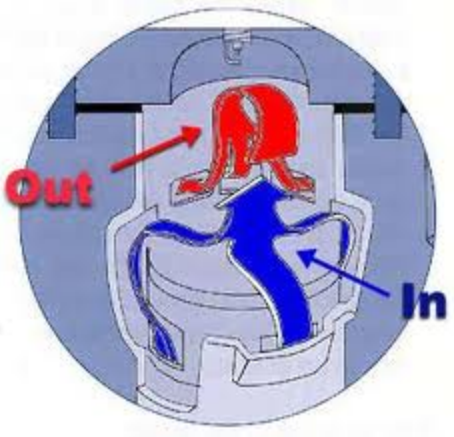


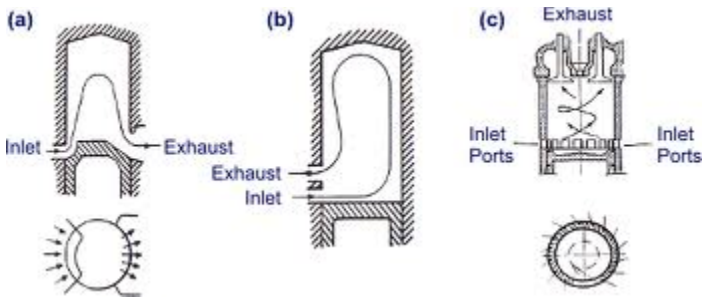
Figure 10-15. *With splash system, some oil dippers are cast onto connecting rod, others are bolted on. Oil level must be high enough for dipping action. (Briggs and Stratton Corp.)*

Two-Stroke Engine

- Two Design Variations
  - Cross-scavenge
  - Loop-scavenge

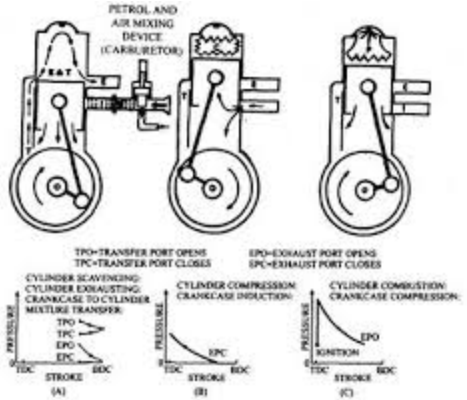


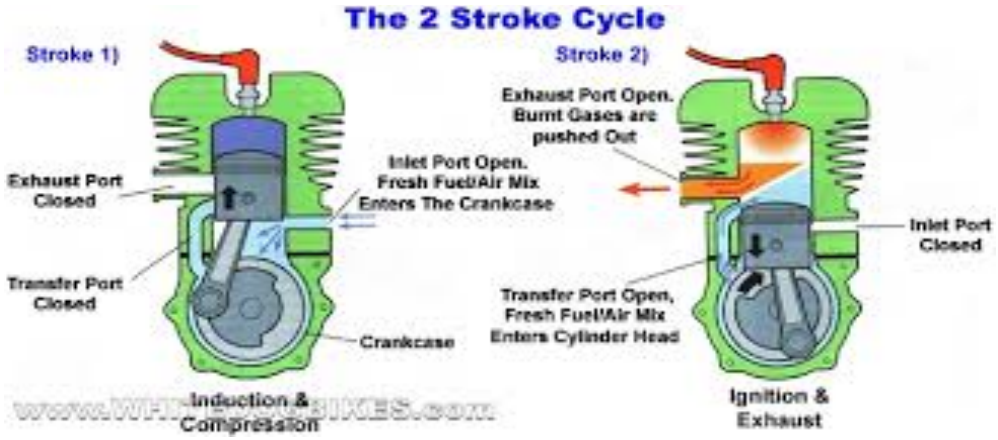




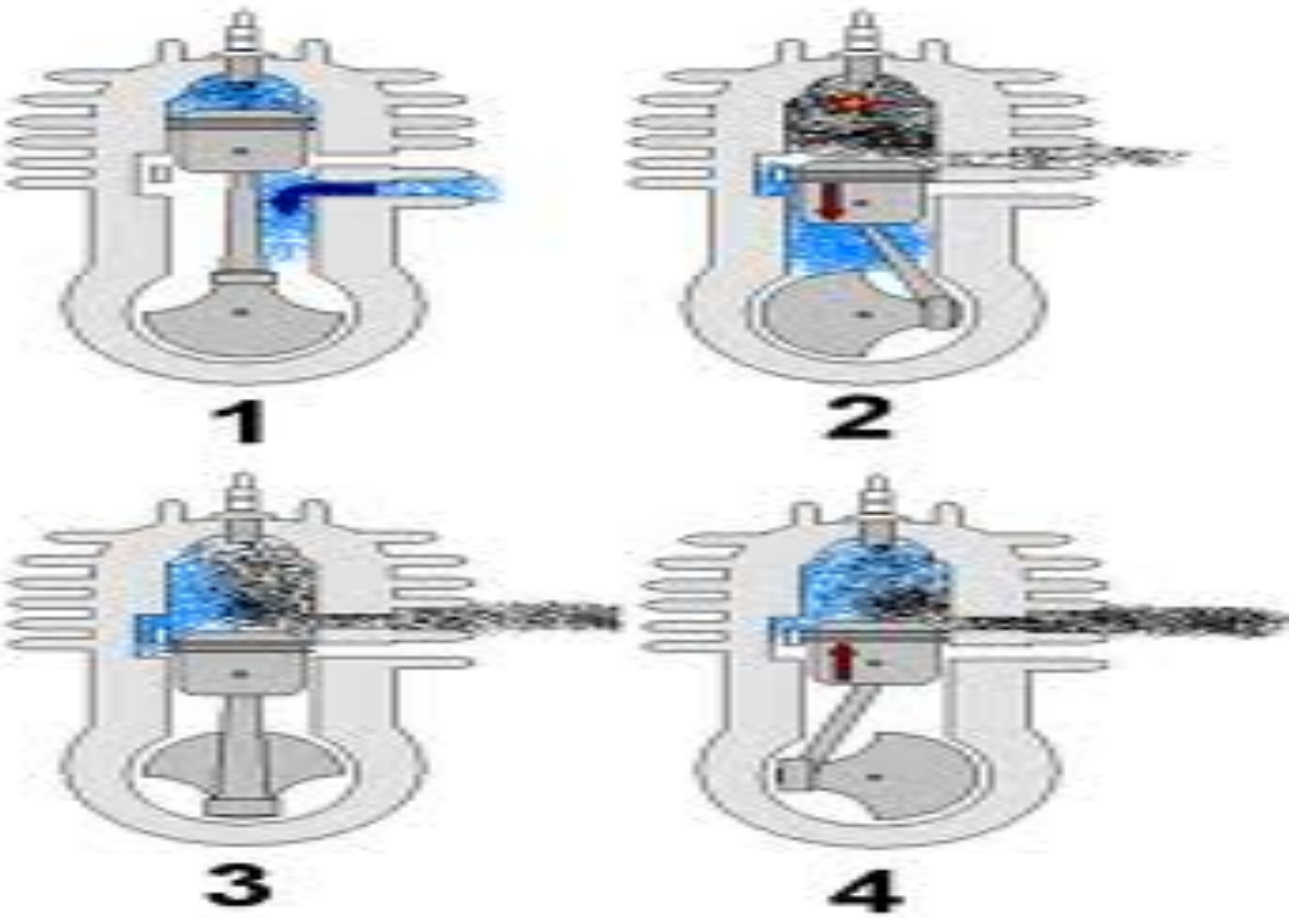
Two-Stroke Engine

- Principle of Operation
  - Intake into the crankcase
  - Ignition-Power
  - Exhaust
  - Fuel transfer

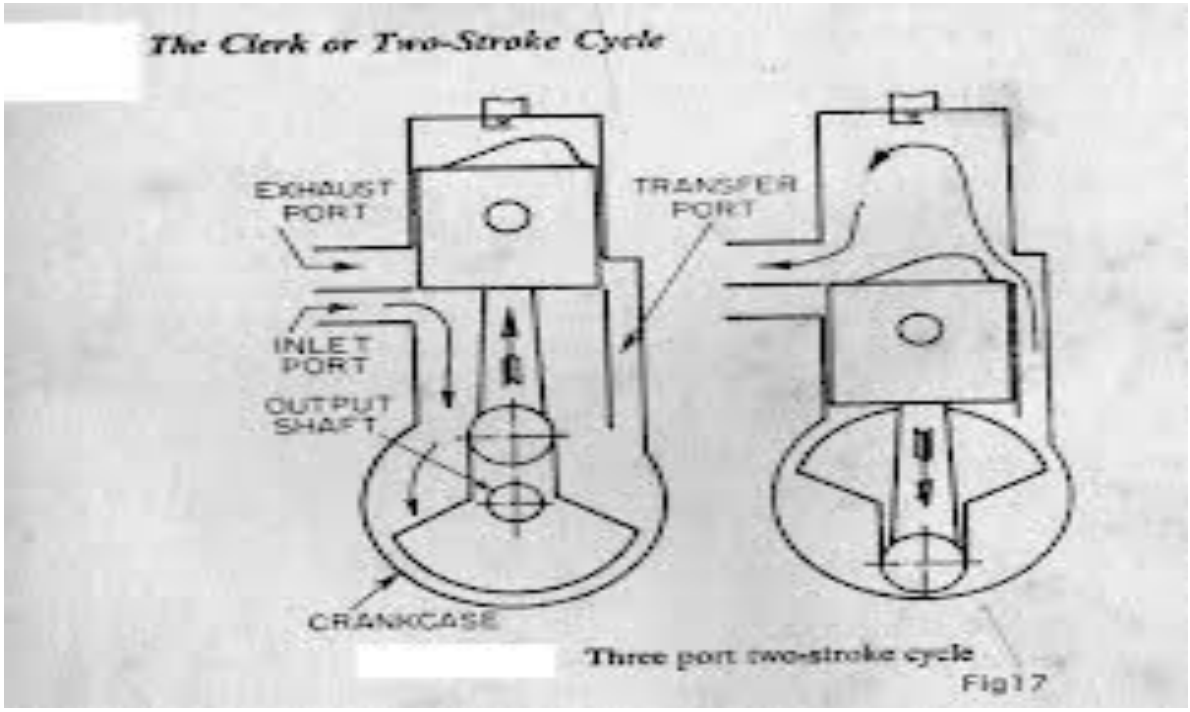




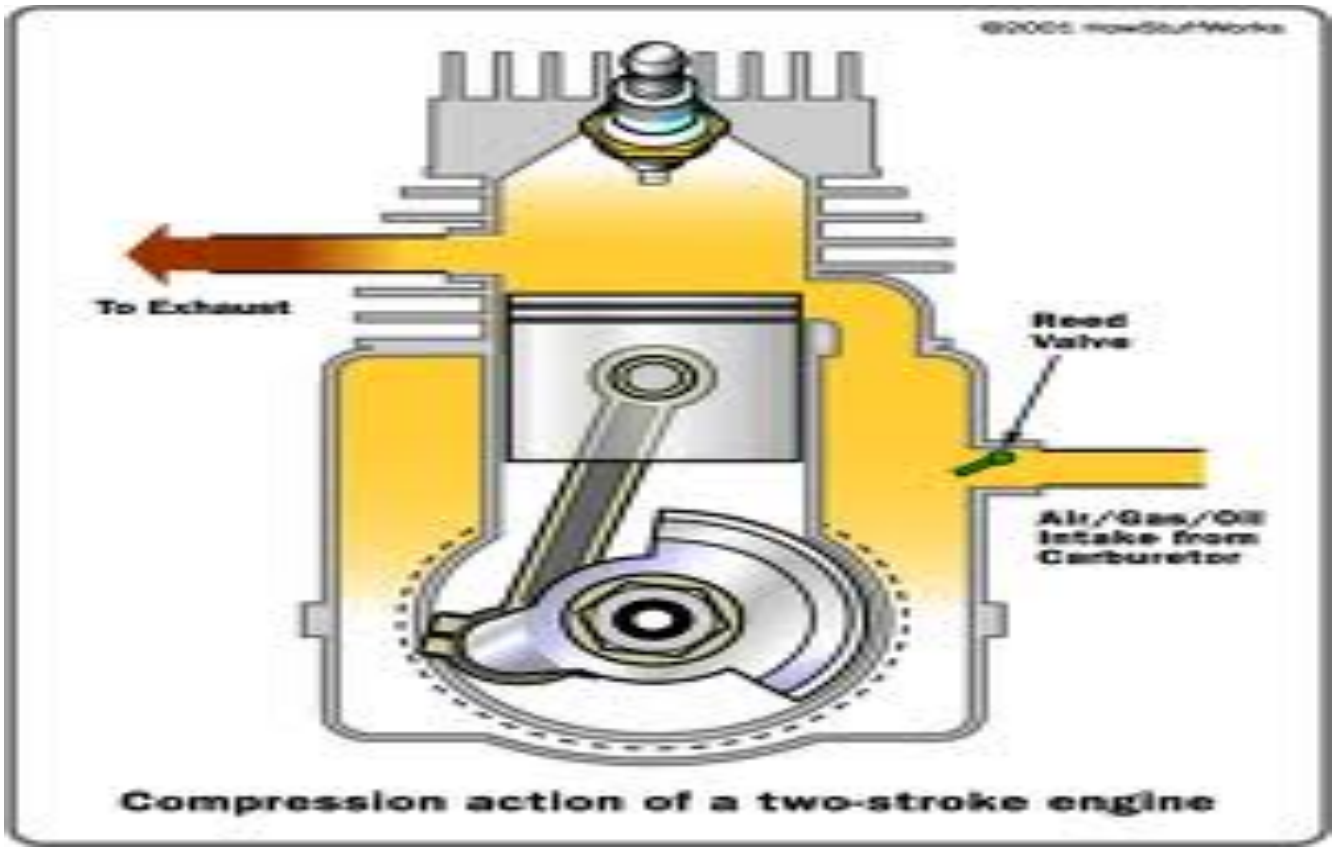
Two-Stroke Engine



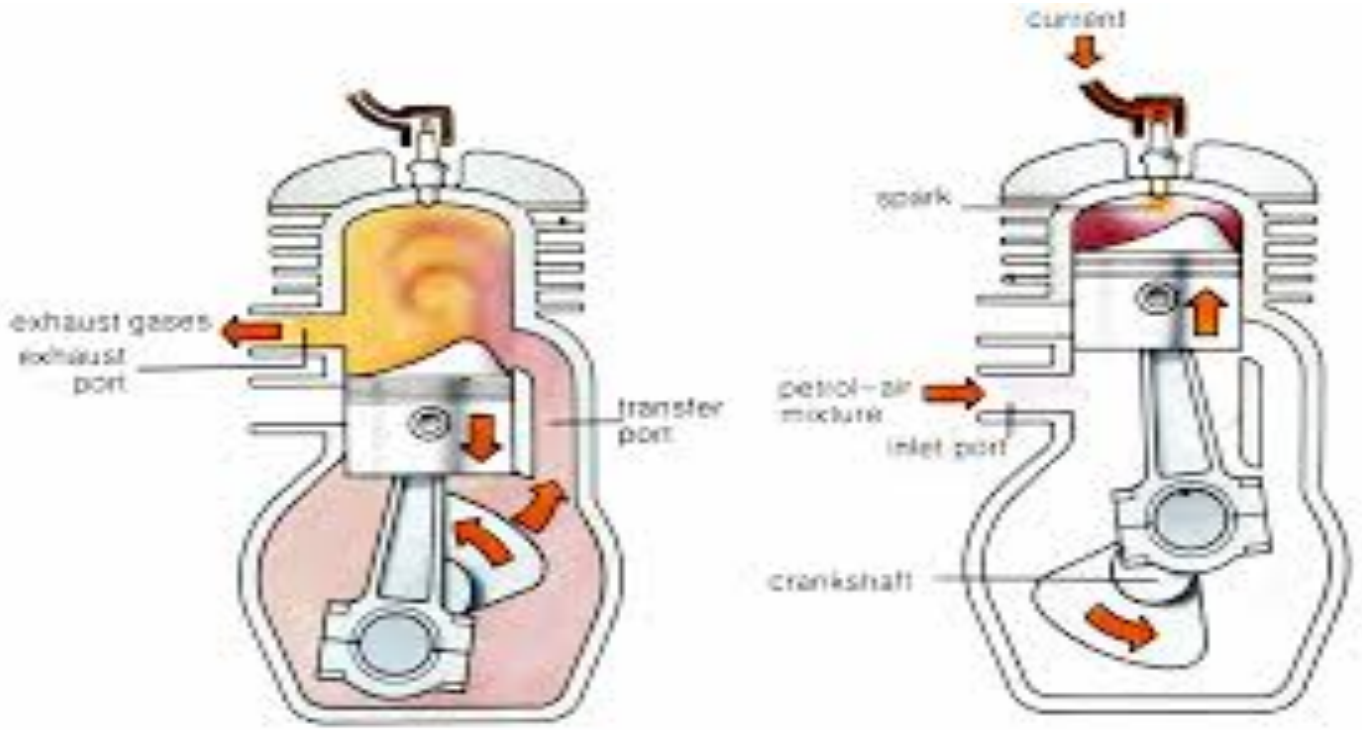
Two-Stroke Engine



Two-Stroke Engine



Two-Stroke Engine



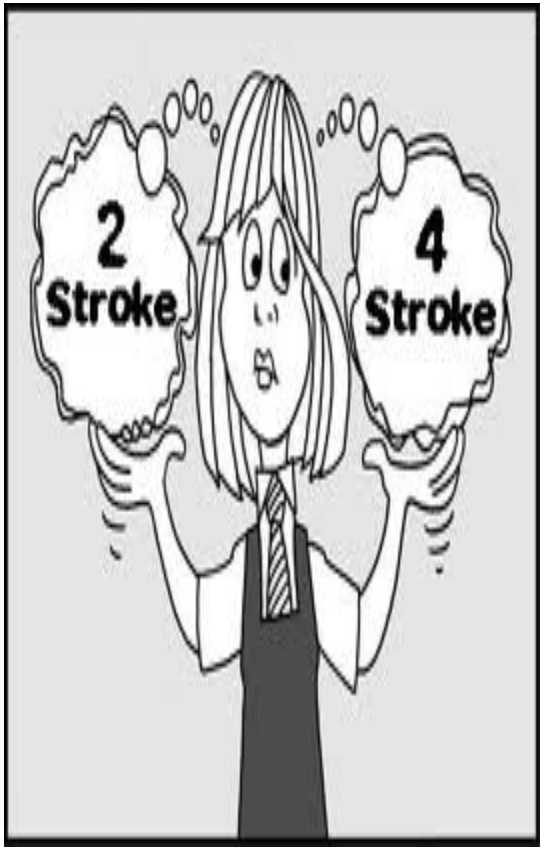
Two-Stroke Engine

2-Cycle Scavenging and Tuning

- When properly designed the exhaust system scavenges all the exhaust gases from the combustion chamber.

2 vs. 4 cycle

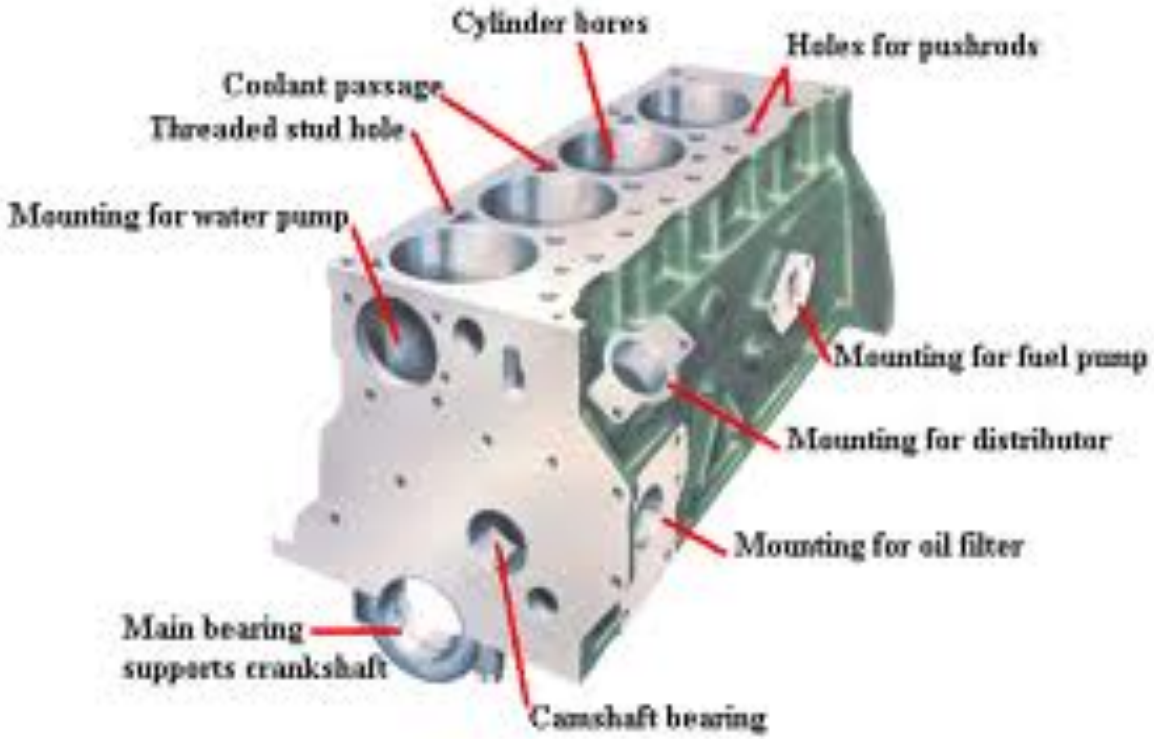
- Textbook page 106, figure 5-17

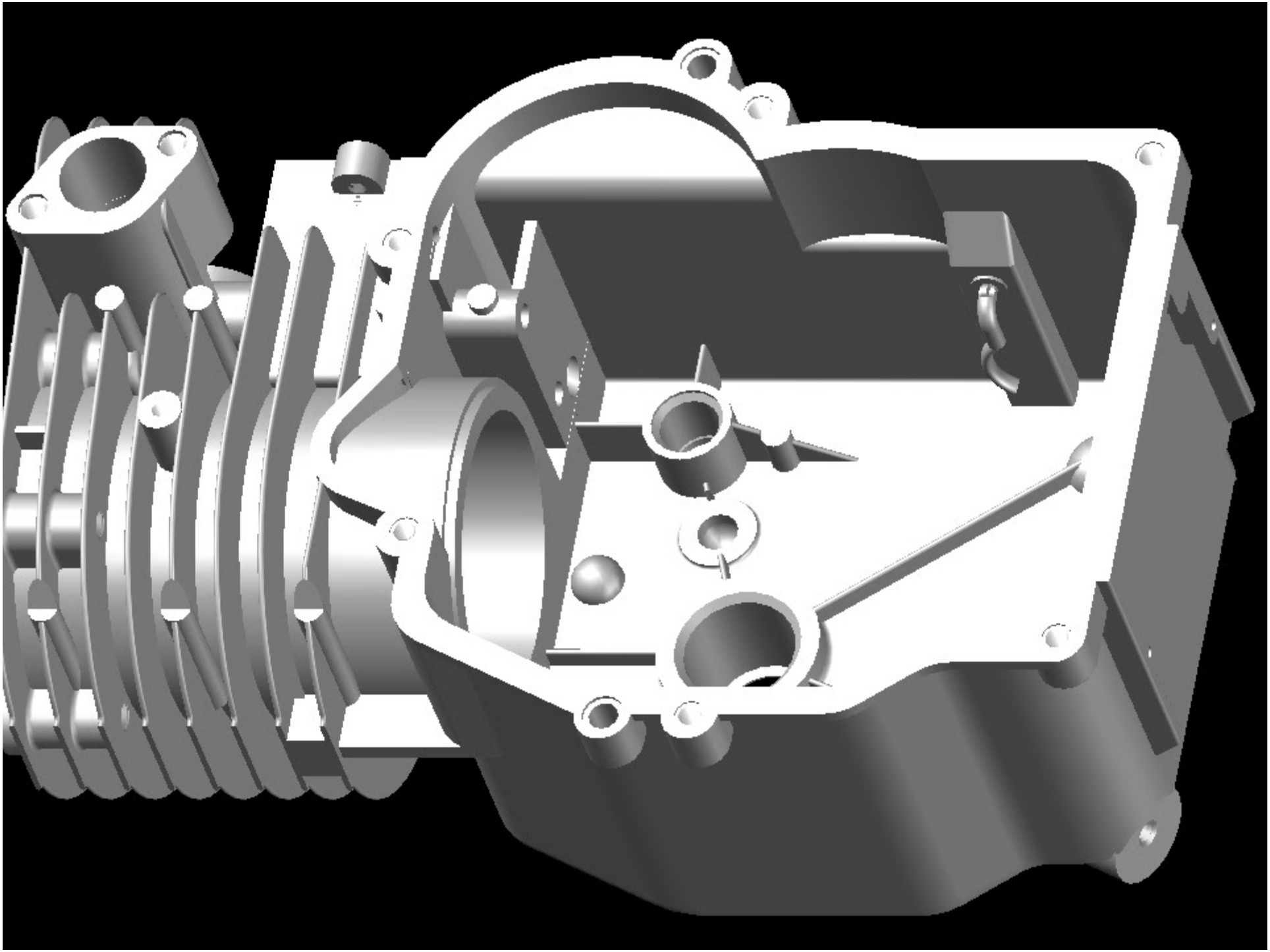


Engine Components

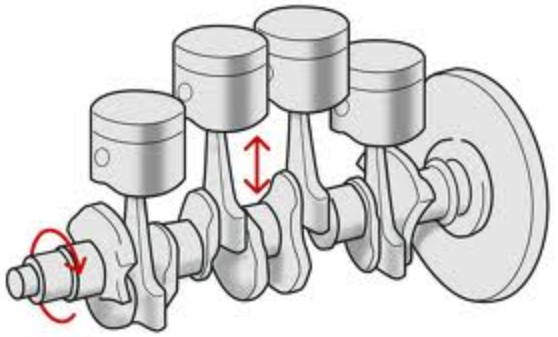
Chapter #6

Engine Block





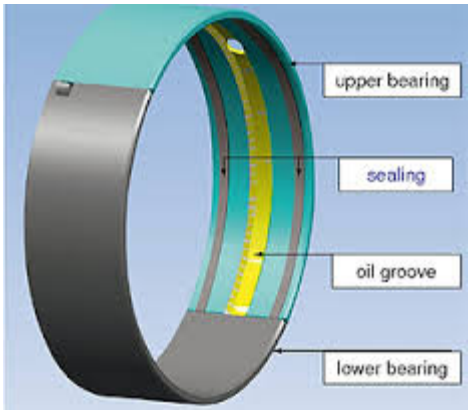
Crankshaft



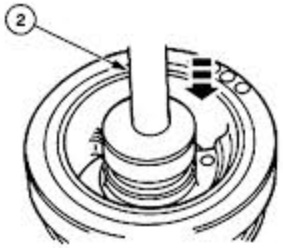
- Forged or cast
- One piece or multi
- Coverts reciprocal motion to rotary

Multi-piece Crankshaft

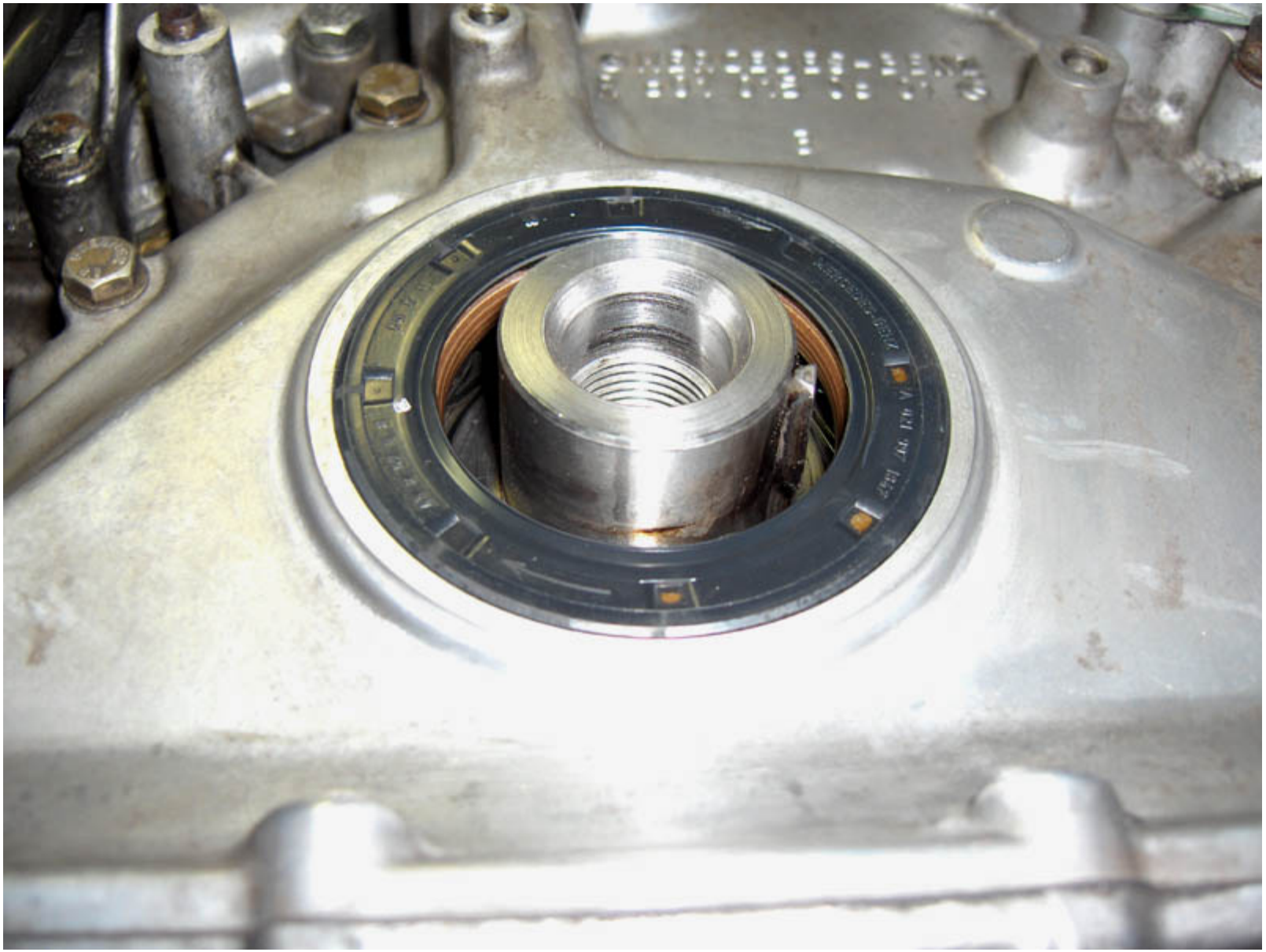
Crankshaft Main Bearings



Crankcase seals

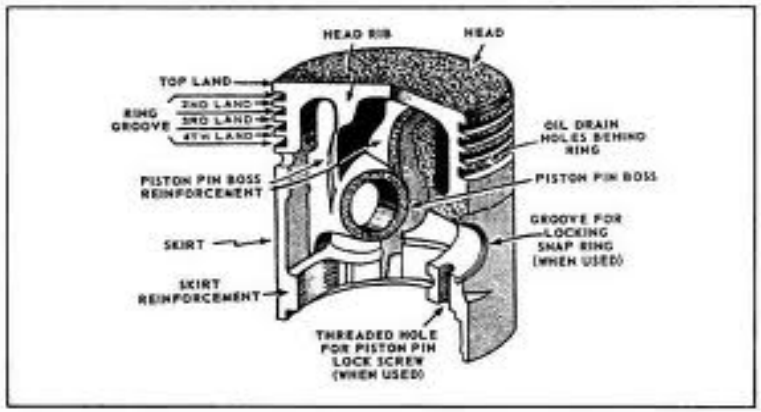


Representative Image



Piston Construction

- One to four grooves



Cam-Ground Pistons

- Elliptical (oval) shape

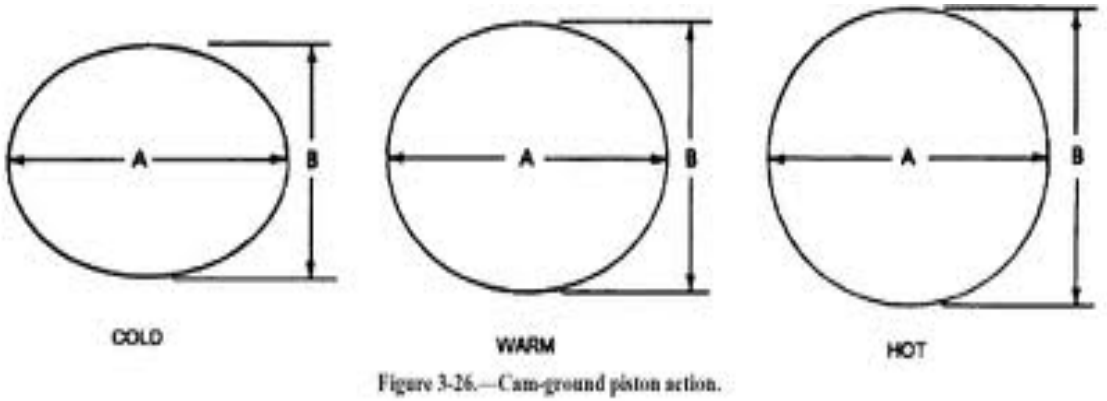
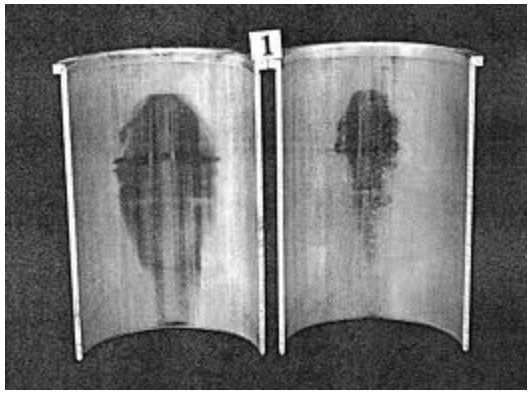
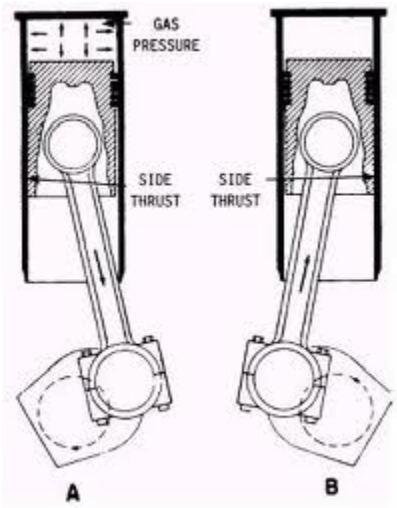


Figure 3-26.—Cam-ground piston action.

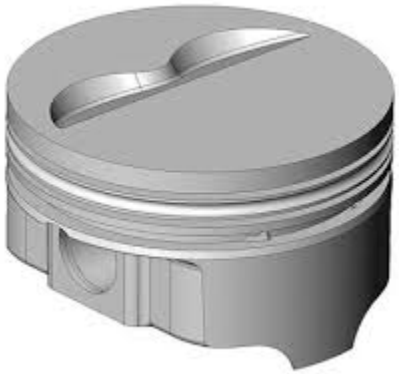
Piston Thrust Surfaces





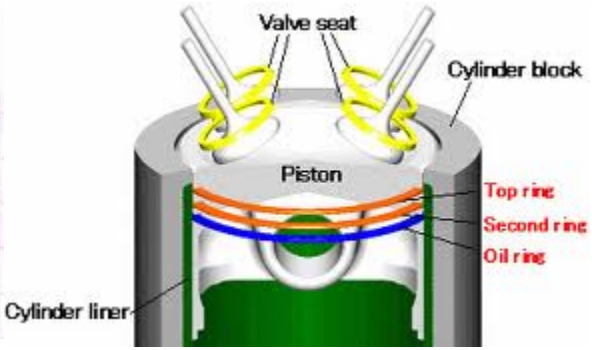
Piston Head Size

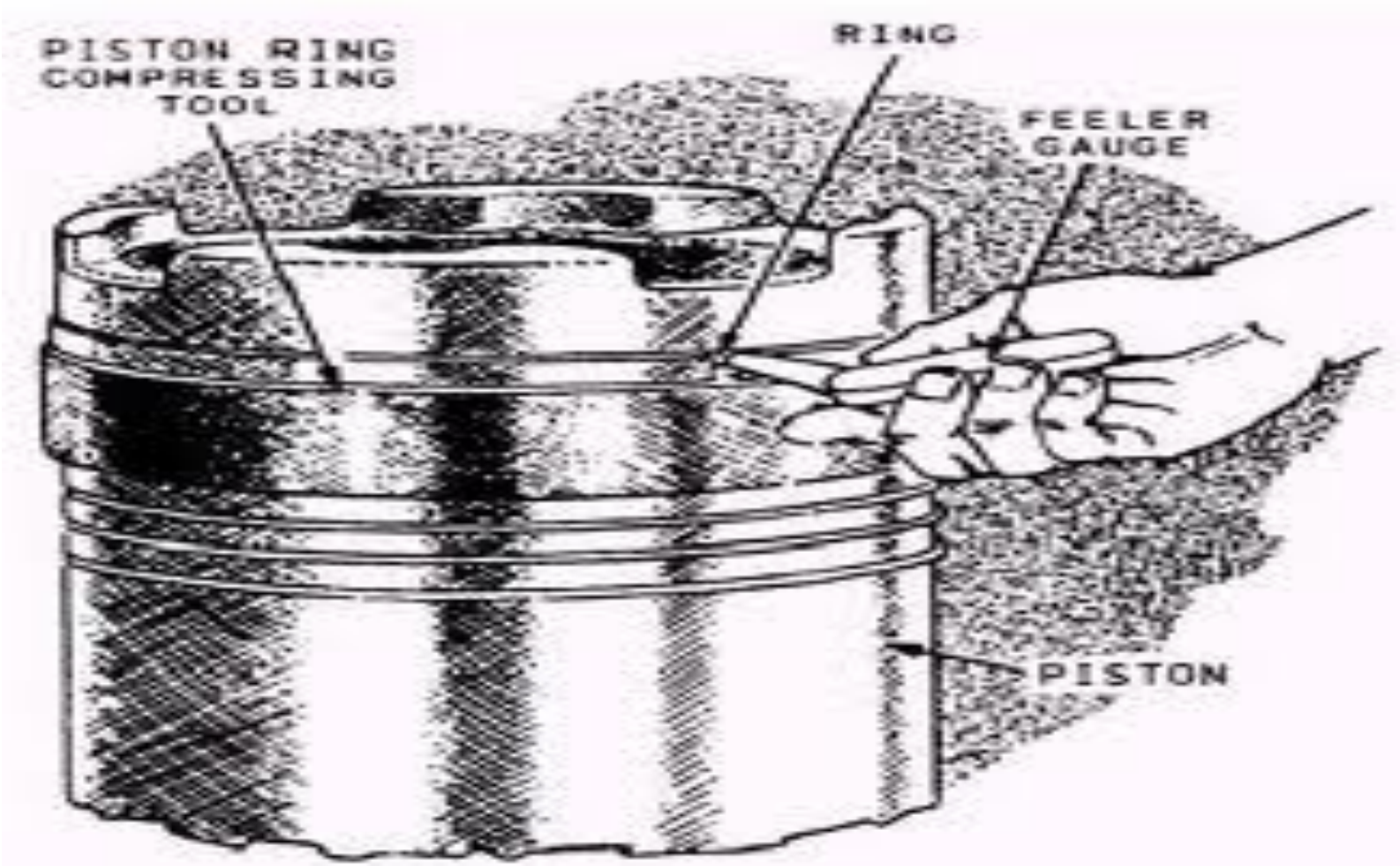
- Clearance a few thousands of an inch.



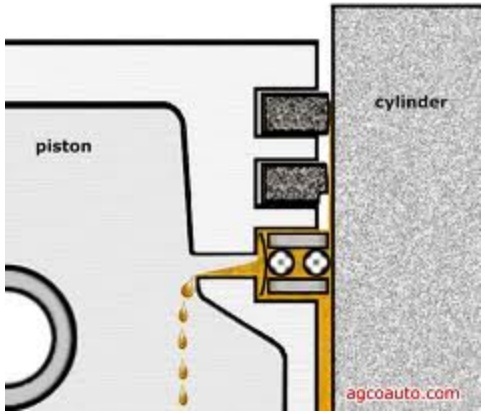
Piston Head Shape

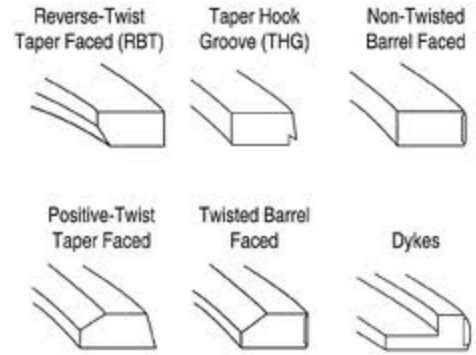
Piston Rings



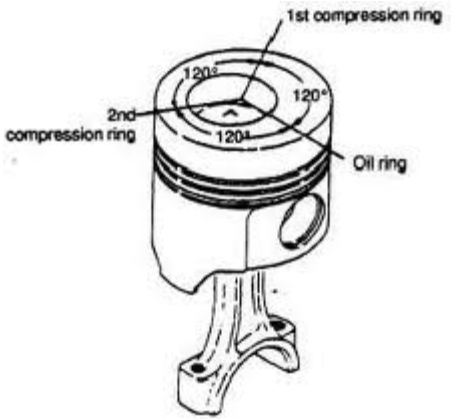

PISTON RING
COMPRESSING
TOOL
RING
FEELER
GAUGE
PISTON

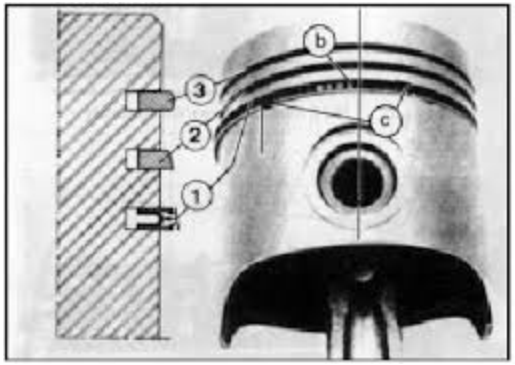
Piston Ring Types





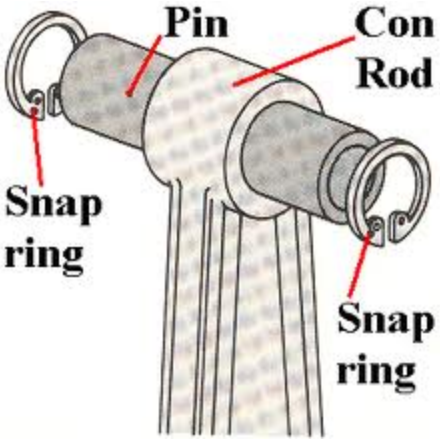
- Compression
- Oil Control





Piston Pin

- Floating
- Press-fit



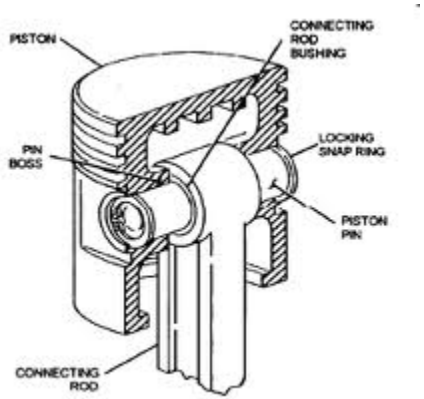


Figure 3-29.—Piston pin.

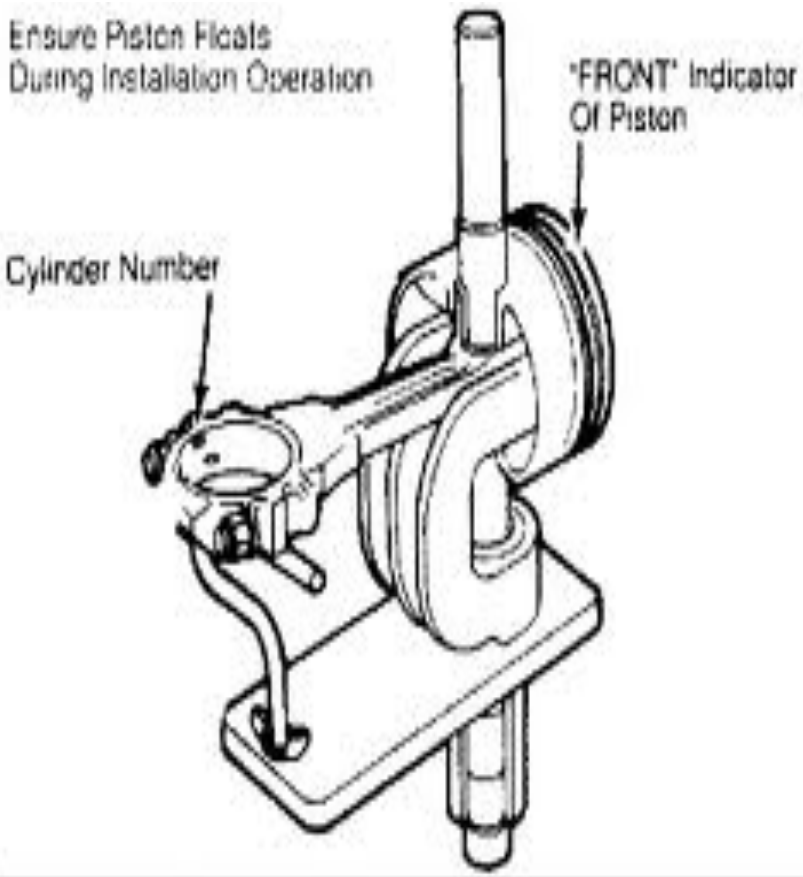


Fig. 11: Piston Pin Installation - Typical
This Graphic For General Information Only

Connecting Rods and Bearings

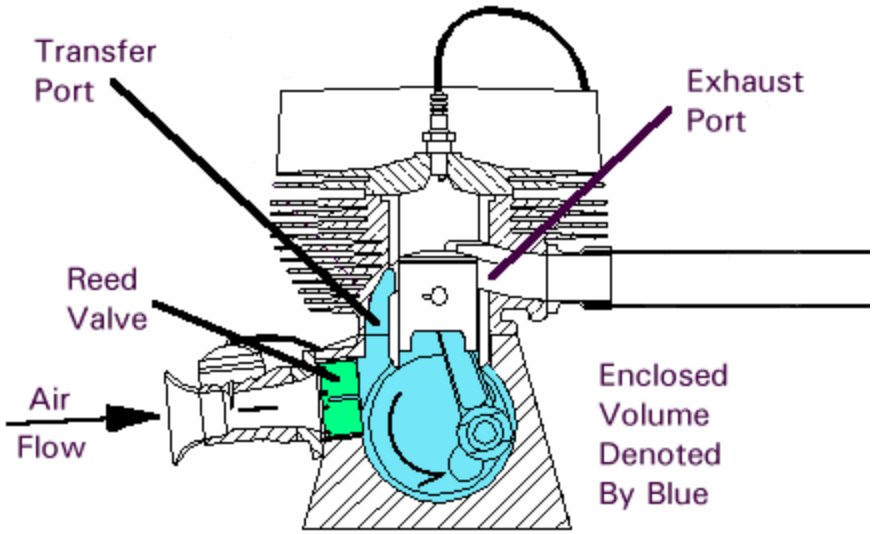
- Connecting rods

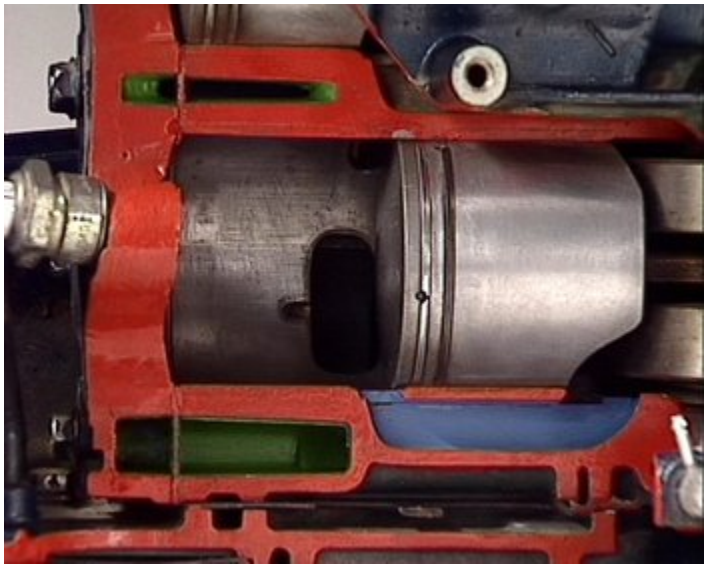
Friction-type Bearings

- Antifriction Bearings

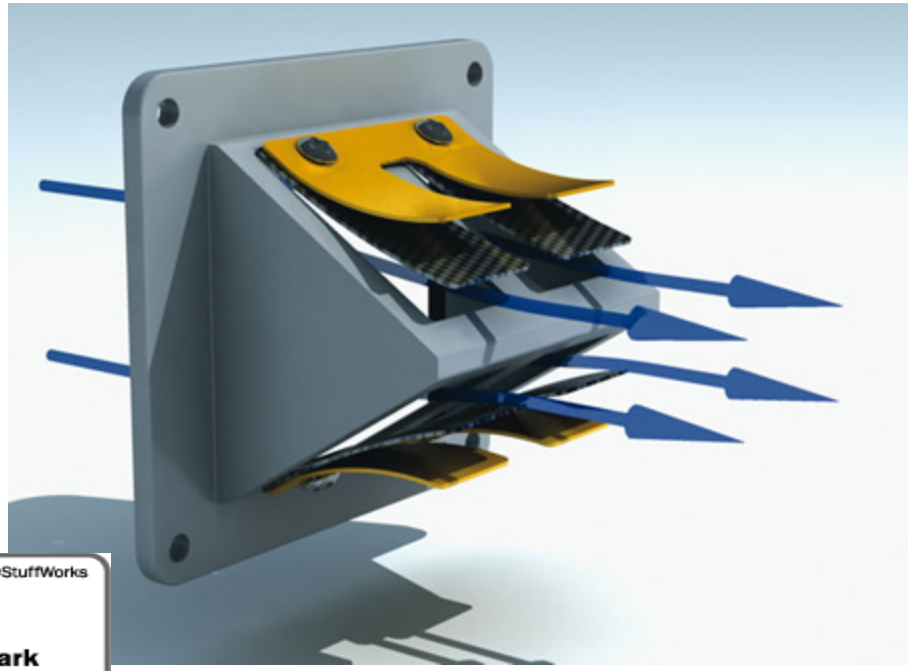
Intake and Exhaust Ports

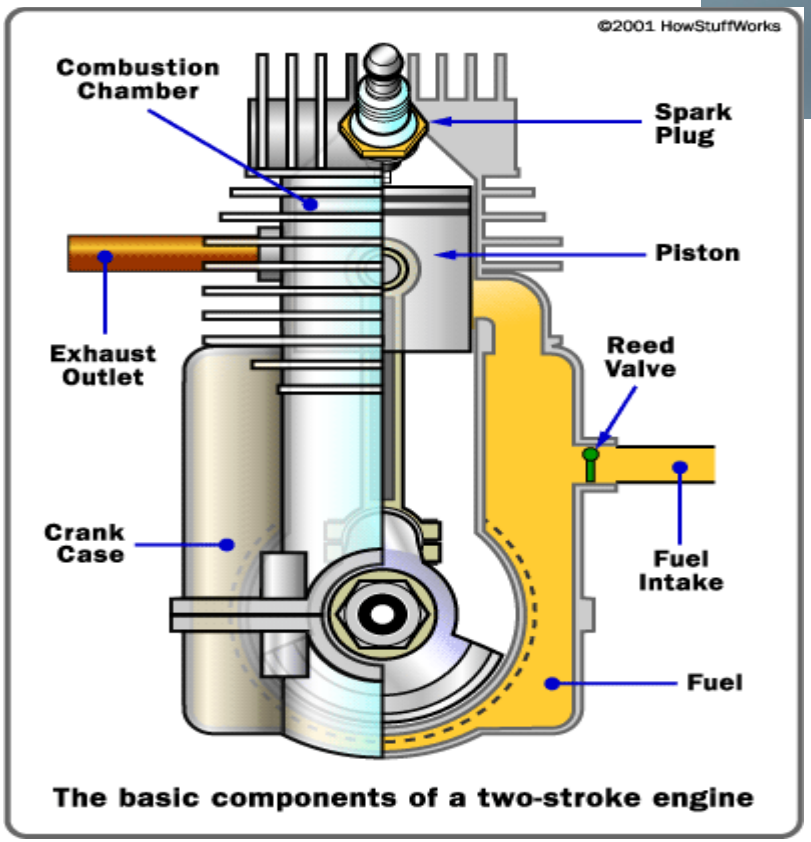
- 2-Stroke
  - Ports

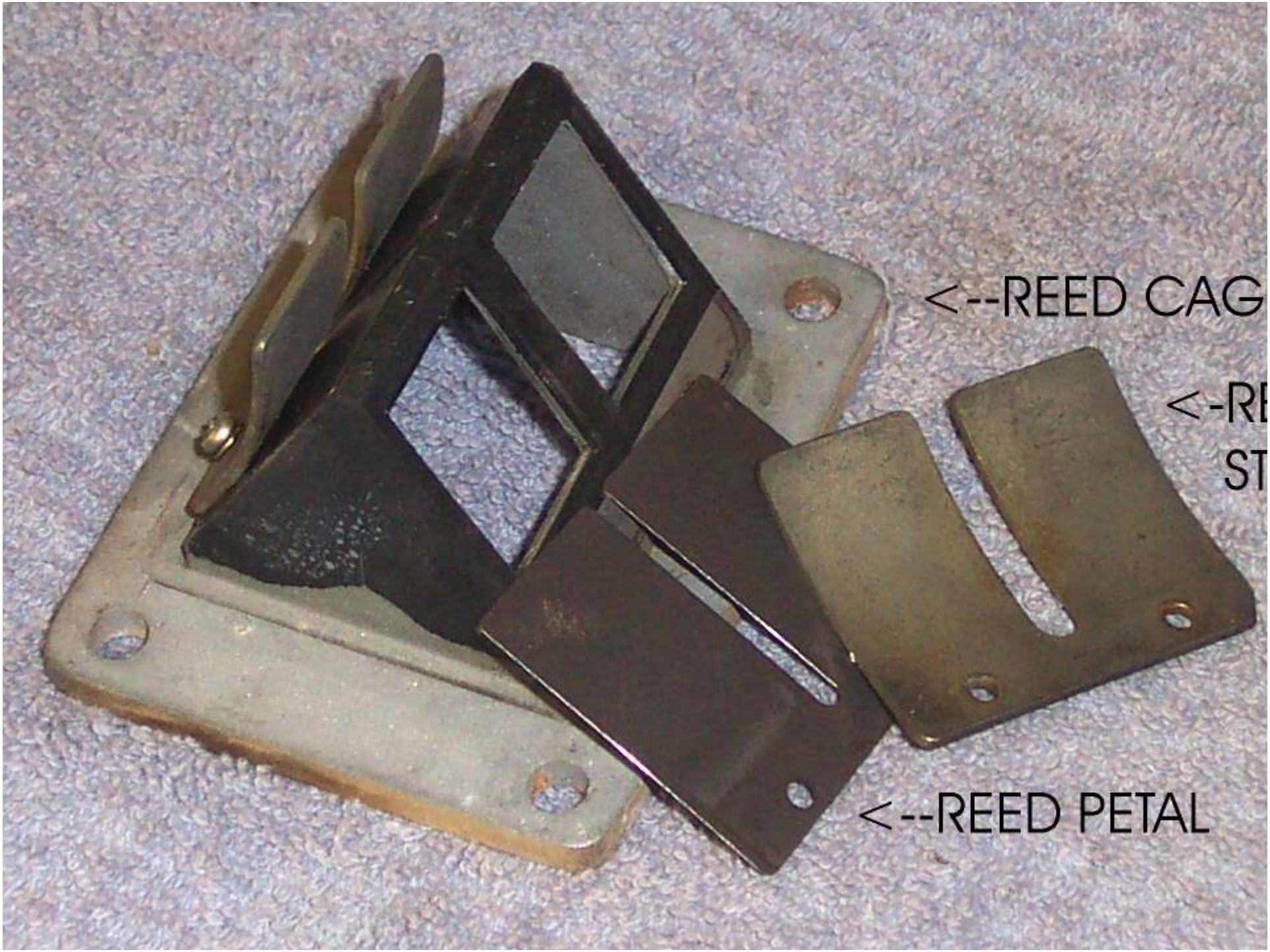




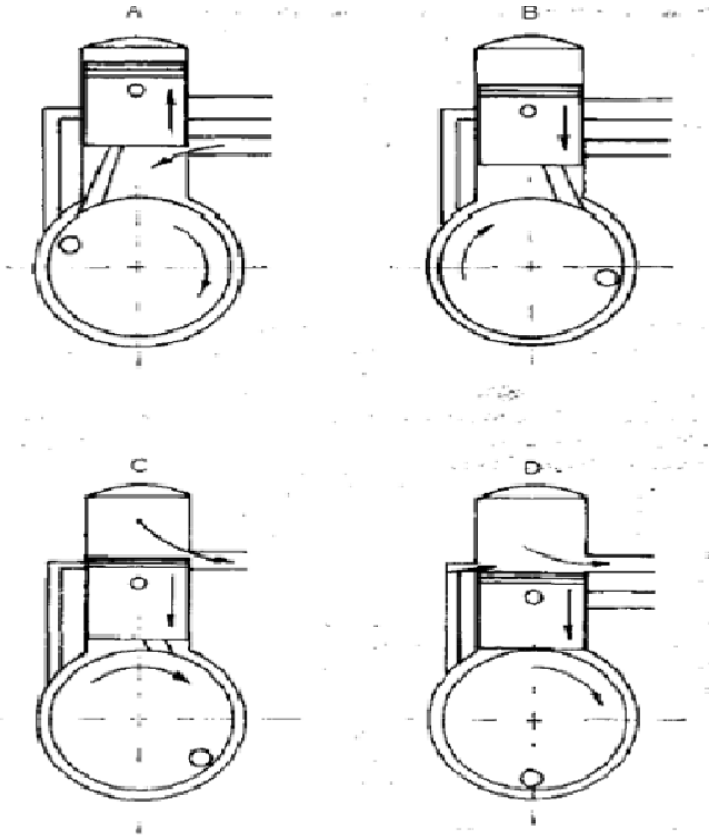
- 2-Cycle
  - Reed Valves

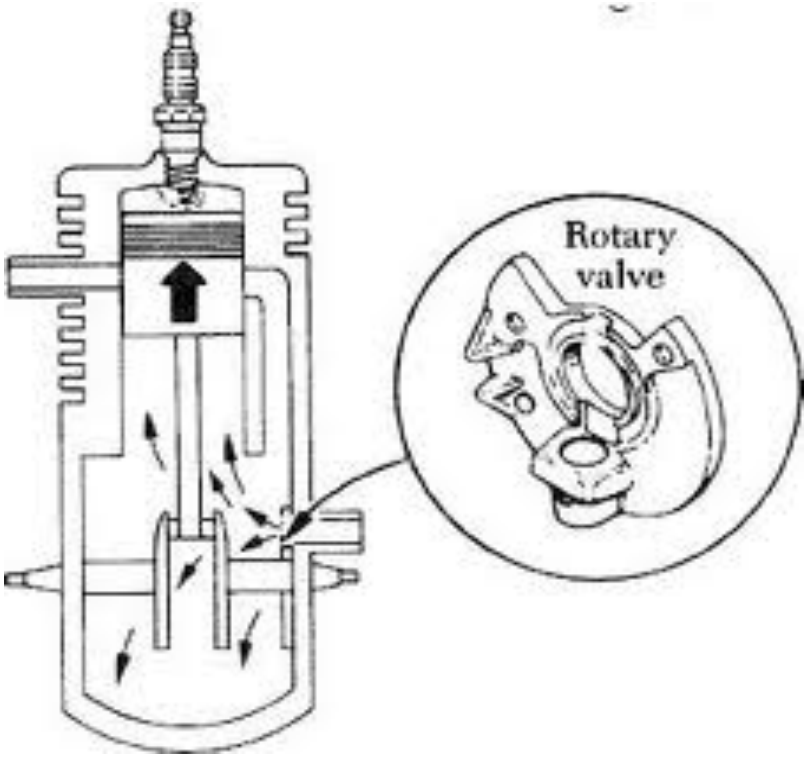


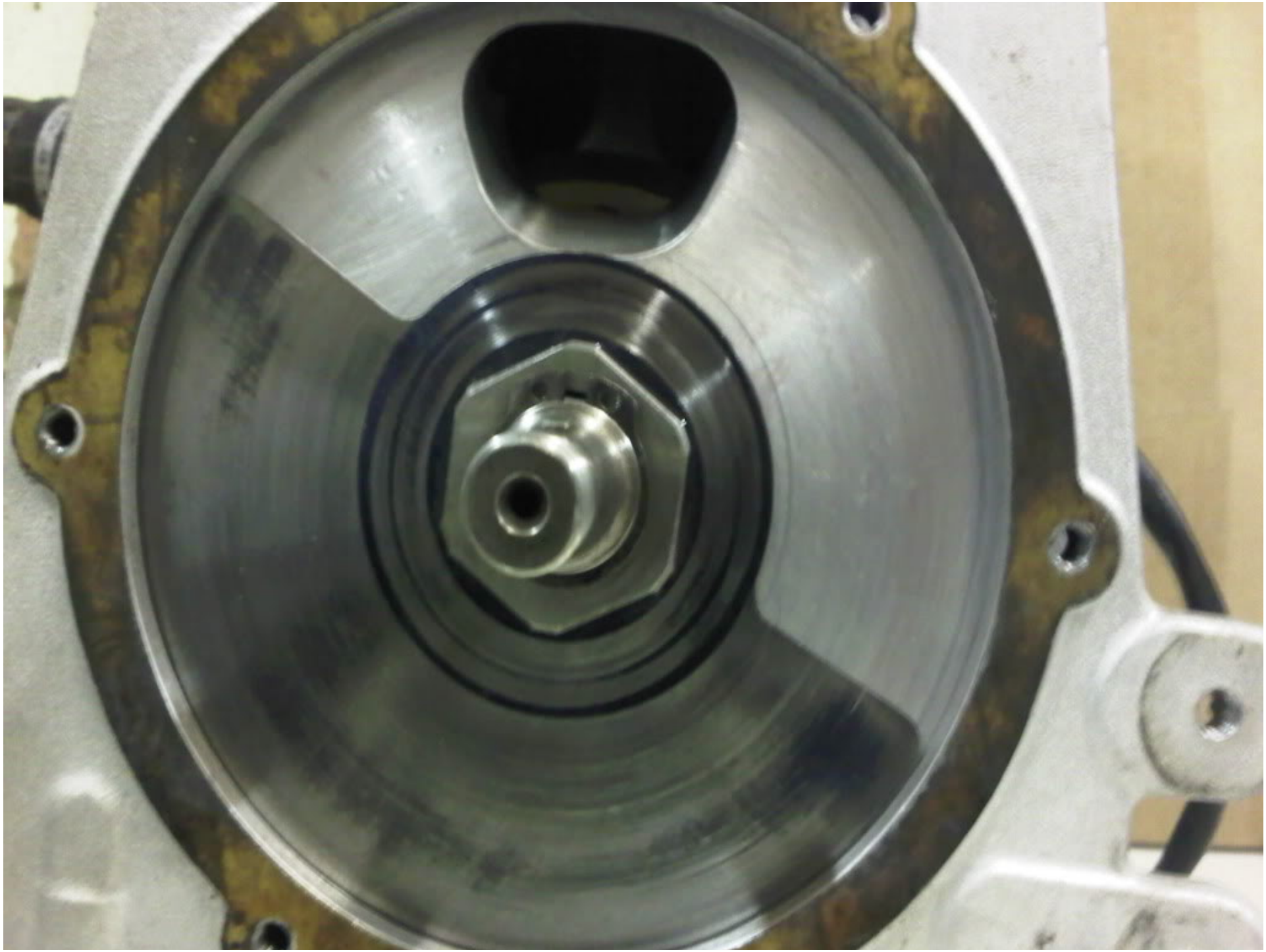



<--REED CAG
<-RE
ST
<--REED PETAL

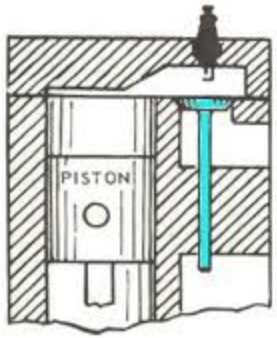
- 2-Stroke
  - Rotary Valve, page 124







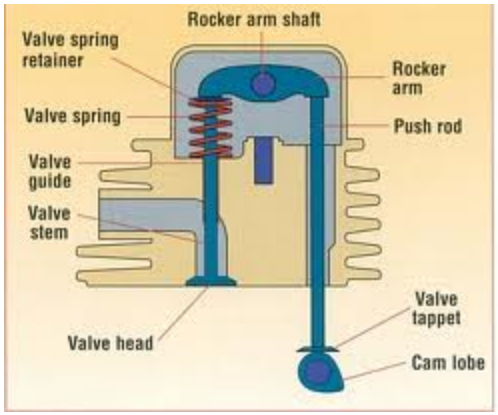
- 4-Cycle
  - Poppet Valves
    - OHV
    - Side Valve



Valves

Cylinder

Form an inverted letter L



- Valve Spring Assembly

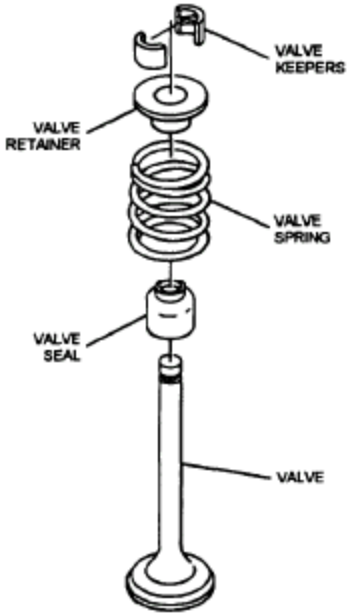
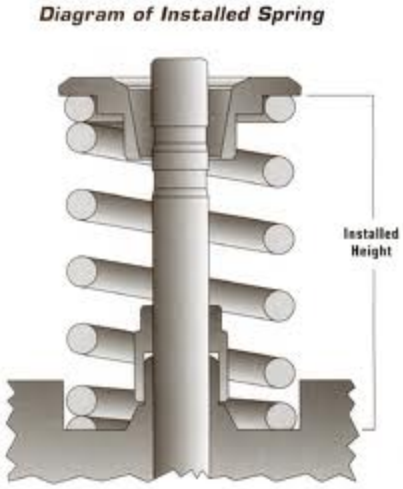
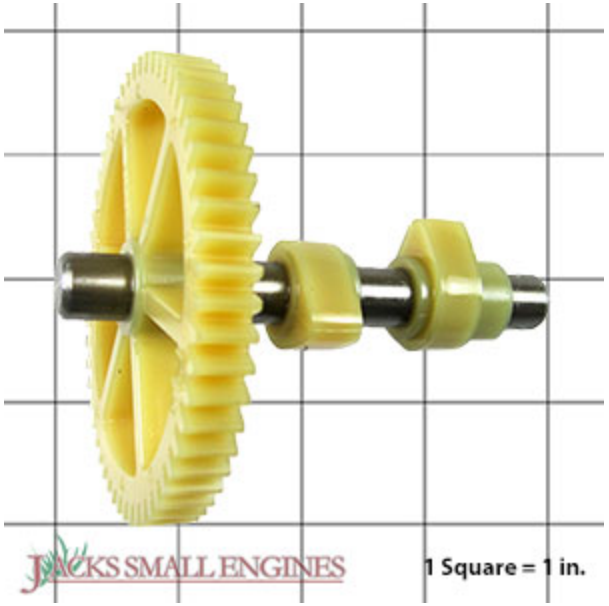
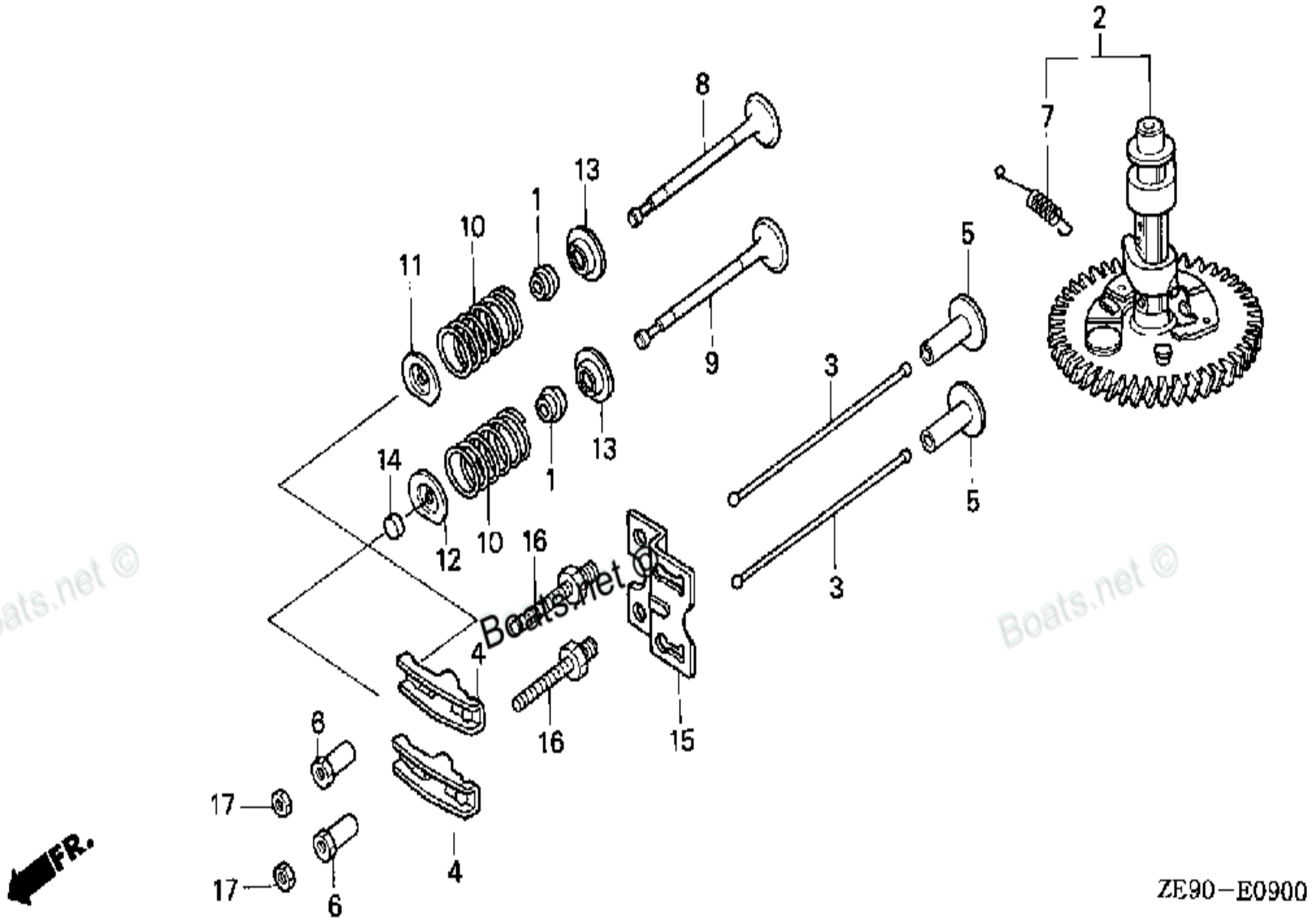


Figure 3-53.—Valve spring, retainer, and seal.



Camshaft and Gears





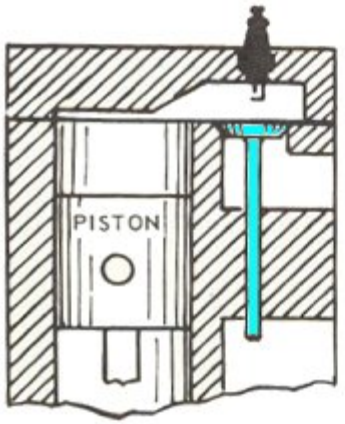
ZE90−E0900

Valve Lifter or Tappet

Valve Train Configurations

- Valve in block
- Overhead Valve – OHV
- Overhead Cam

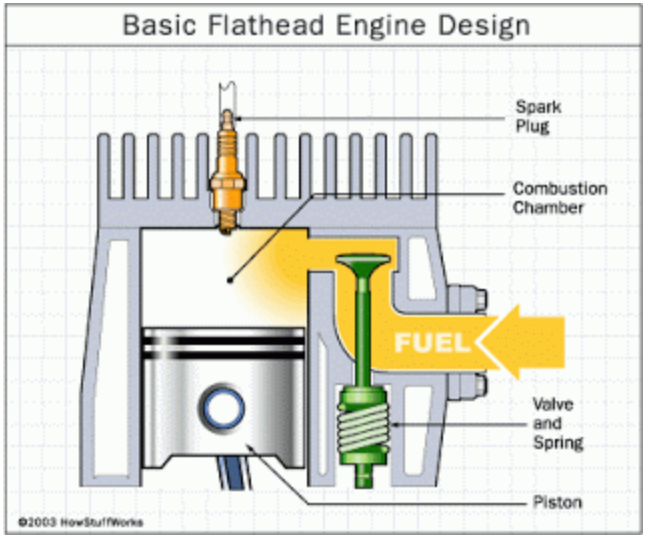
Valve in Block

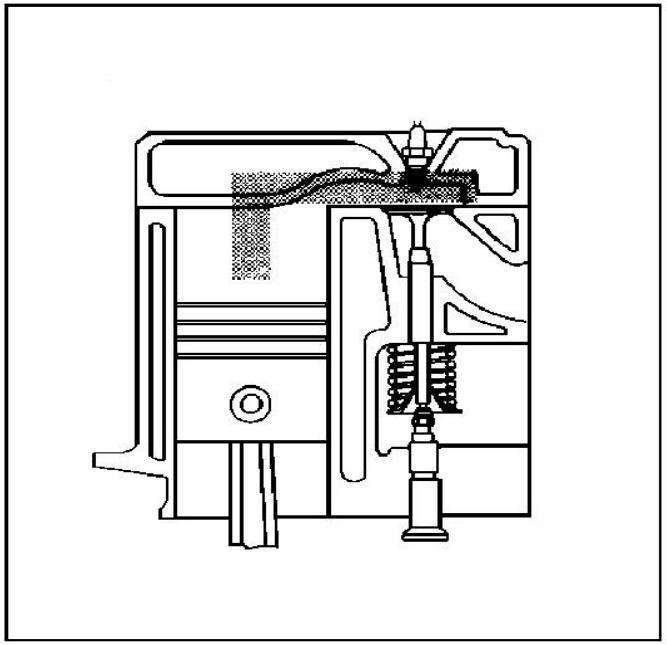


Valves

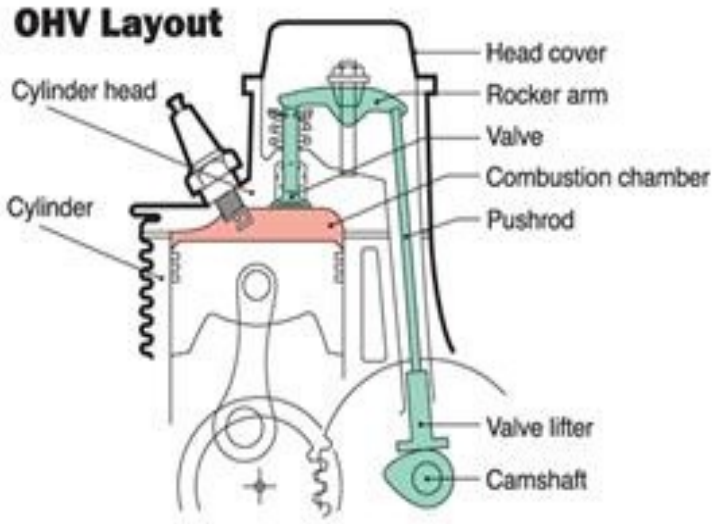
Cylinder

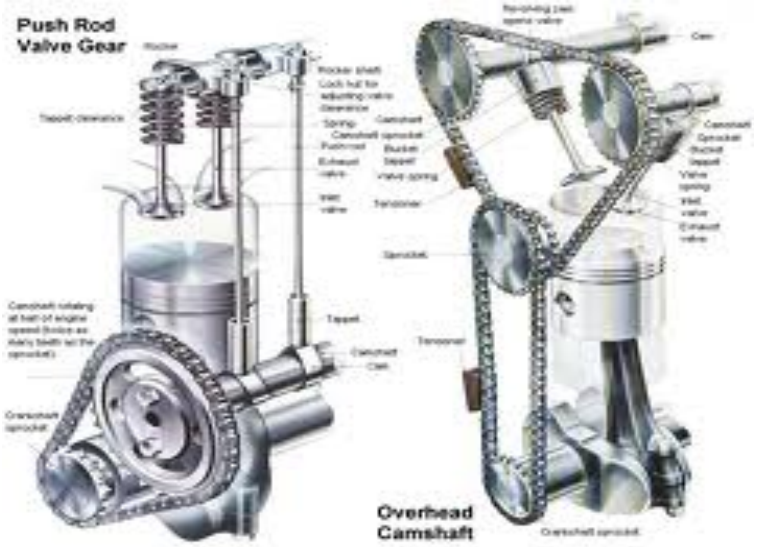
Form an inverted letter L



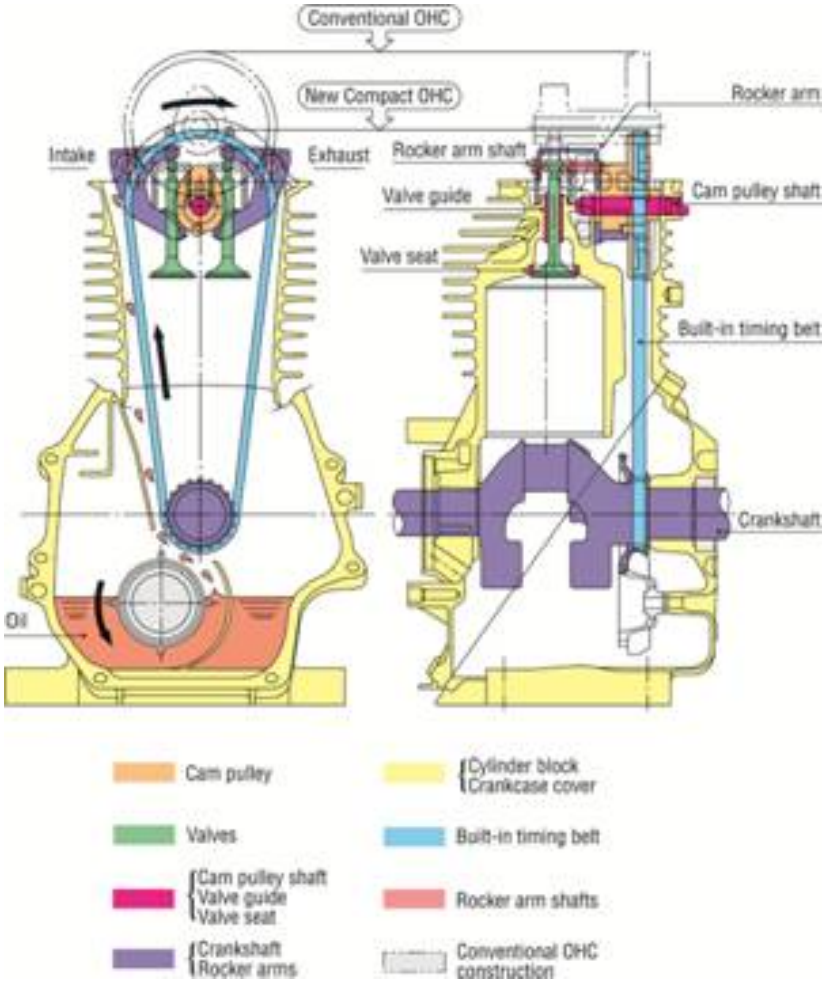


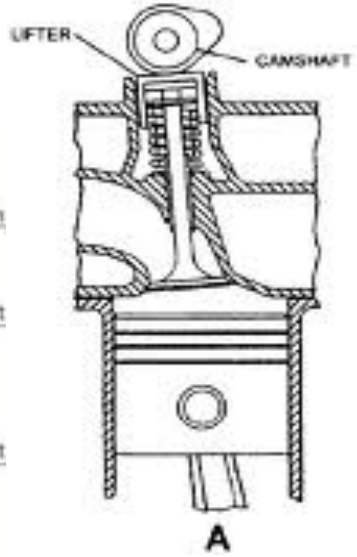
OHV

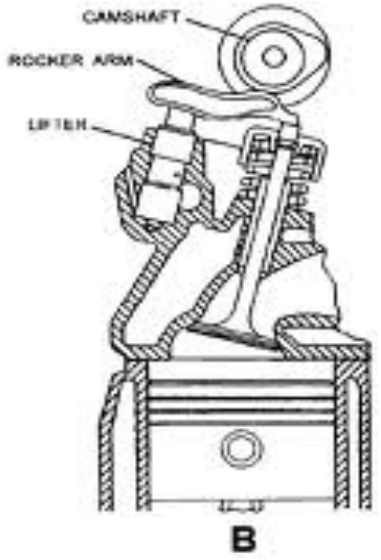

OHV Layout
Head cover
Cylinder head
Rocker arm
Valve
Combustion chamber
Cylinder
Pushrod
Valve lifter
Camshaft

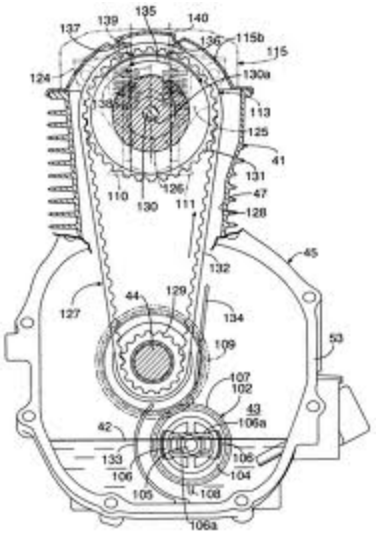

Push Rod
Valve Gear
Overhead
Camshaft

OHC


Conventional OHC
New Compact OHC
Intake
Exhaust
Rocker arm
Rocker arm shaft
Valve guide
Cam pulley shaft
Valve seat
Built-in timing belt
Crankshaft
Oil
Cam pulley
Valves
Cam pulley shaft
Valve guide
Valve seat
Crankshaft
Rocker arms
Cylinder block
Crankcase cover
Built-in timing belt
Rocker arm shafts
Conventional OHC construction


LIFTER
CAMSHAFT
A


CAMSHAFT
ROCKER ARM
LIFTER
B



Starter Assembly

Automatic Compression Release

- @ 600 RPM flyweights retract tabs

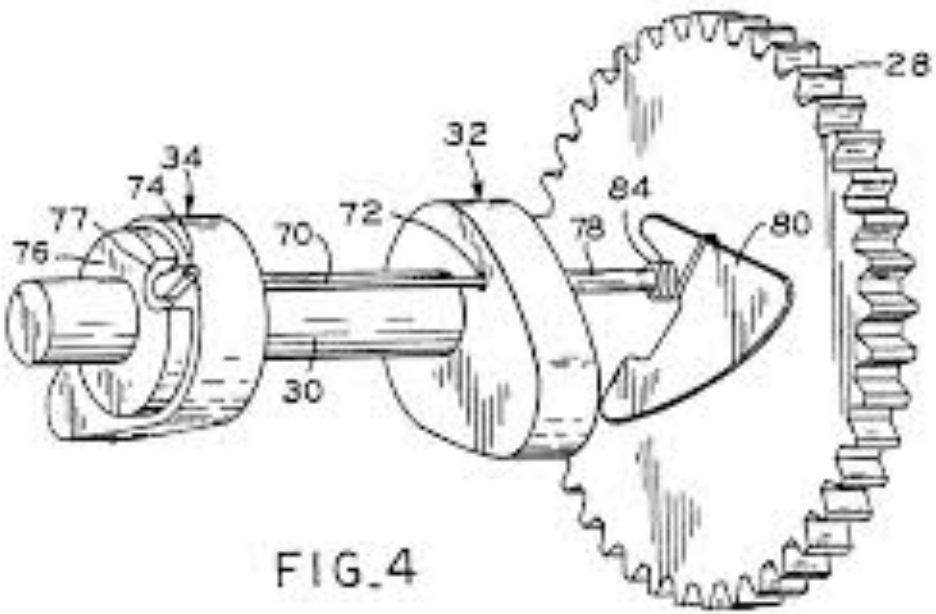


FIG. 4

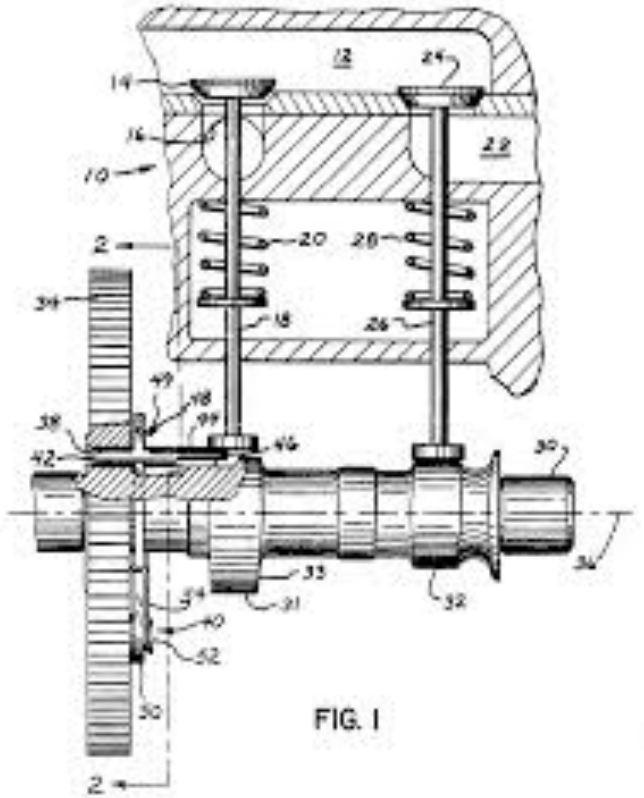
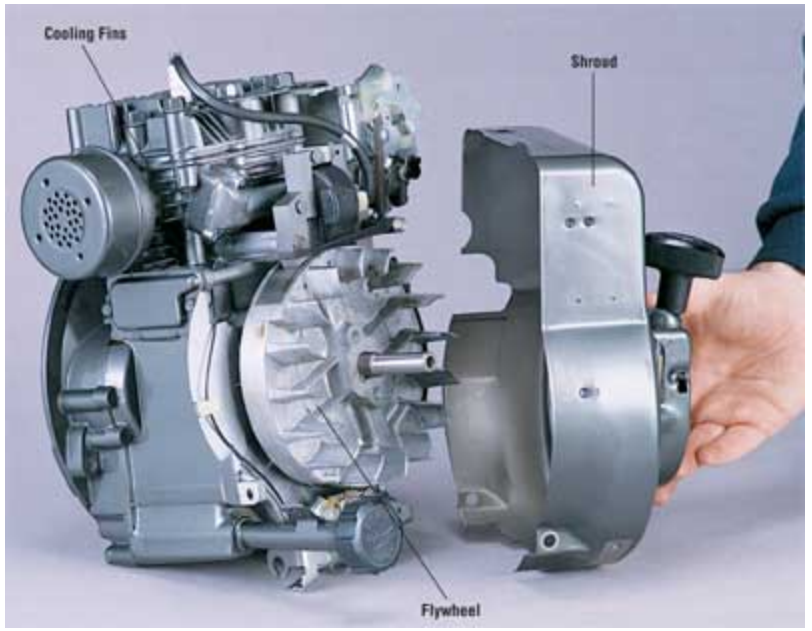


FIG. 1

Flywheel

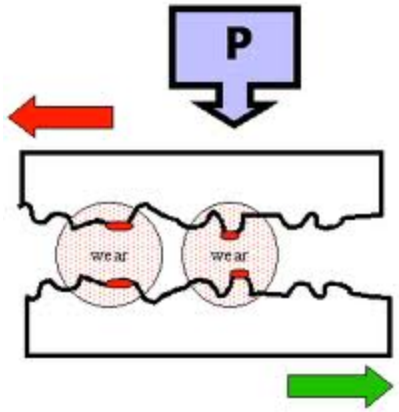


Lubrication Systems

Chapter #11

Friction

- The enemy…

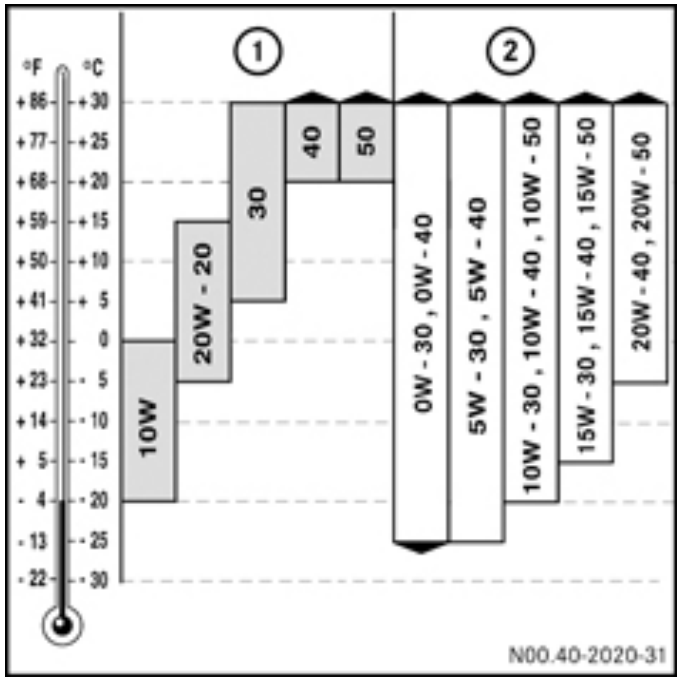


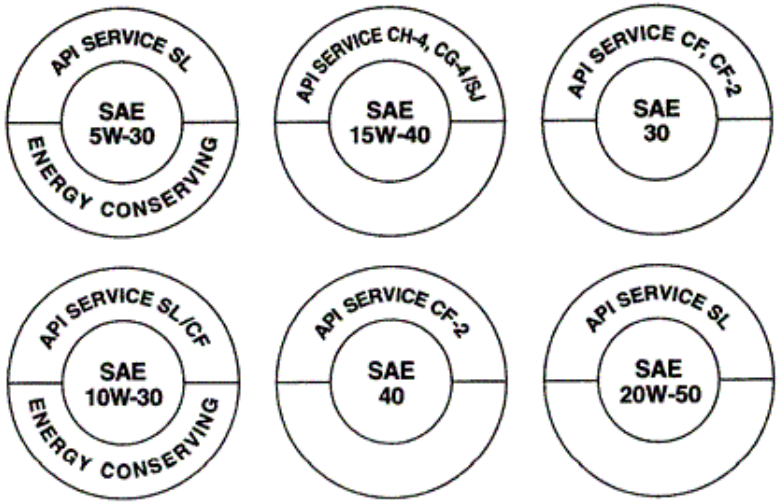
Qualities of Lubricating Oil

- Permits easy start
- Lubricates and prevents wear
- Protects against rust and corrosion
- Keeps engine parts clean
- Cools engine parts
- Seals combustion pressures
- Prevents foaming
- Aids fuel economy

Oil Specifications

- SAE Viscosity Grade
- API Engine Oil Service Classification – SN for 2011 or older vehicles





API OIL SERVICE RATINGS

2-cycle Engine Lubricant

- Mixing oil and fuel
- Classification TC-W
  - Use manufactures oil? You decide.
  - Buy premixed fuel in quart containers – I would for customers machines

2 stroke fuel / oil mixing chart					
Fuel -Oil Ratio	%	cc/ml per 1litre	cc/ml per 5 litres	cc/ml per 10 litres	cc/ml per 20 litres
25:1	4.0	40	200	400	800
30:1	3.33	33.3	166.5	333	666
40:1	2.5	25	125	250	500
50:1	2.0	20	100	200	400
60:1	1.67	16.7	83.5	167	334
70:1	1.43	14.3	71.5	143	286
80:1	1.25	12.5	62.5	125	250
90:1	1.11	11.1	55.5	111	222
100:1	1.0	10	50	100	200

Engine Lubricating Systems

- 3 oil systems used… Most side valve engines employ a dipper on end of connecting rod or slinger off cam
- Semi-pressurized system- combine splash lubricant w/ positive feed to some bearings & to OHV, Tecumseh uses plunger driven off cam
- Full-pressure system – gear type pump, pressure relief valve limits to 50 lbs

4-Stroke Engine lubrication

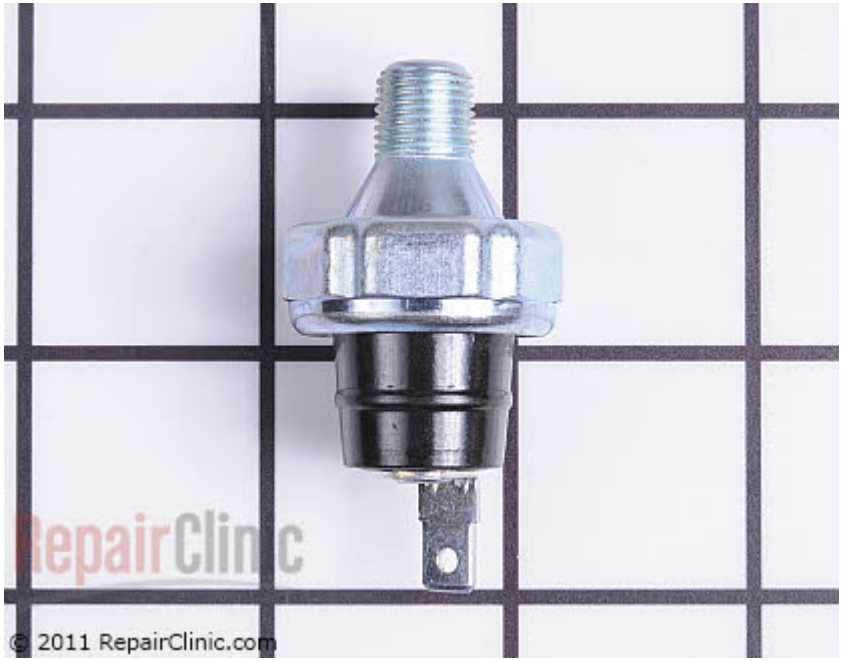
- Splash
- Constant Level Splash System – adds an oil pump (cam operated), splash trough, & strainer
- Ejection and Barrel Pump System
- Pressurized Lubrication System
- Positive Displacement Oil Pump

Oil Filter Systems

- W/ pressurized lubrication systems
- Bypass filter system- some of the pressurized oil is delivered to bearings and some to filter
- Shunt Filter System – pressurized oil feed to filter then some goes to bearing and some goes back to sump
- Full-flow Filter System

Low-Oil Warning and Shutdown Systems (LOS)

- Check wiring diagram
- Grounds or opens ignition circuit



Cooling Systems

Chapter #12

Principles of Engine Cooling

- Average temp of burned gases in combustion chamber of an air-cooled engine is about 3,600 degrees
- 1/3 heat used to produce mechanical energy
- 1/3 heat carried away by exhaust
- 1/3 heat carried away by cooling system
- Excessive heat can lead to pre-ignition

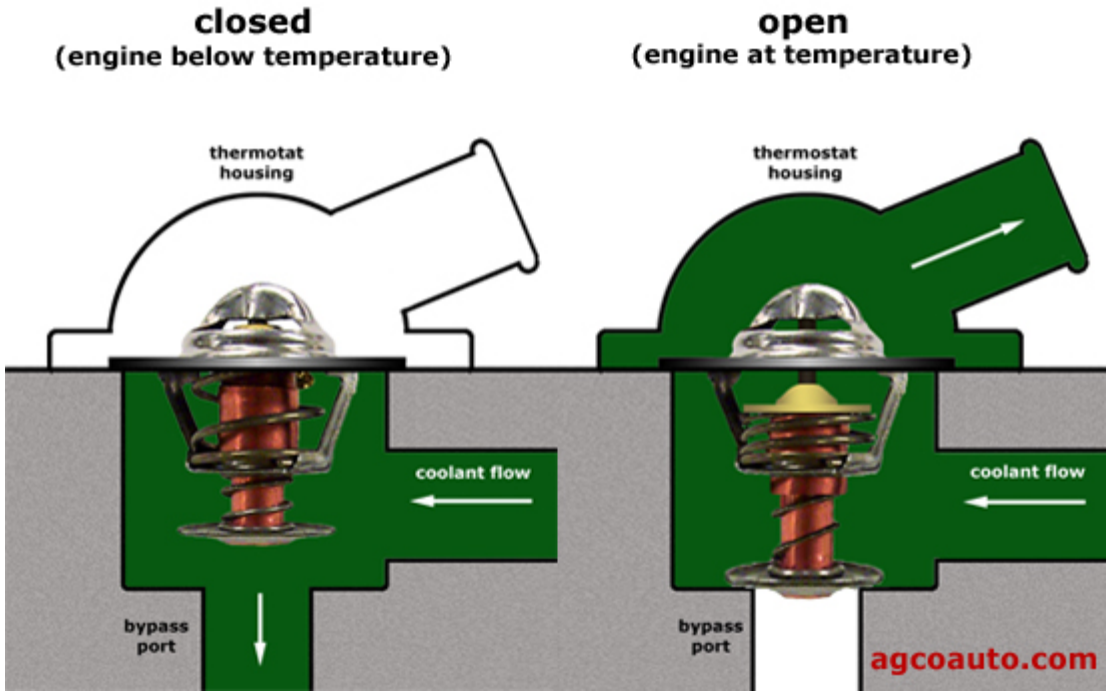
Air Cooling

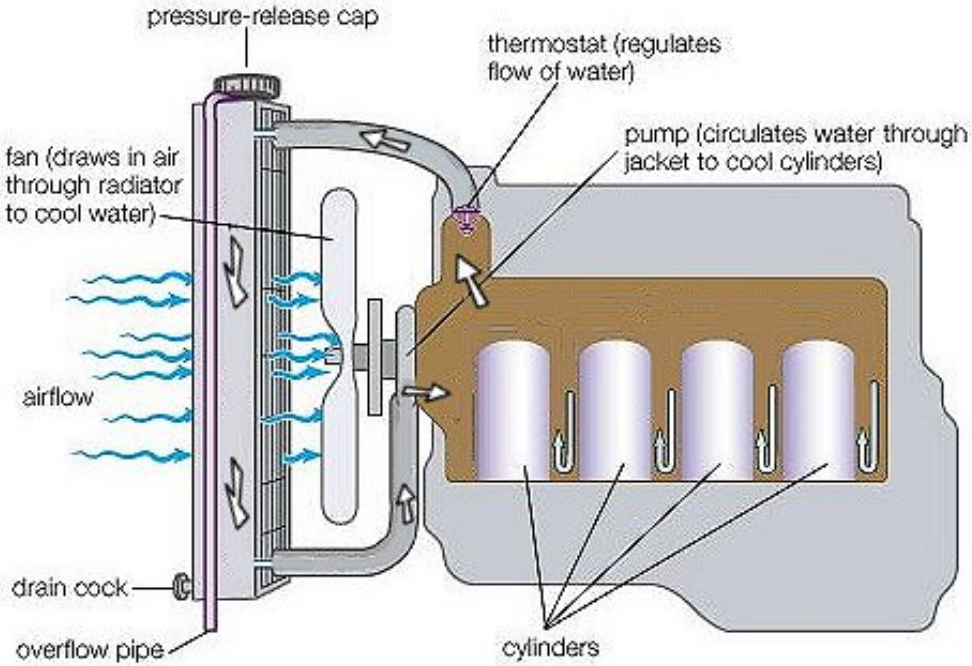
- Thin cooling fins increase the surface area
- Flywheel has fins that blow air – shroud directs air over cylinder fins
- Everything must be kept clean to work efficiently
- Convection

Liquid Cooling

- Pressurized cooling system
  - Radiator
  - Water pump
  - Radiator cap
  - Hoses
  - Fan
  - Thermostat

- Thermostat


closed
(engine below temperature)
open
(engine at temperature)
thermotat housing
thermostat housing
coolant flow
coolant flow
bypass port
bypass port
agcoauto.com


pressure-release cap
thermostat (regulates flow of water)
pump (circulates water through jacket to cool cylinders)
fan (draws in air through radiator to cool water)
airflow
drain cock
overflow pipe
cylinders

Outboard engine Cooling Systems

- Sliding vane pump, rotor-type pump, plunger pump, vari-volume pump

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