Lubrication System

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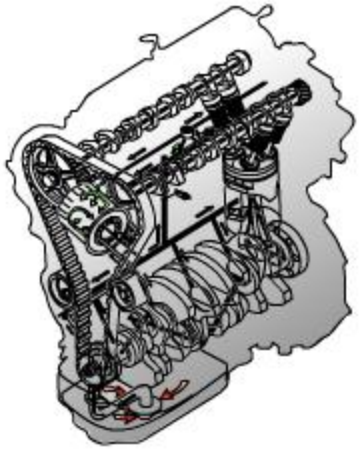
Objectives

- Explain the purpose of the lubrication system.
- Describe oil ratings
- Identify the main components of the lubrication system
- Describe the lubrication system of modern internal combustion engines
- Describe the theory and operation of the lubrication system
- Describe oil system failures
- Describe oil system diagnosis

Purpose

- An internal combustion engine produces many byproducts from its normal process:
  - Water vapor
  - Heat
  - Friction
  - Debris

    (particles and corrosives)



- The lubrication system is used to control each.

Purpose

- The lubrication system has several functions:
  - Absorb shock loading from compression, power stroke, engine braking, ect.
  - Increase fuel economy by providing low friction surfaces
  - Cleaning the internal components of dirt and other particles
  - Remove heat from engine components
  - Reduce friction between engine components

Lubrication Types

- There are Thee types of lubrication types:
  - Gravity
    - Uses the falling oil to lubricate components.
    - Oil control ring to piston pin
  - Splash
    - Uses spun oil from crank to lubricate
    - Oil from rod bearing splashed onto cylinder wall
  - Pressure
    - Main source of all types. Pressurized oil fed to low tolerance bearing clearances
    - Oil pump to main bearings
- Gravity and Splash are sometimes used together.

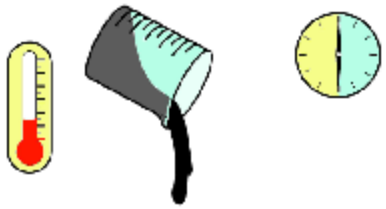
Engine Oil

- Engine oil (motor oil) is made in one of three processes.
  - Petroleum (natural)
    - Created by refining crude oil from oil deposits in earth.
    - Traditional oils
  - Synthetic (man-made)
    - Made of small molecular building blocks. Created from one particle and built upon.
    - Lower molecular mass, higher performing, and more thermally stabile
  - Partial Synthetic (natural/man-made)
    - Includes benefits of Synthetic with lower cost of Petroleum

Engine Oil

- Motor oils are categorized in SAE viscosity classes.
- Viscosity is a measure of a fluid's ability to flow.
  - High # thick does not flow well
  - Low # thin flows easily
- Oil viscosity is graded by the oil ability to flow at ambient temperature

Engine Oil Temperature



High Viscosity Oil
At Low Temperatures

Low Viscosity Oil
At Low Temperatures

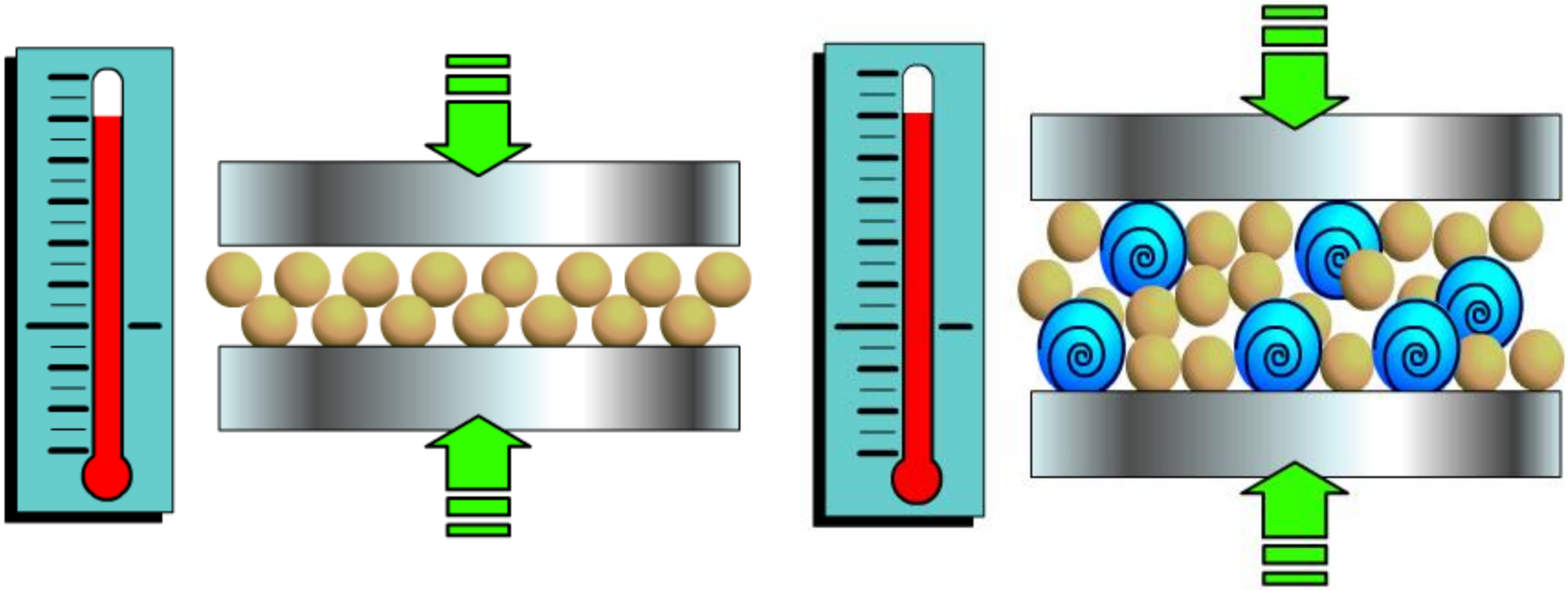
BACK

- Single weight oil viscosity is greatly effected by the temperature of the oil.
  - At low temperatures the oil has a higher viscosity.
  - At high temperatures the oil becomes thinner and its viscosity lowers.
- For this reason most engines use multi-grade oils that are more stabile at temperature changes.

Engine Oil Multi-Viscosity

- SAE 40 oil performs well at higher temperatures, but becomes thick at low temperatures.
- Multi-Viscosity oil can perform well across a larger range of oil.
  - Retains a specific viscosity at 0 F.
  - Increase in viscosity at high temperatures.
- The molecule in MV oils line up and increase in size the hotter they get.

Single vs. Multi-Weight



Multi-Viscosity

- 5W20:
  - 5 Low viscosity at cold temperatures
  - W Winter
  - 20 High viscosity at high temperatures
- 20W50:
  - 20
  - W
  - 50

Oil Service Ratings

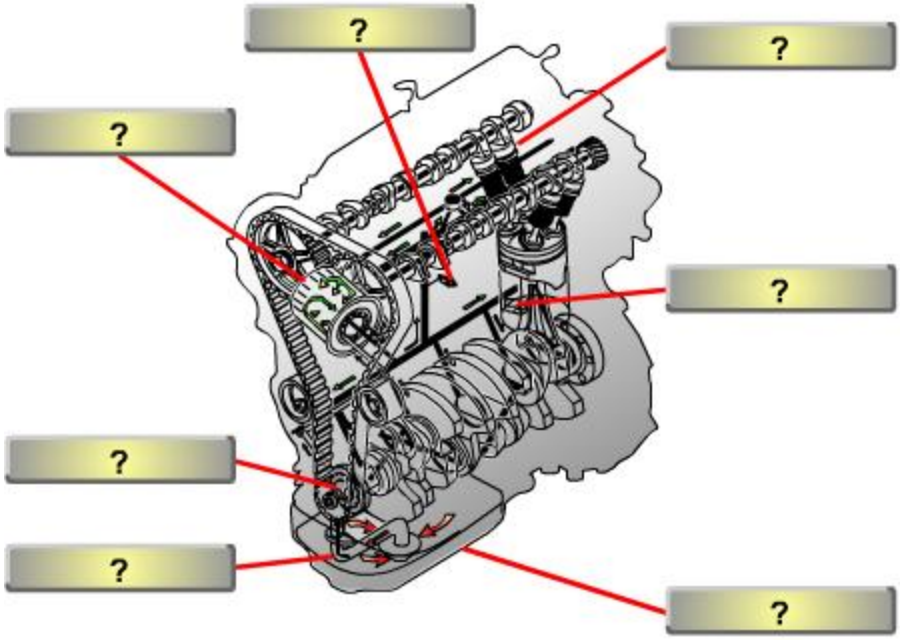
- How well an engine oil performs is indicated by the API (American Petroleum Institute) rating on the bottle.
- Service ratings are determined by API for specific vehicles, operating conditions, and manufacturer specifications.
- May be a starburst or donut on the bottle of oil.

Gasoline Engines		
Category	**Status**	**Service**
SM	Current	For all automotive engines presently in use. Introduced November 30, 2004. SM oils are designed to provide improved oxidation resistence, improved deposit protection, better wear protection, and better low-temperature performance over the life of the oil. Some SM oils may also meet the latest ILSAC specification and/or qualify as Energy Conserving.
SL	Current	For 2004 and older automotive engines.
SJ	Current	For 2001 and older automotive engines.
SH	Obsolete	For 1996 and older engines. Valid when preceded by current C categories.
SG	Obsolete	For 1993 and older engines.
SF	Obsolete	For 1988 and older engines.
SE	Obsolete	CAUTION - Not suitable for use in gasoline-powered automobile engines build after 1979.
SD	Obsolete	CAUTION - Not suitable for use in gasoline-powered automobile engines build after 1971. Use in more modern engines may cause unsatisfactory performance or equipment harm.
SC	Obsolete	CAUTION - Not suitable for use in gasoline-powered automobile engines build after 1967. Use in more modern engines may cause unsatisfactory performance or equipment harm.
SB	Obsolete	CAUTION - Not suitable for use in gasoline-powered automobile engines build after 1963. Use in more modern engines may cause unsatisfactory performance or equipment harm.
SA	Obsolete	CAUTION - Not suitable for use in gasoline-powered automobile engines build after 1930. Use in more modern engines may cause unsatisfactory performance or equipment harm.

Oil Additives

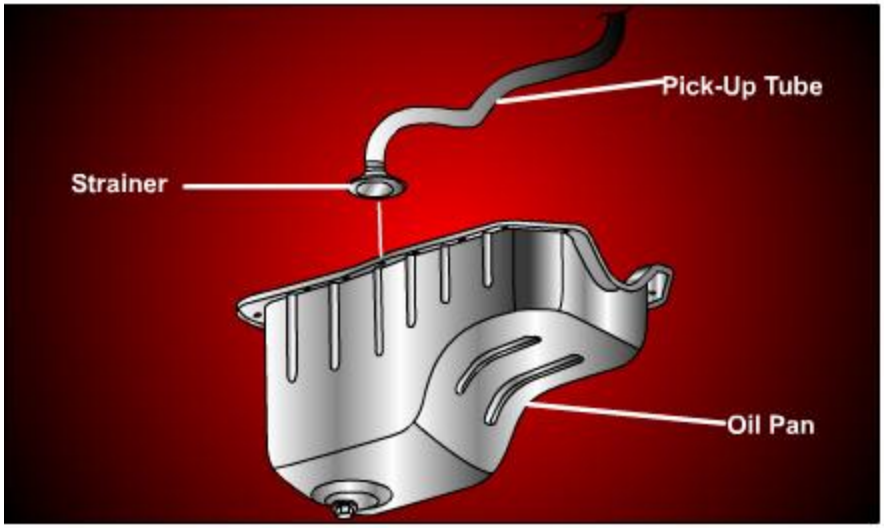
- Anti-wear:
  - Bond with metal surfaces to prevent wear. Under high stress loading the oil is pushed out of clearance, the Anti-wear component adheres to metal.
- Detergent/Dispersants:
  - Prevents carbon from blow-by from building up. Keep the particles in suspension to be trapped by the filter.
- Corrosion Inhibitor:
  - Prevent the condensation and dissimilar metals from reacting and corroding the internal components of the engine.
- Viscosity Index Improver:
  - Synthetic oil thickeners. Polymers that modify oil viscosity at temperature.
- Foam Inhibitors:
  - Prevents oil from foaming. If there is air in the oil then bearing damage can occur.
- Pour Depressants:
  - Modifies the oils cold pour point by preventing wax particle clumping
- Oxidation Inhibitor:
  - Prevents high temperature oil state changes. Keeps oil clean and varnish free.

System Components



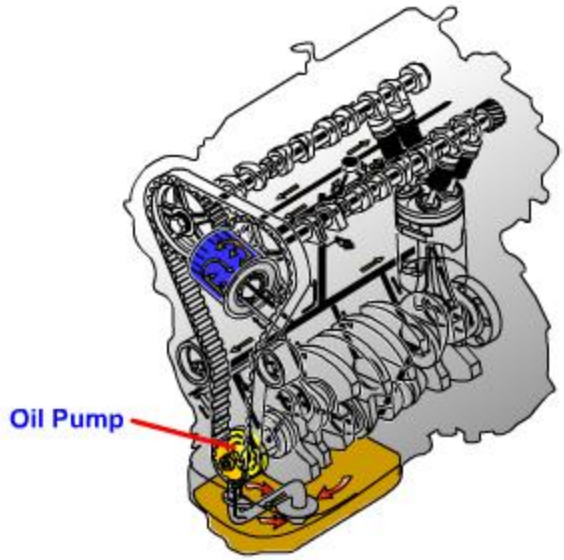
- Components:
  - Oil pressure switch
  - Lifter/buckets
  - Piston jets
  - Sump/pan
  - Pickup tube
  - Oil pump
  - Oil filter

Oil Pan and Pickup Tube



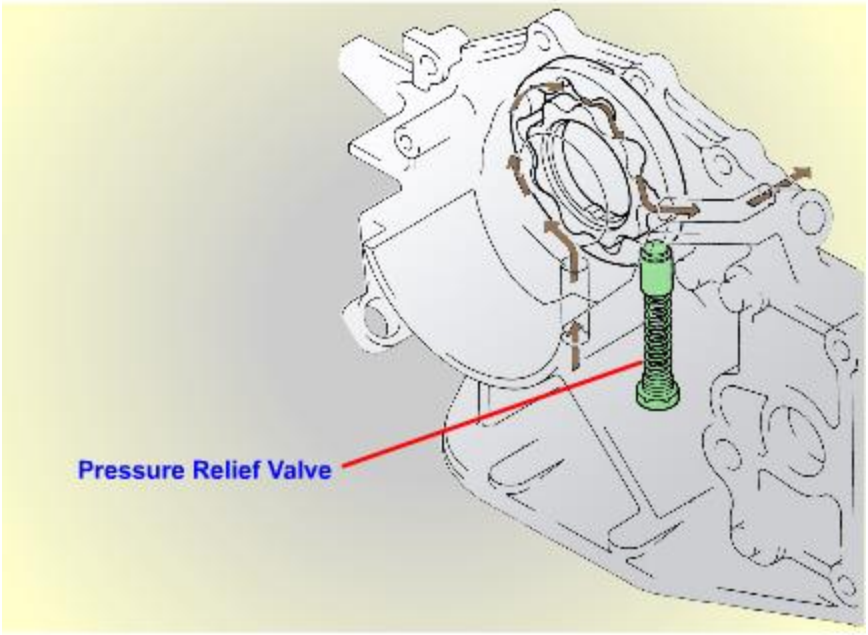
- The oil pan is the reservoir for the engine oil. It provides a seal for the bottom of the crankcase.
- The pickup tube connects the oil pump to the reservoir of oil. Placed as close as ¼” from bottom of pan.

Oil Pump



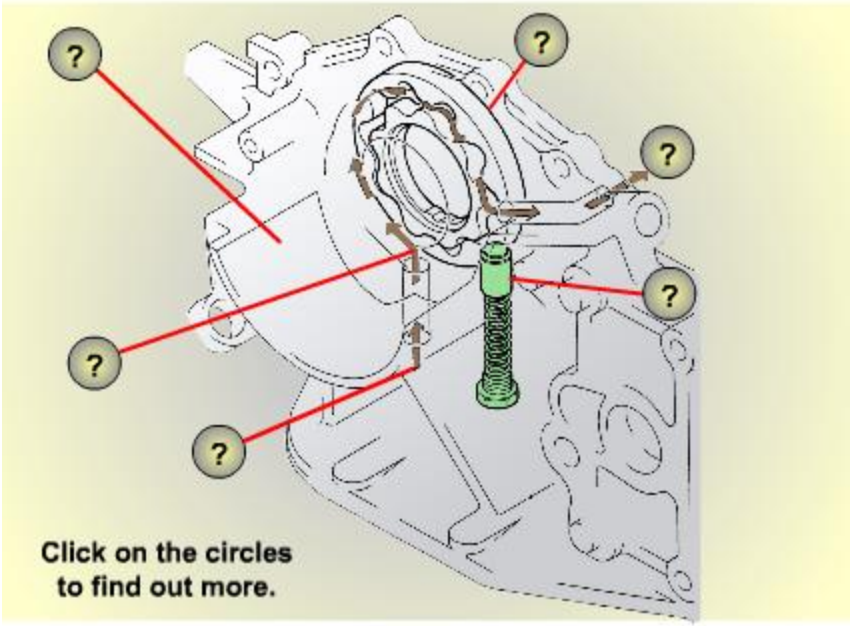
- The oil pump circulates the oil from the sump to all of the pressurized passages.
- Mountings:
  - On bottom of pan. Driven by distributor/synchronizer
  - Front of crankshaft. Driven directly by crankshaft. More efficient method of driving.

Pressure Relief Valve

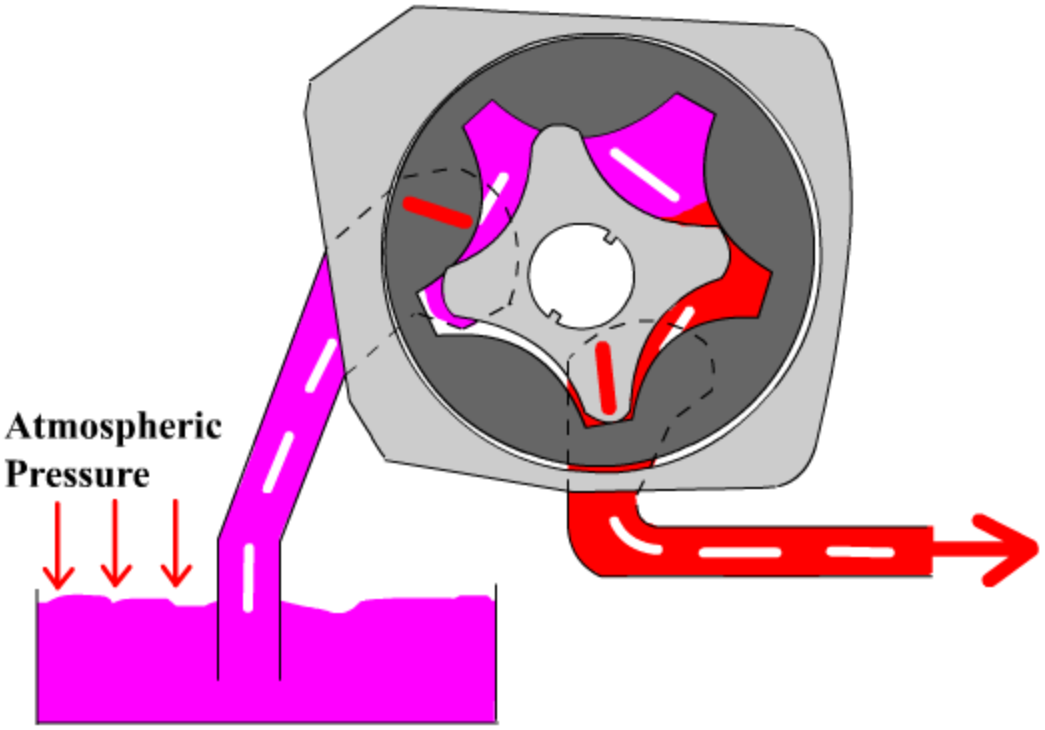


- The engine needs only a fraction of the oil pumps capacity. Excess pressure is returned directly to the oil pan by the Pressure Relief Valve.
- Oil pressure is controlled by a calibrated spring.
- Excessive pressure can cause ruptured seals.
- Insufficient pressure can cause bearing damage or engine noise.

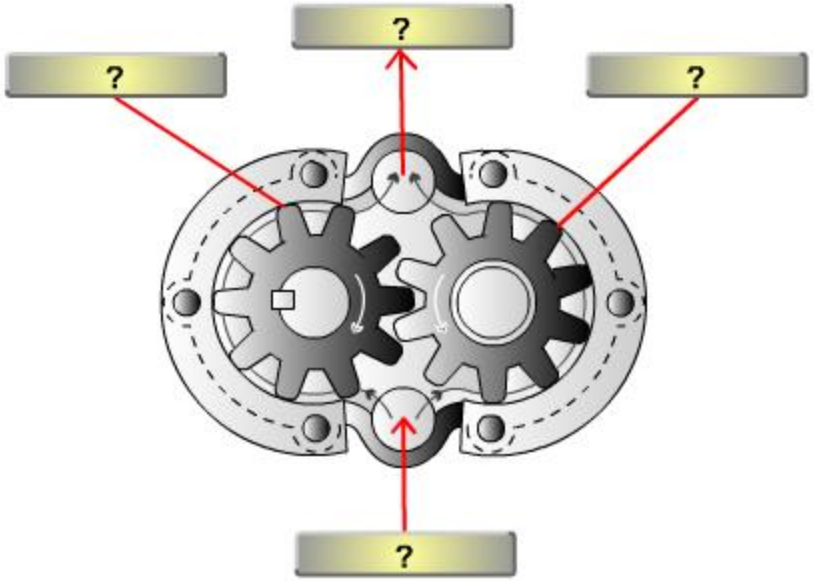
Gerotor



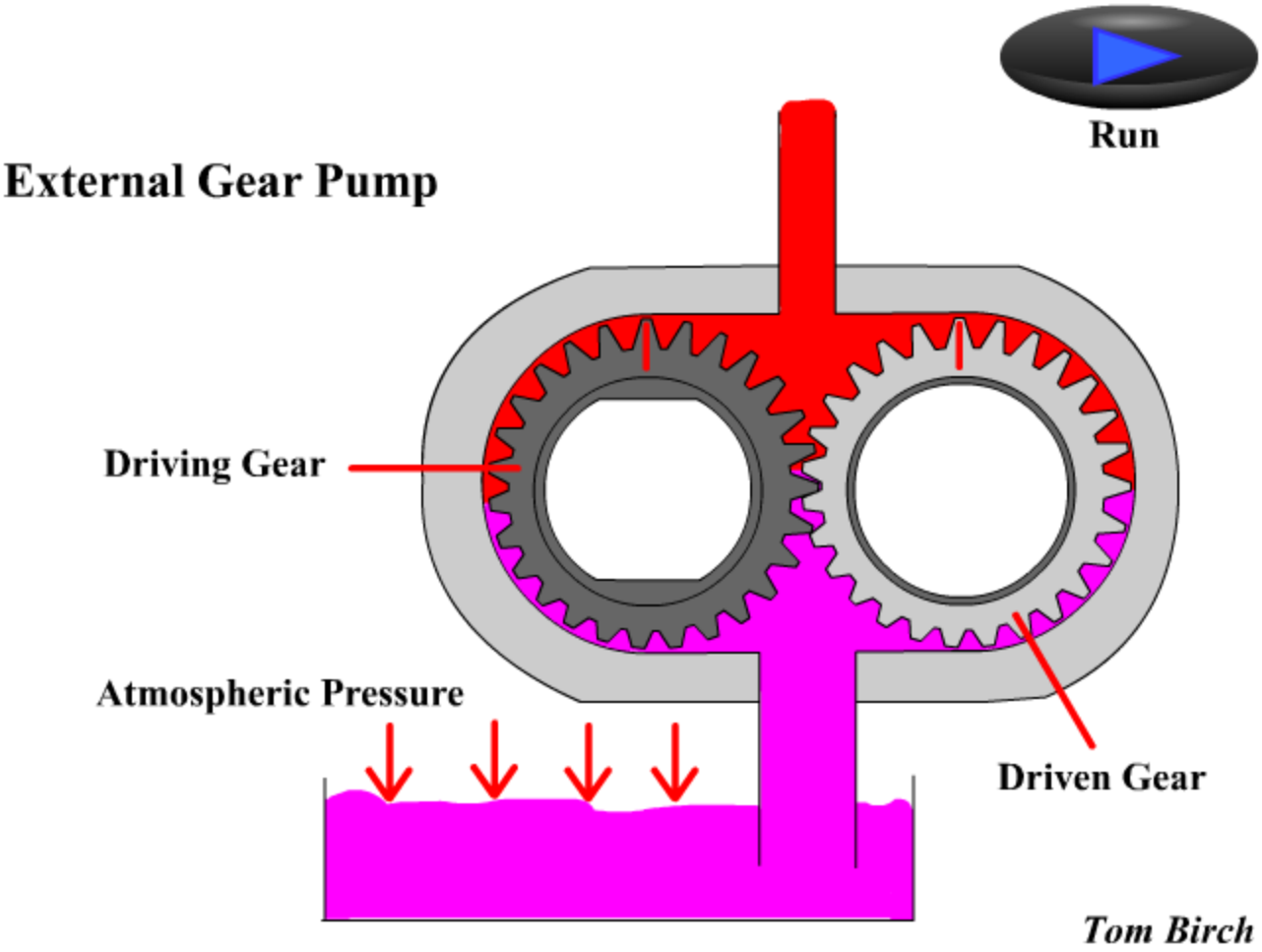
- Oil pumps driven directly by the crank snout are of the Gerotor type.
- Components:
  - Housing
  - Internal gear (drive)
  - External gear (driven)
  - Passages
  - Pressure relief valve
- Pump output is proportional to engine rpm.


Atmospheric
Pressure

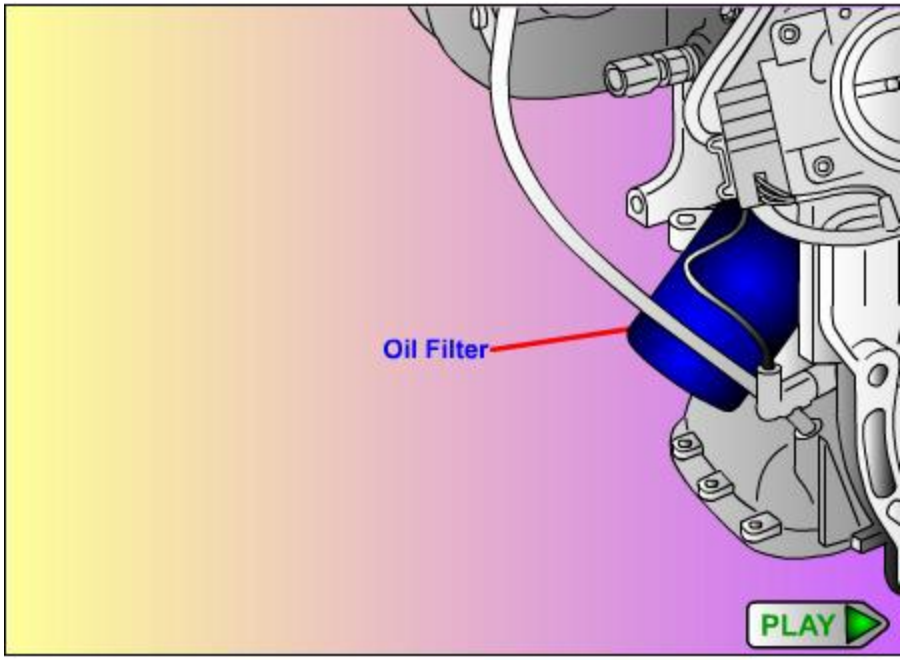
External Gear Pump



- Pumps driven by a distributor/synchronizer are of the External Gear Type.
- Components:
  - Housing
  - Drive gear
  - Driven gear
  - Inlet port
  - Outlet port
- Output is proportional to rpm

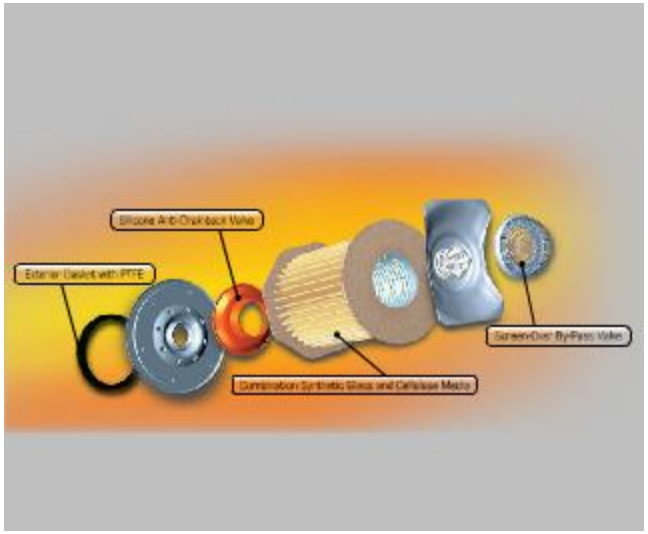

Run
External Gear Pump
Driving Gear
Atmospheric Pressure
Driven Gear
Tom Birch

Oil Filter



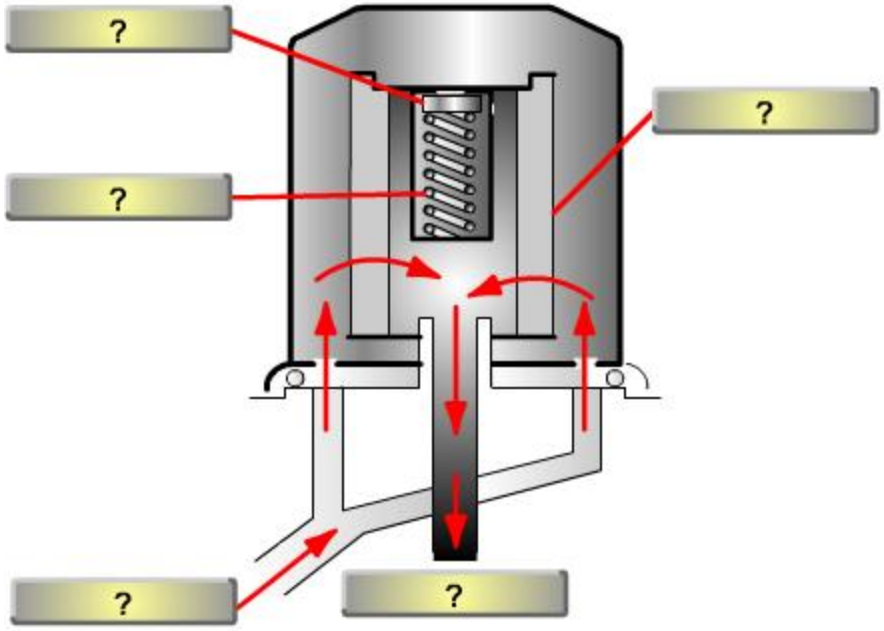
- The Oil Filter is used to capture small particles of metal, dirt, and other debris. Keeps the engine oil clean to reduce wear and increase oil life.
- All of the oil that exits the pump is pumped through the filter. 100%

Filter Types



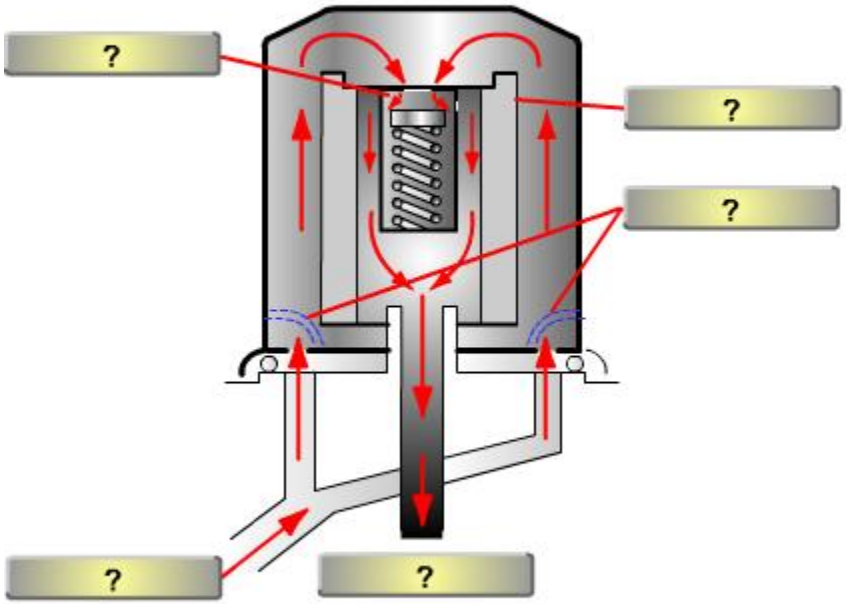
- Cartridge:
  - Only includes the filter element is replaced.
  - The housing has the bypass valve, drain valve, and anti-drainback valve.
- Canister:
  - Includes element, all valves.

Bypass Valve



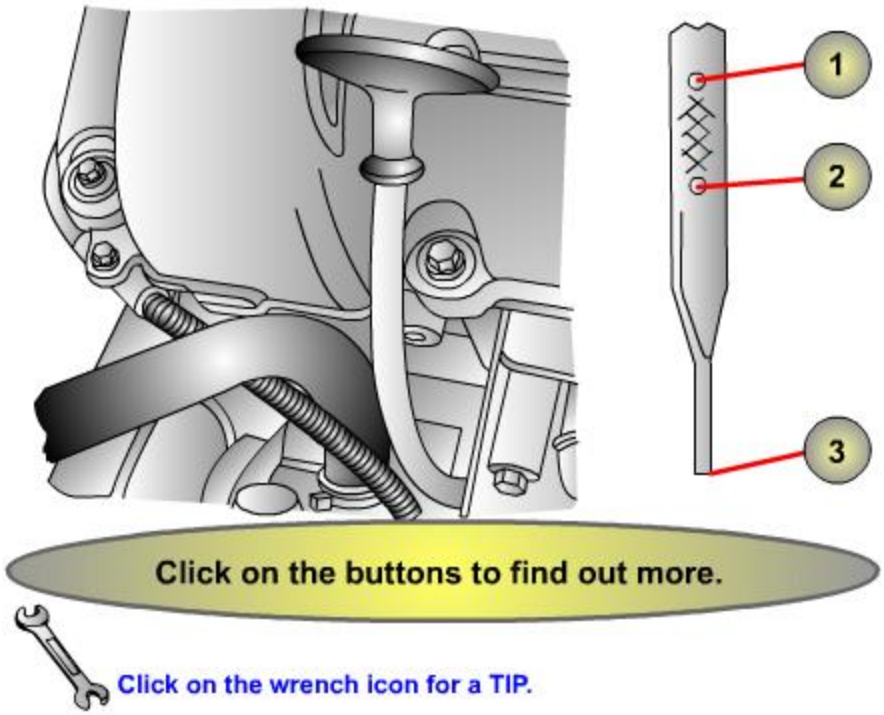
- In the event of a high pressure differential the Bypass Valve opens allowing unfiltered oil to continue to galley.
- Dirty oil is better than no oil.
- When can an engine have a high pressure differential?

Anti-Drainback Valve



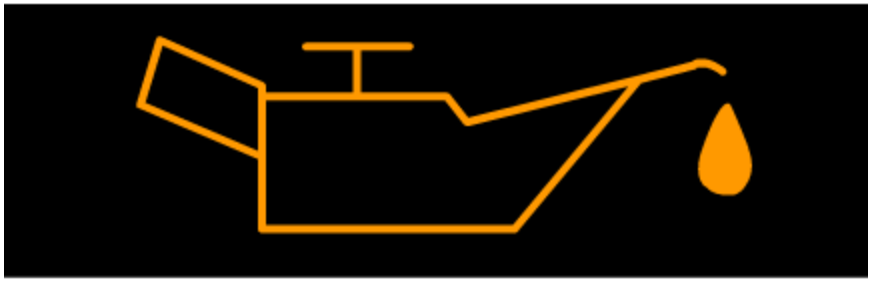
- When the engine is shut off the oil has a tendency to fall to the pan. This may drain the galleys of their oil. If the galleys can be filled, even partially, of oil the engine will have an easier start-up.
- The Anti-Drainback valve is used to keep the oil in the filter and in the galleys.
- If there is no valve the engine oil pump would have to fill the filter and the galleys before the bearings got any oil.

Dip Stick



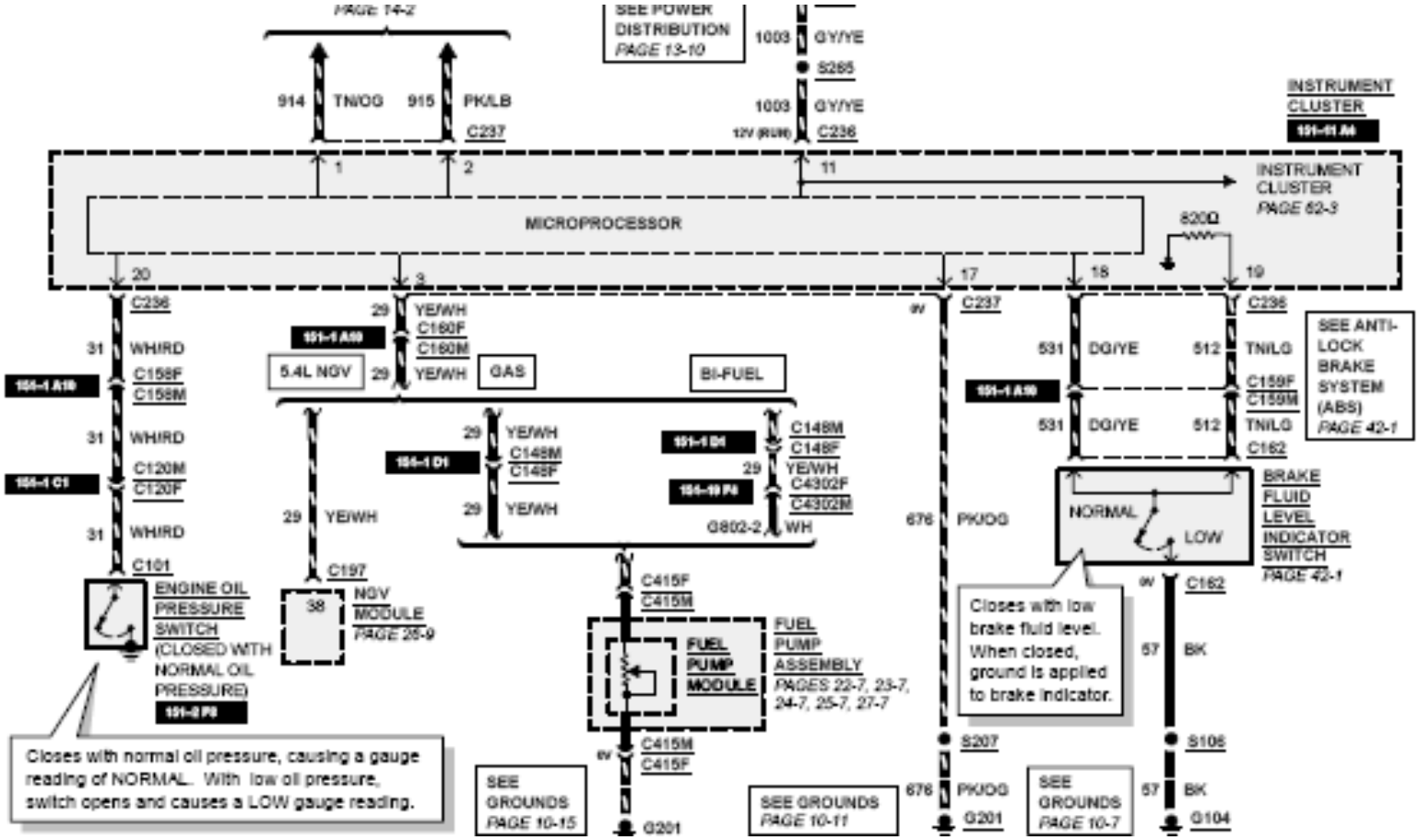
- The oil Dipstick is used to measure the oil level in the sump.
- The engine oil level can be anywhere within the crosshatching or holes.
- Do not allow the engine to run either above or below the ranges.
- If above the crankshaft would churn the oil, this may cause engine runs rough.
- If below the oil pump may ingest air during high rpm operation.

Oil Pressure Indicator

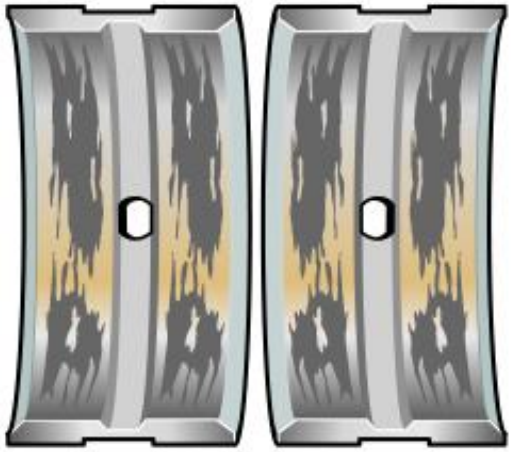


- The driver always has a way of determining engine oil pressure.
- Indicator light:
  - Only indicates when engine oil pressure is above 5-10psi.
- Gauge:
  - Only indicates when engine oil pressure is above 5-10psi.
- Types of sending unit:
  - Piezo-resistive
  - Pressure switch.

Oil Pressure Gauge

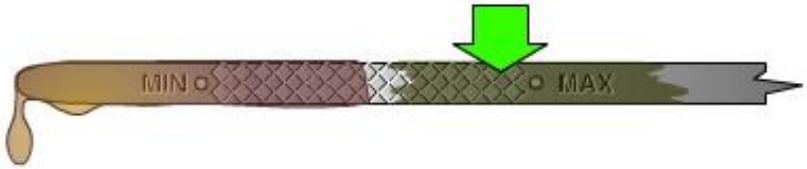


Engine Damage



- Engine damage can be due to many factors:
  - Lack of oil
  - Improper oil
  - Contaminated oil

Engine Damage



- Insufficient oil is the most common cause of engine damage. Can be caused by improper maintenance, oil leaks, or engine burning oil.
- Lack of maintenance can be found if there is a varnish on the dipstick above the oil lines.

Engine Damage

- Contaminated oil:
  - Oil smells of fuel. Excess fuel is entering the crankcase.
  - Oil is thick and gooey. Water/coolant has entered the crankcase.