Automotive Engines

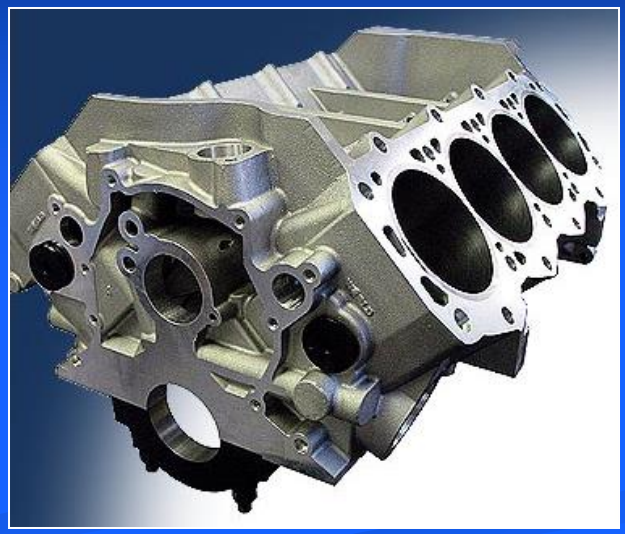
Engine Block & Cylinder Head Materials

- materials used in engine blocks and cylinder heads construction are…

Cast iron

- heavy
- inexpensive
- painted

fig. a

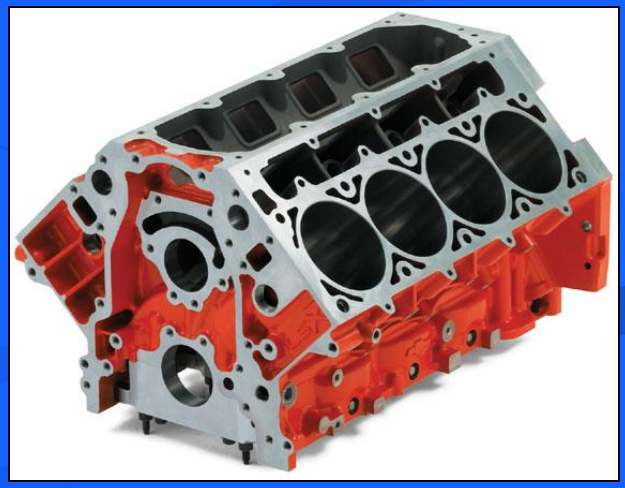


Aluminum

- lighter than cast iron
- $$$
- unpainted
- warps more readily when overheated

Magnesium has been used as well

- Porsche, Corvette, VW, BMW, Mitsubishi
- lighter than aluminum



engines can be manufactured with…

- all cast iron
- all aluminum or…
- cast iron block & aluminum head (fig. a)

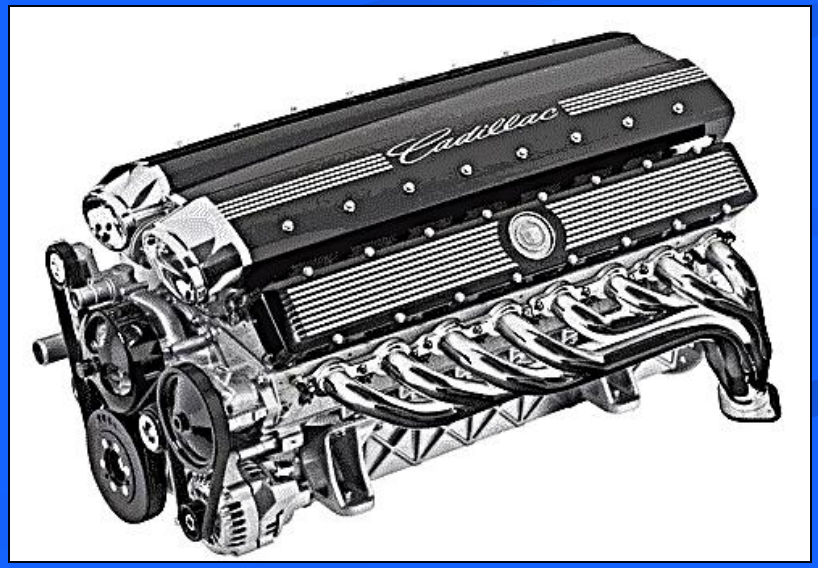
Engine Classification - Number of Cylinders

Gasoline & diesel engines may have…

- 2 cylinders – Citroen
- 3 cylinders – Smart ForTwo, Chevy Sprint/Geo Metro
- 4 cylinders
- 5 cylinders – Audi, GM & Volvo
- 6 cylinders
- 8 cylinders

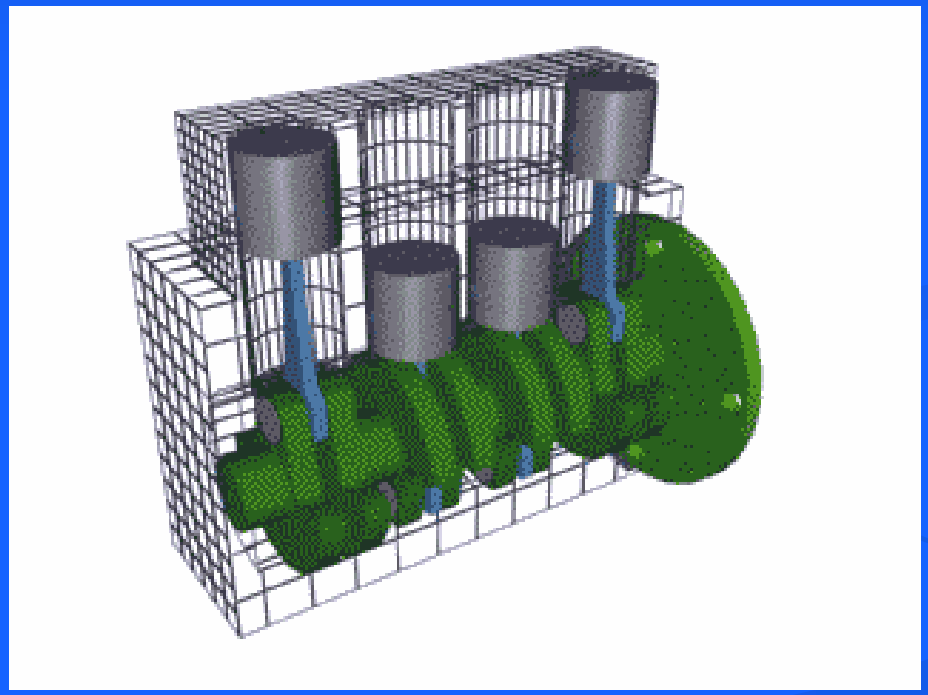
Engine Classification - Number of Cylinders

- 10 cylinders – Dodge Viper, Ford Pickups
- 12 cylinders – Jaguar, Ferrari, Lamborghini
- 16 cylinders - Cadillac



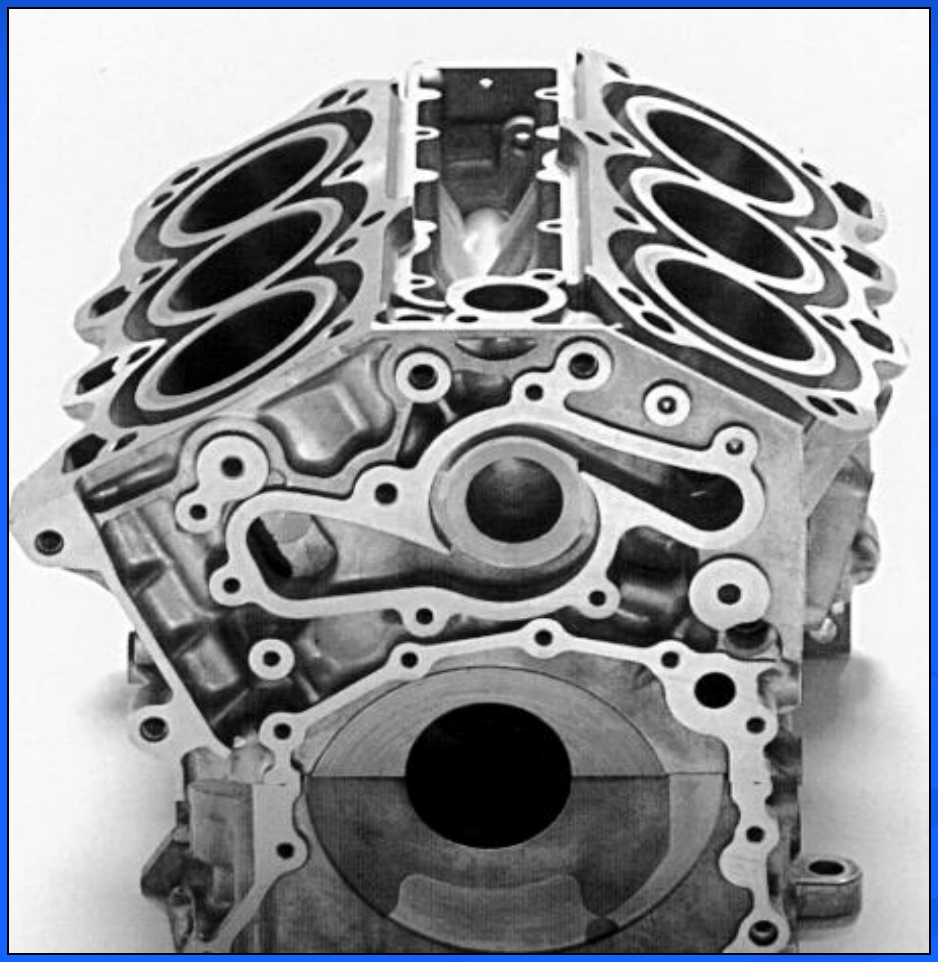
Engine Classification - Cylinder Arrangement

- cylinders can be arranged in-line



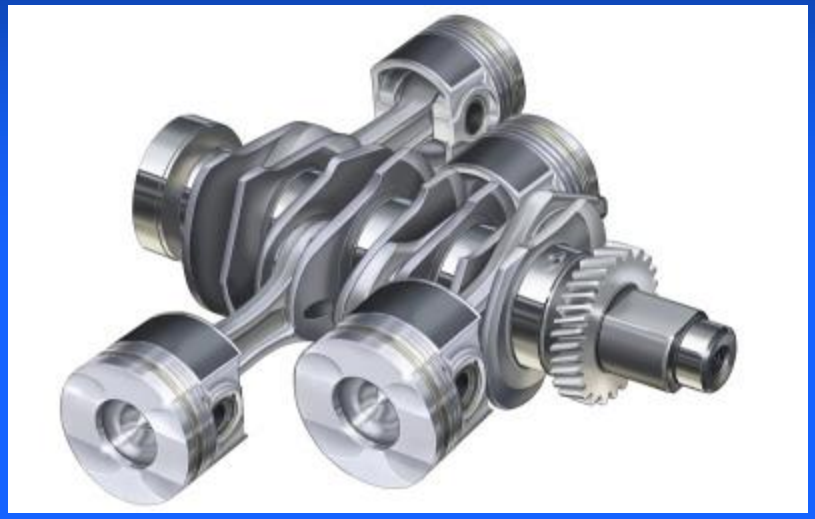
Engine Classification - Cylinder Arrangement

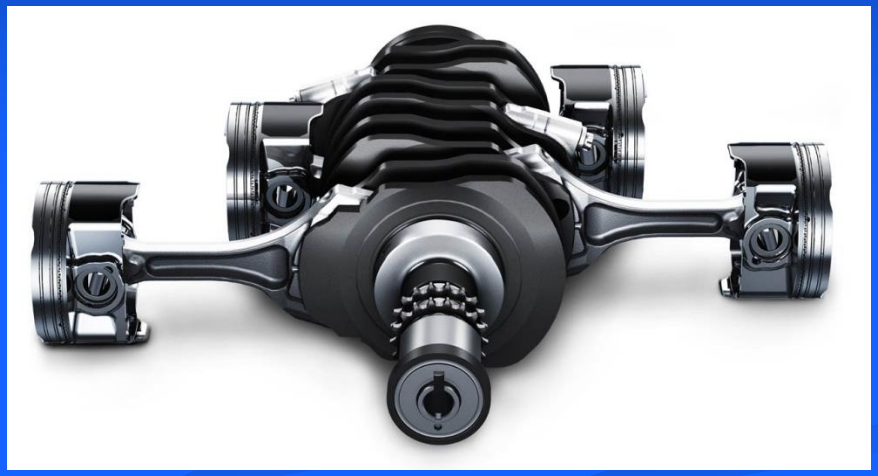
- cylinders can be arranged in a "V" formation
- more compact package than an in-line engine
- "V" angle can be 45°, 60° or 90°

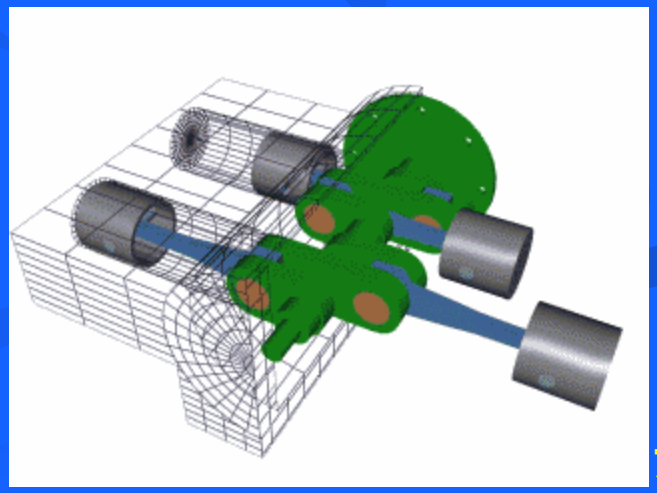


Engine Classification - Cylinder Arrangement

- cylinders can be arranged horizontally
- Subaru, VW & Porsche 911 (aka: opposed or boxer engine)
  - low center of gravity





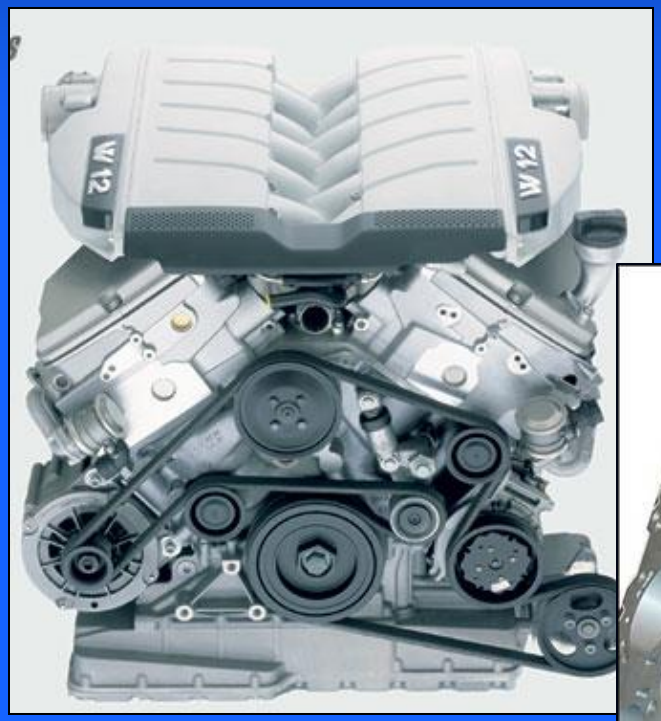


Engine Classification - Cylinder Arrangement

- Volkswagen's VR6 engine ("inline V")
  - narrow 15° V
  - one cylinder head
  - 2 camshafts instead of 4

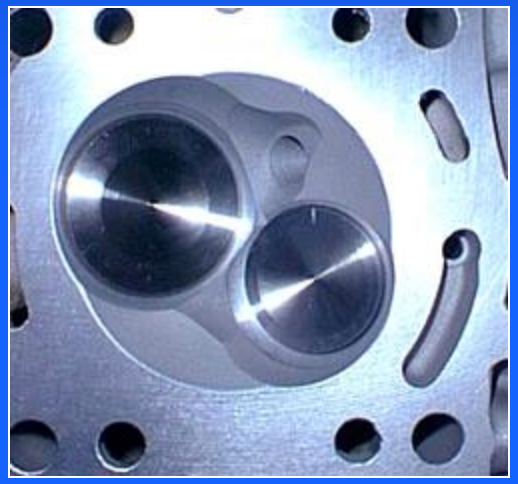
Engine Classification - Cylinder Arrangement

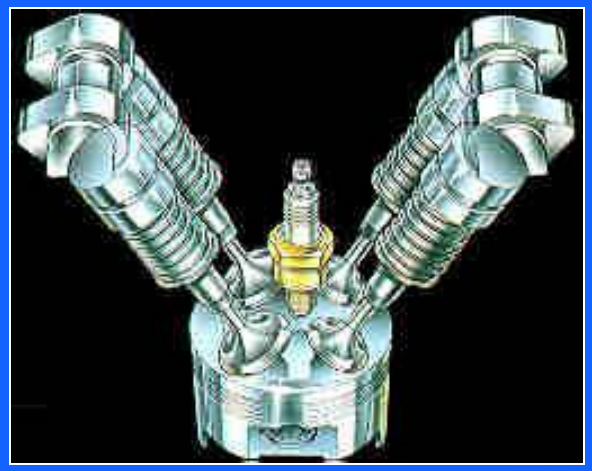
- cylinders can be arranged in a "W" formation
- more compact than a traditional V engine
- Volkswagen also has a W8 and W16
- Bentley & Bugatti have W16 and W18



Engine Classification - Valve Arrangements

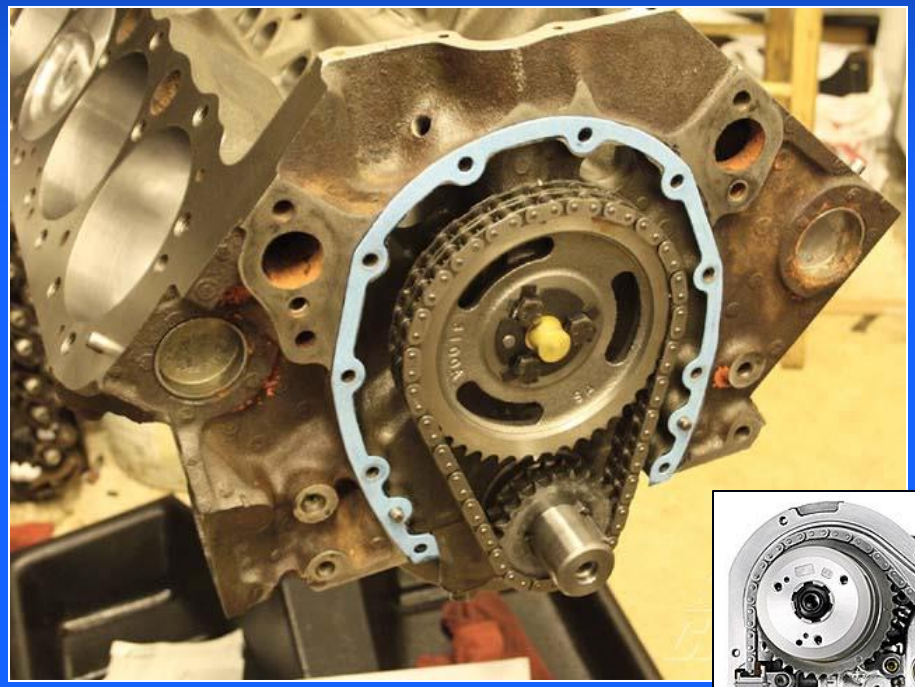
- most of today's engines use more than 2 valves per cylinder
- to improve volumetric efficiency, cylinder heads may have…
  - 2 intakes & 1 exhaust
  - 2 intakes & 2 exhaust
  - 3 intakes & 2 exhaust

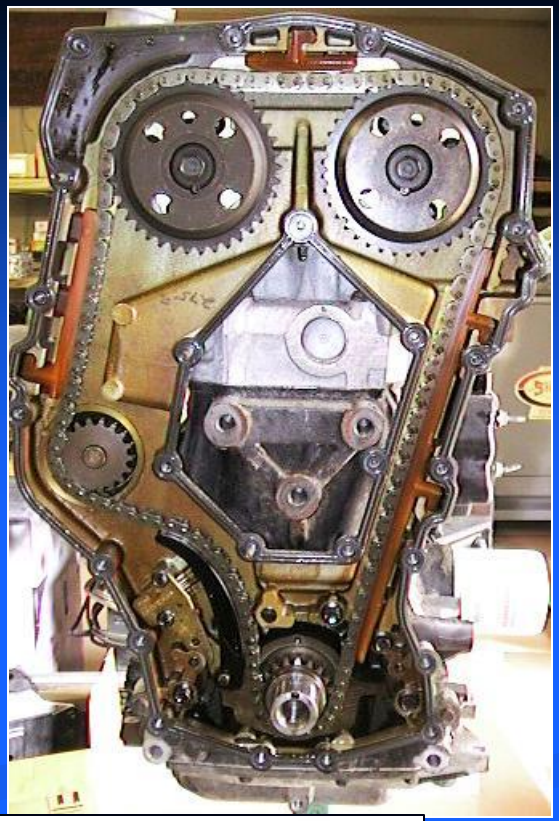


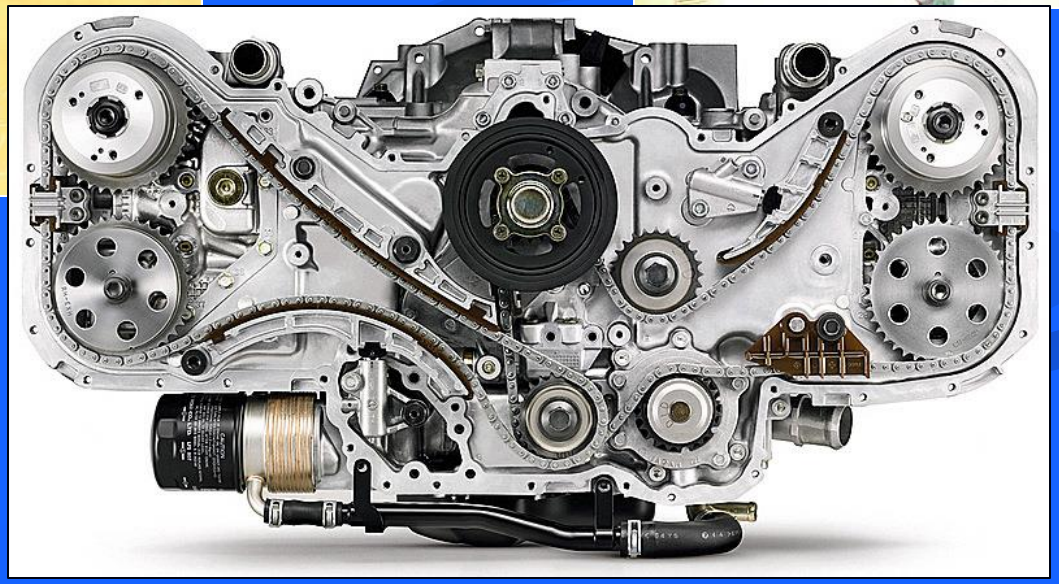


Camshaft Drives – 1 of 3

- the camshaft is always mechanically connected to the crankshaft
- this can be accomplished with either a timing chain
- camshaft gear will always be twice as big as the crankshaft gear

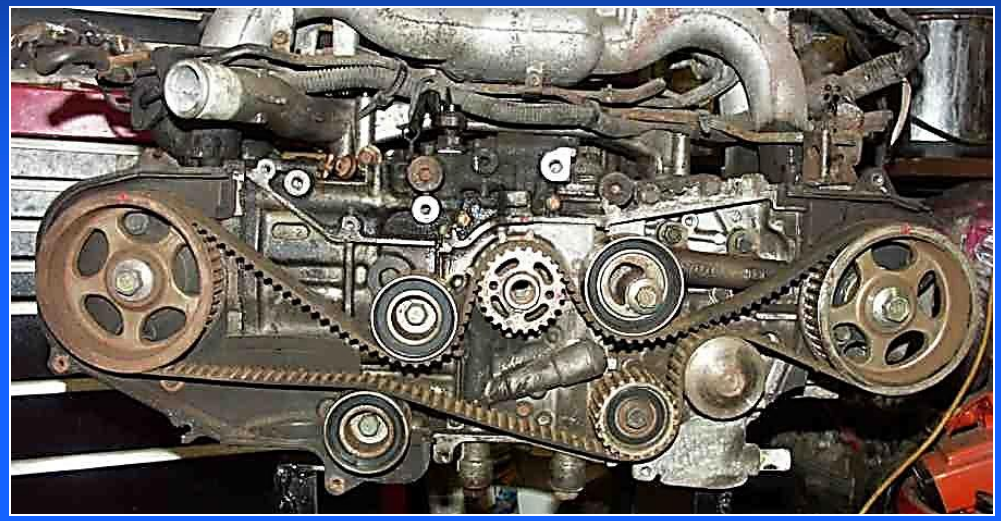


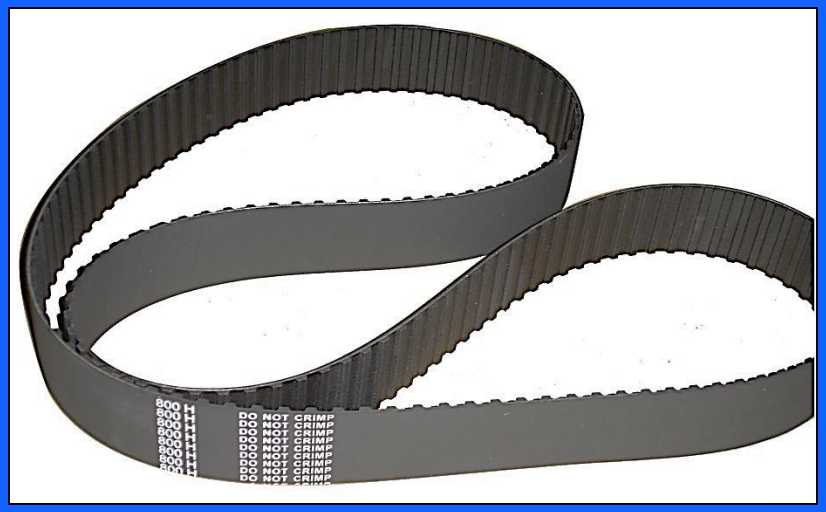




Camshaft Drives – 2 of 3

- **timing belt**



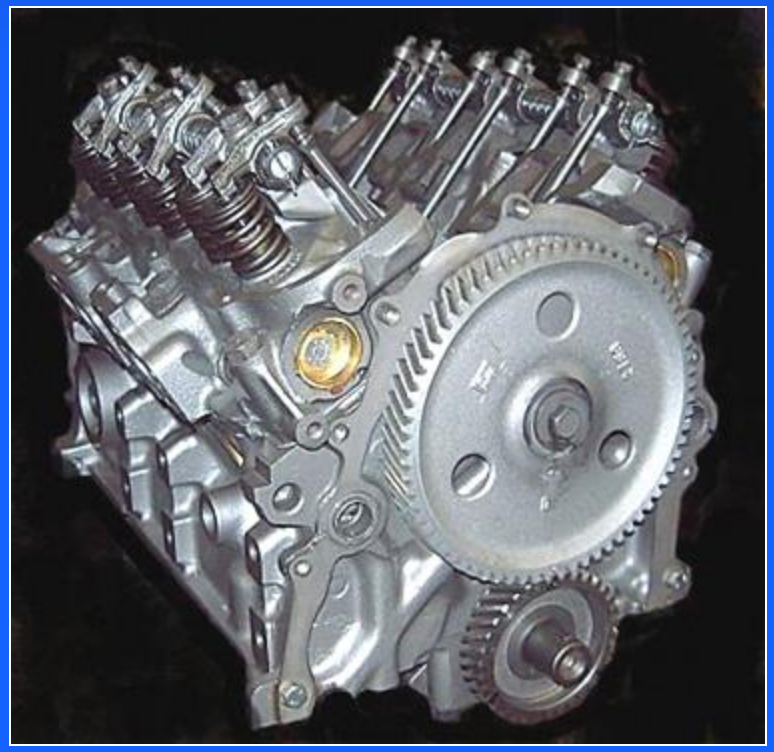


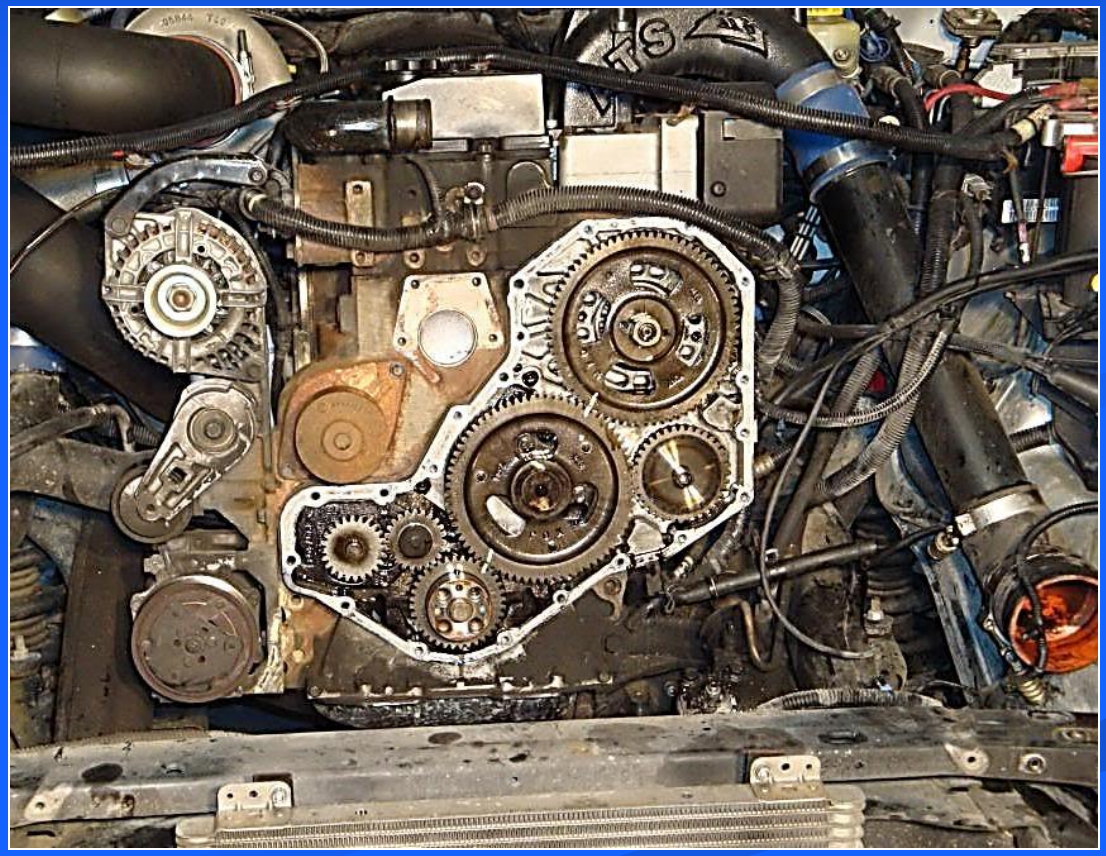
Camshaft Drives – 2 of 3

- timing belt – must be changed at specified intervals
  - usually every 100,000 km but this varies

Camshaft Drives – 3 of 3

- timing gears
  - tend to be noisy
  - excellent durability
  - no scheduled replacement intervals





Interference Engines

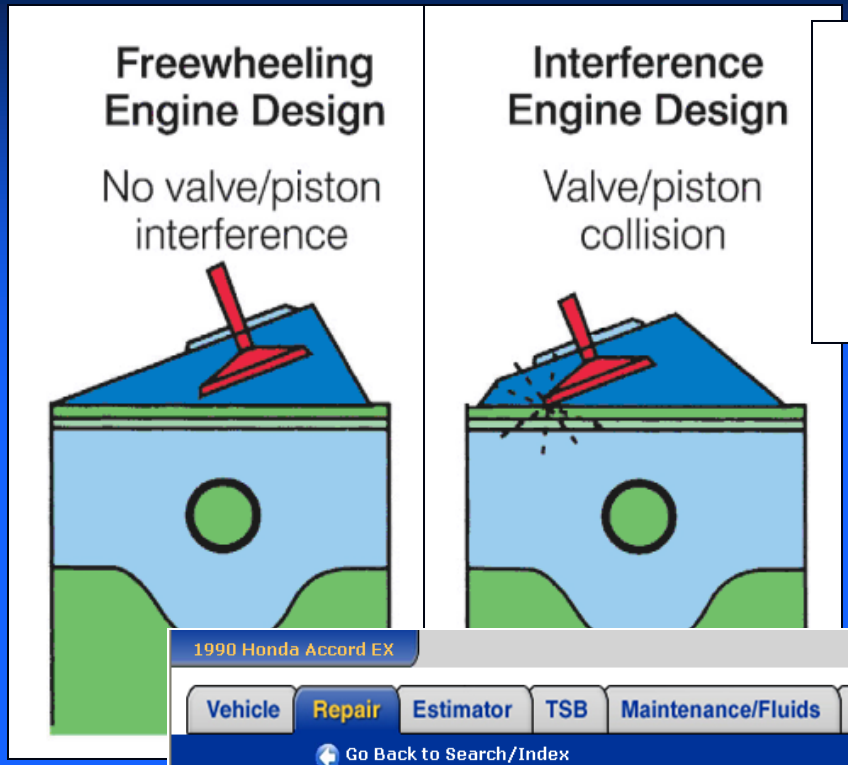


Figure 9–13 Many engines are of the interference design. If the timing belt (or chain) breaks, the piston still moves up and down in the cylinder while the valves remain stationary. With a freewheeling design, nothing is damaged, but in an interference engine, the valves are often bent.

1990 Honda Accord EX

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MANUFACTURER'S SUGGESTED SCHEDULED MAINTENANCE

For 1990-94 vehicles, the manufacturer recommends camshaft and balance shaft belts be replaced at 90,000 miles. For 1995-96 vehicles, the manufacturer recommends the belt be replaced at 90,000 miles for normal service or 60,000 miles for severe service.

For 1997 vehicles, normal replacement interval is at 105,000 miles or 84 months. Replace at 60,000 miles if car is regularly driven in extreme temperatures (over 110 degrees F, or under -20 degrees F).

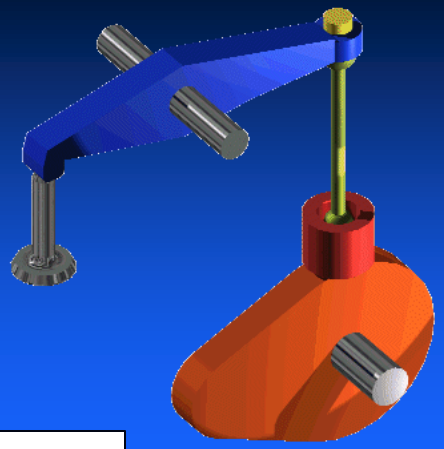
REMOVAL & INSTALLATION

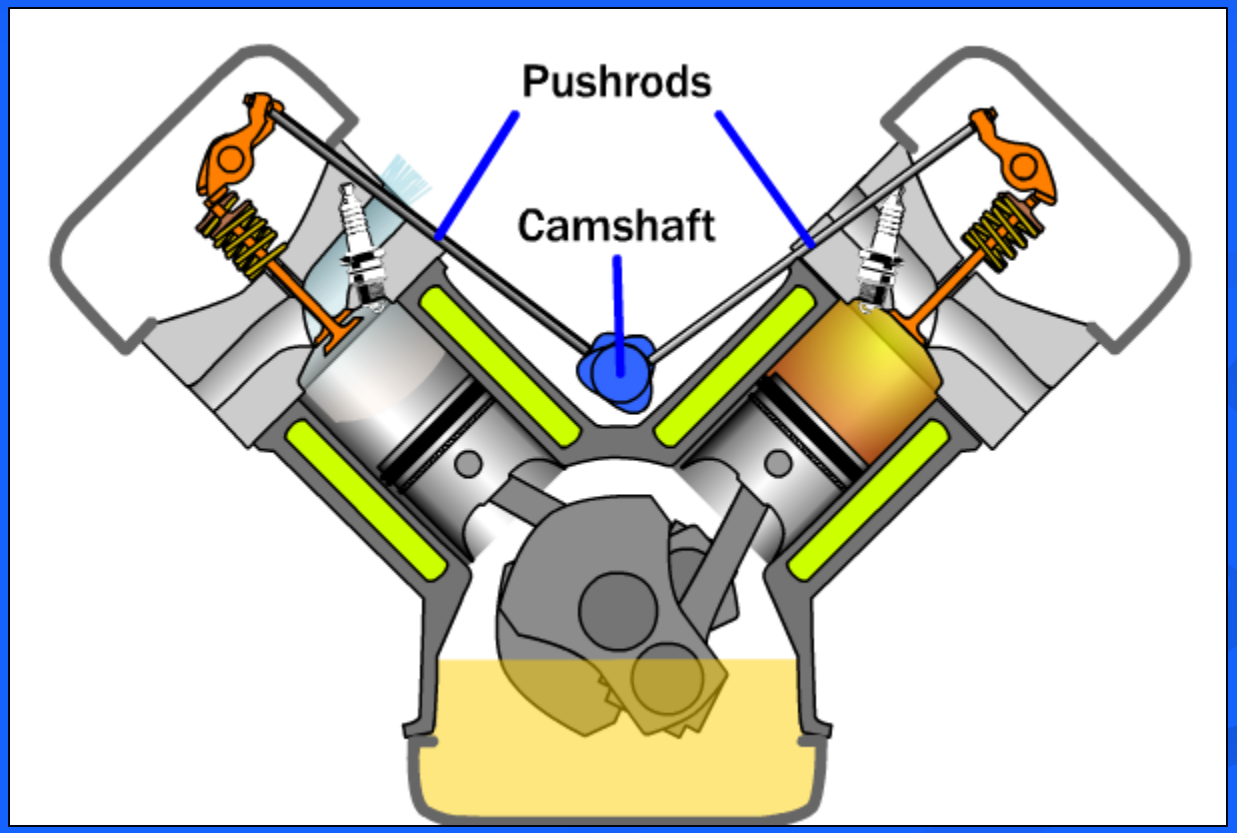
CAUTION: This application is an interference engine. Do not rotate camshaft or crankshaft when timing belt is removed, or engine damage may occur.

Camshaft Locations

1) cam-in-block:

- dated technology (but still widely used)
- more moving parts
- valve movement is less precise
- can be noisier due to additional moving parts

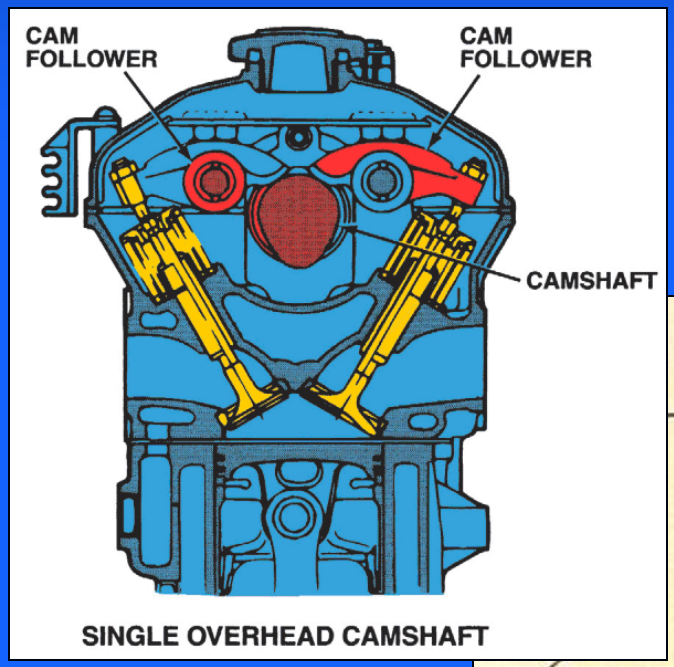




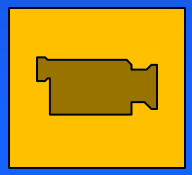
Camshaft Locations

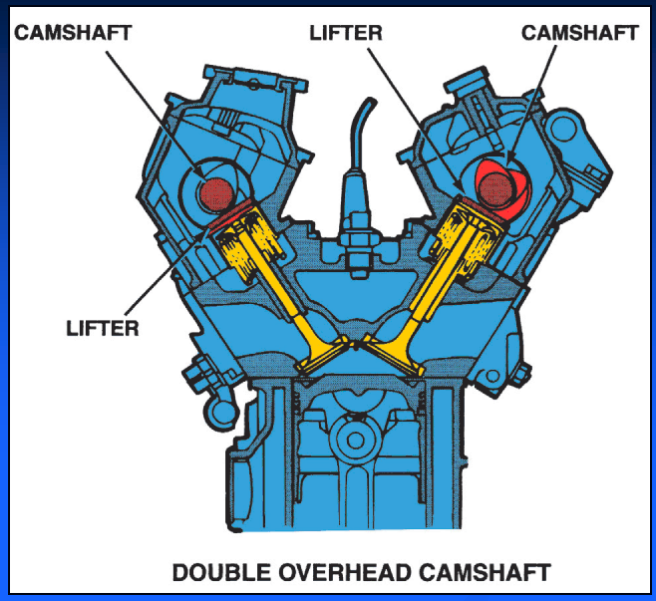
2) Overhead Camshaft:

- OHC, SOHC, DOHC
- more precise valve action
- has replaced cam-in-block

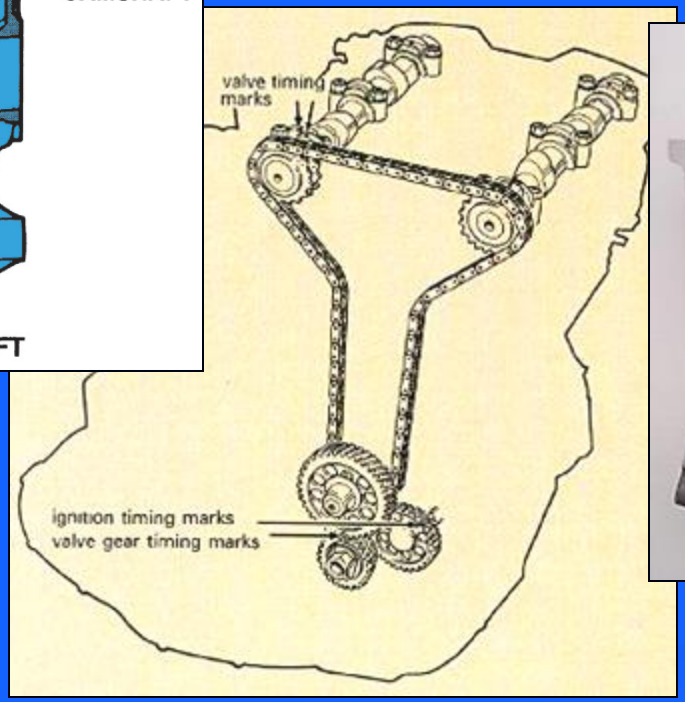


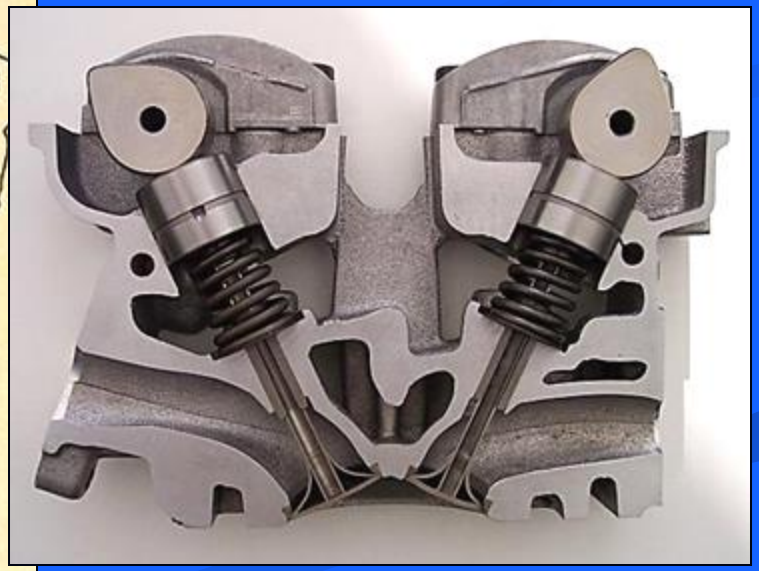
SINGLE OVERHEAD CAMSHAFT





DOUBLE OVERHEAD CAMSHAFT

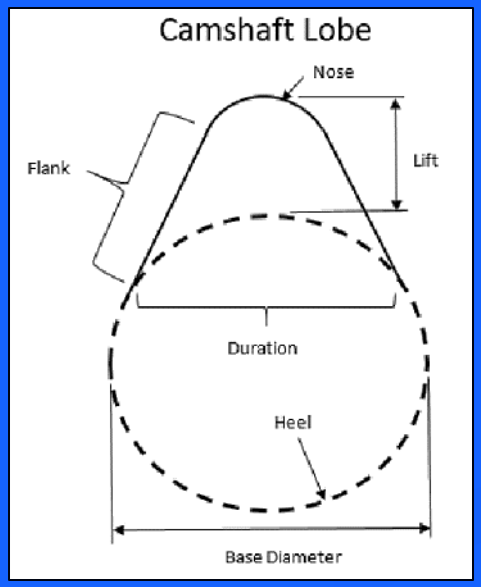




Variable Valve Timing - VVT

- to enhance breathing over a wider rpm range, and thereby increase torque, manufacturers may design engines with either a b, or c or a combination of either…

- a) variable valve opening timing
  - alters *when* valve opens
- b) variable valve lift
  - alters *how much* the valve opens
- c) duration
  - *how long* it opens



Variable Valve Opening Timing

- when the valves open, in relation to the crankshaft's position, can be altered according to the needs of the engine

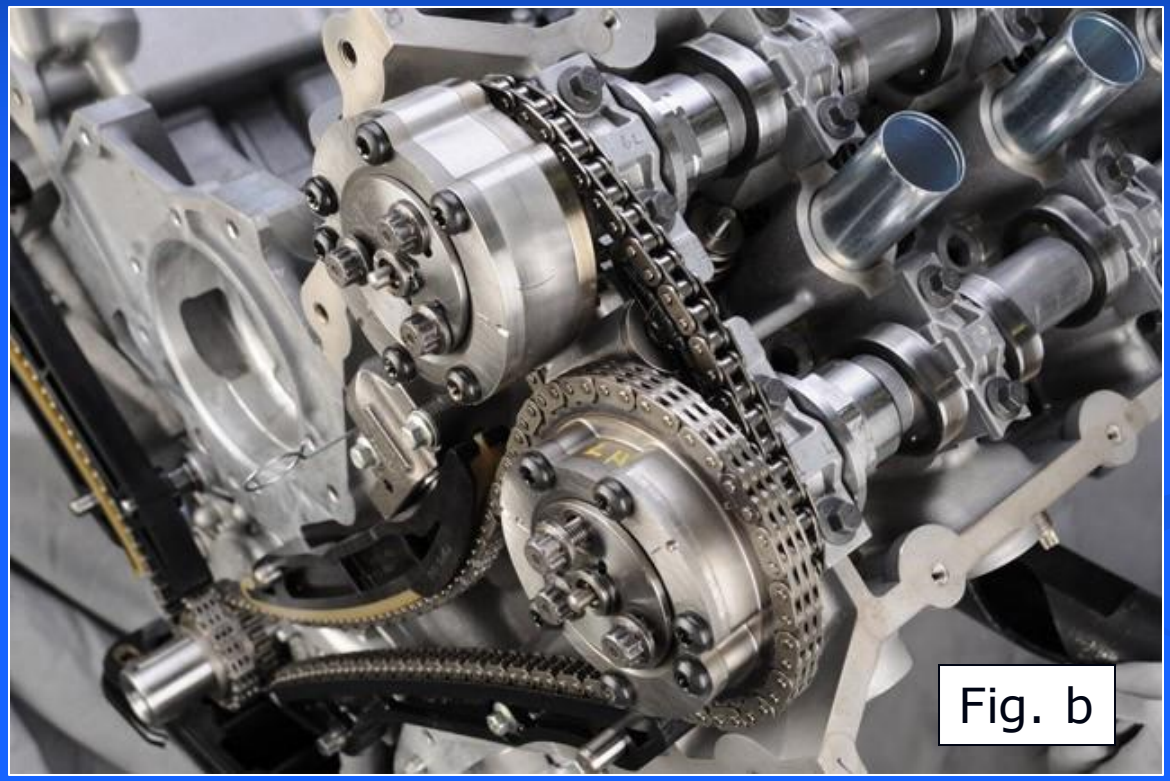


Fig. b

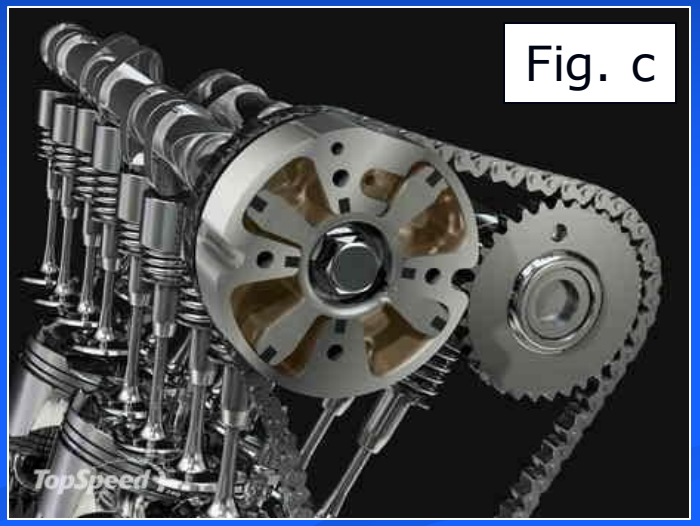
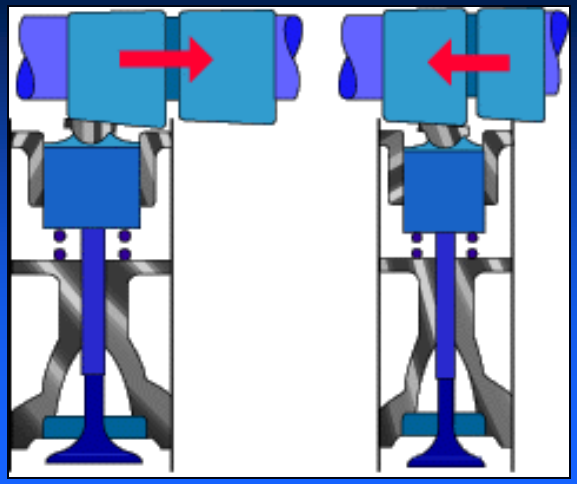
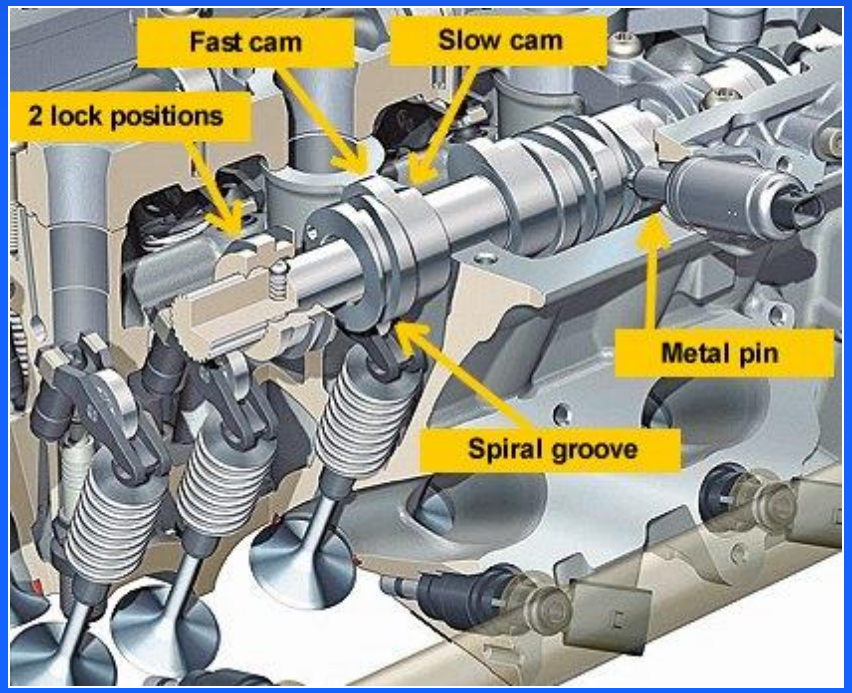


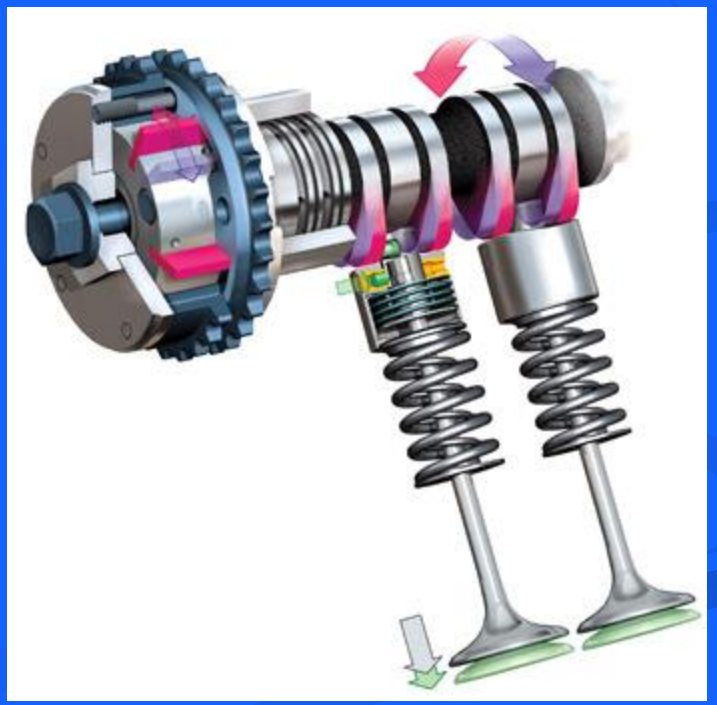
Fig. c

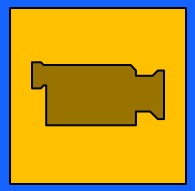
Variable Valve Lift

- variable valve lift
  - *how much* the valve opens

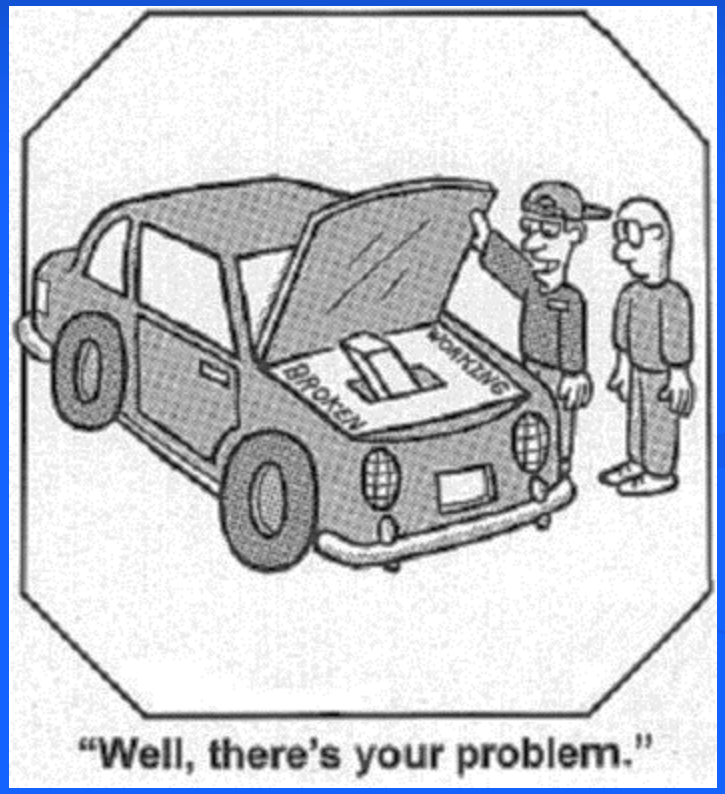






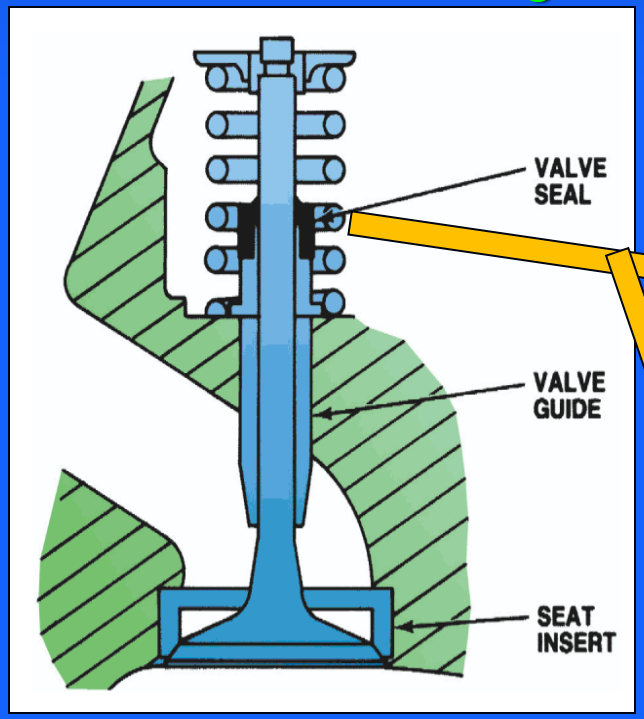


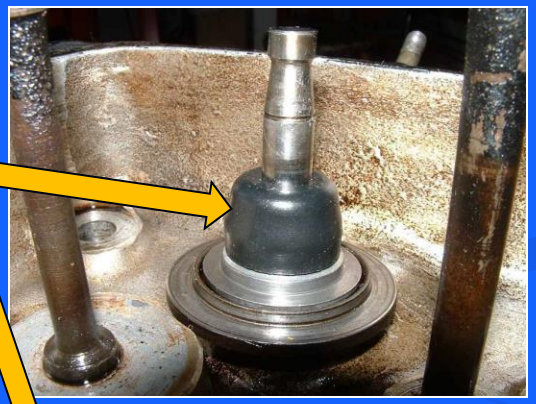
Engine Problem Diagnosis

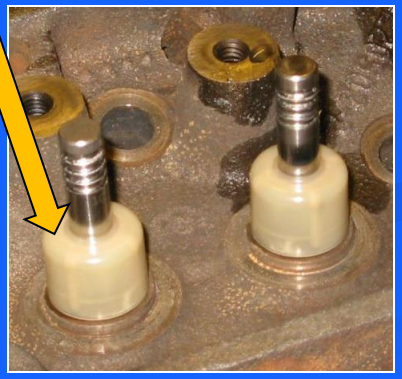


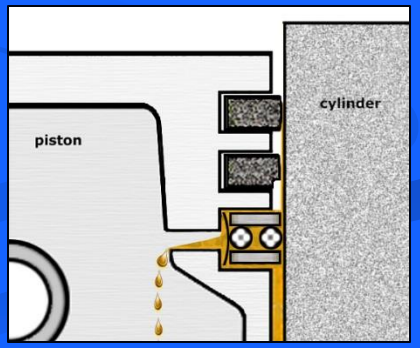
Blue Exhaust Smoke

- oil entering the combustion chamber & burning along with air-fuel mixture
  - worn valve seals and or worn valve guides
    - usually noticeable on initial start-up
    - noticeable on standard transmission equipped vehicles when changing gears
  - worn oil control rings and, or cylinder walls

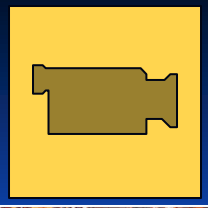




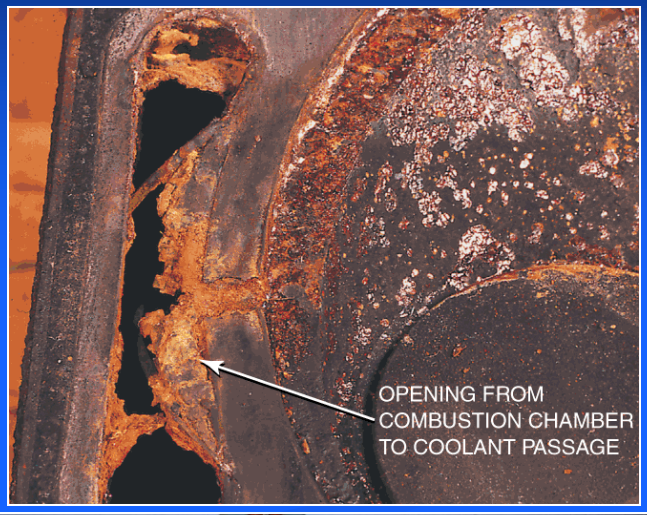


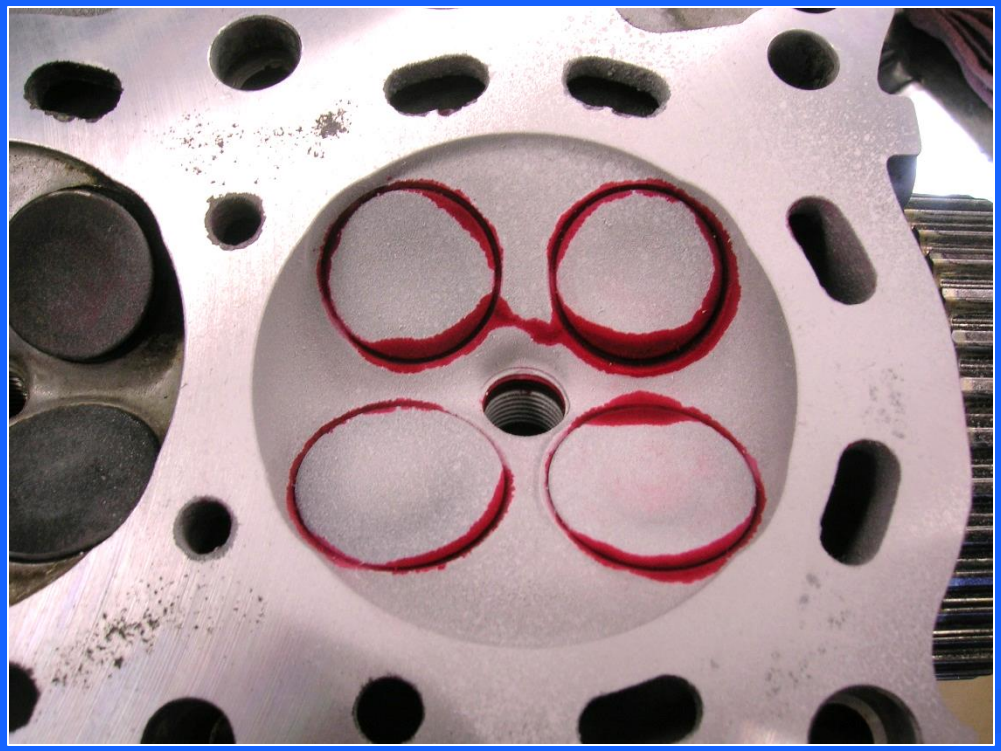


White Exhaust Smoke



- (excessive amounts): coolant entering combustion chamber & burning
  - "blown" cylinder head gasket
    - usually the result of an overheated engine
  - crack in cylinder head or possibly engine block





Checking Cylinder Heads for Cracks…

- if cracks are suspected, head(s) will have to be checked
  - aluminum: checked with a dye (fig. a)
  - cast iron: "Magnafluxing" (magnetic particle inspection) makes cracks visible
  - pressure testing will produce bubbles from the cracks (fig. c)

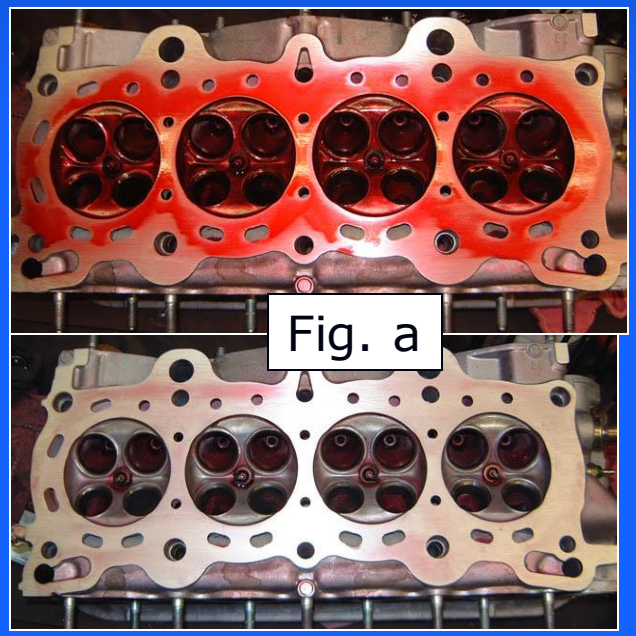


Fig. a

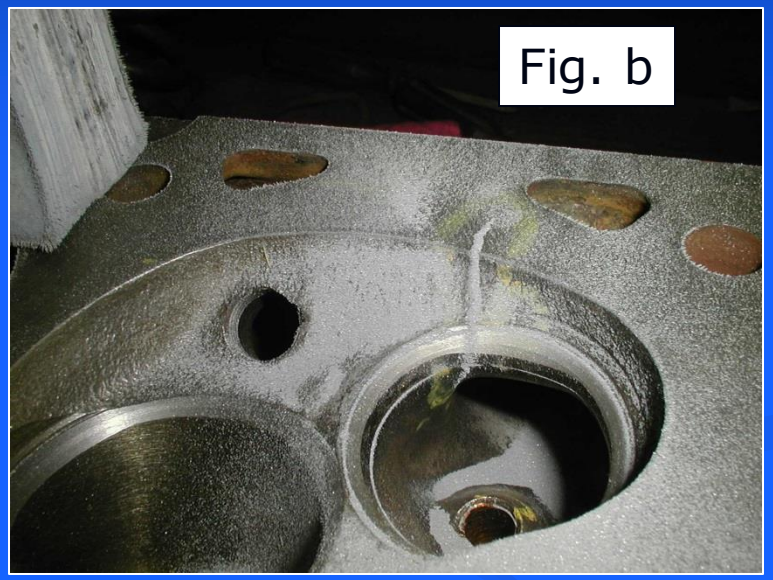
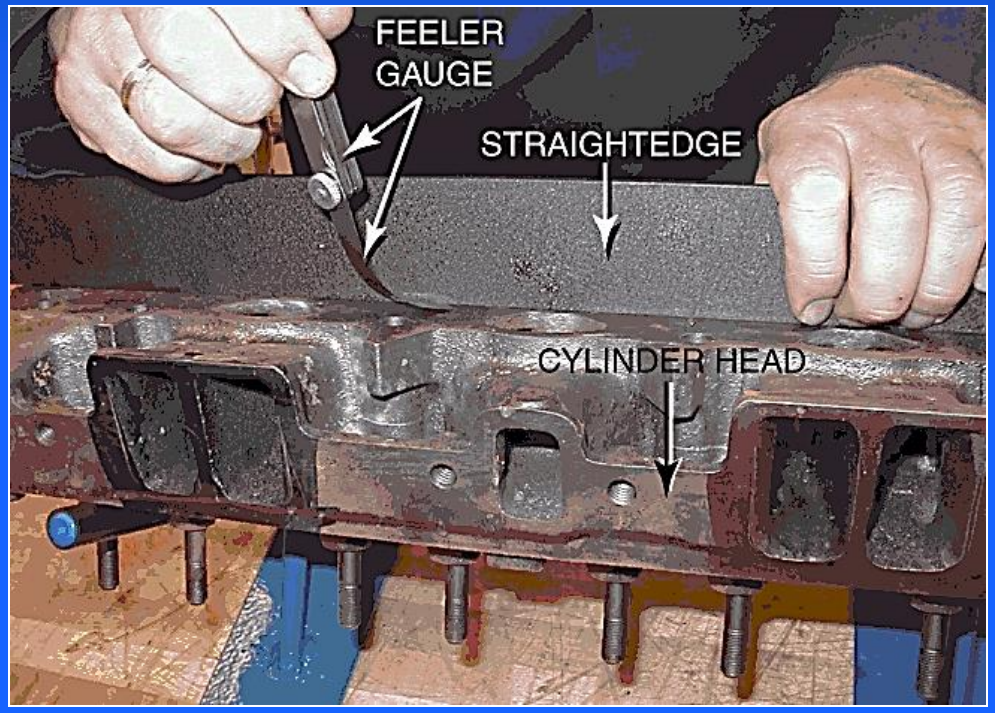


Fig. b

Fig. c

Cylinder Head Surface

- cylinder heads should always be checked for *warpage* with a machinist's straight edge & feeler gauge
  - excessive warpage will require re-surfacing



Noises

- **ticking sound: valve train noise**
  - **solid lifters: adjust valves (fig. a)**
    - require adjustment at each tune-up
    - similar to small engines
  - **hydraulic lifters: replace (figs. b & c)**
    - quieter than solid lifters
    - should not require periodic adjustment

Fig. a

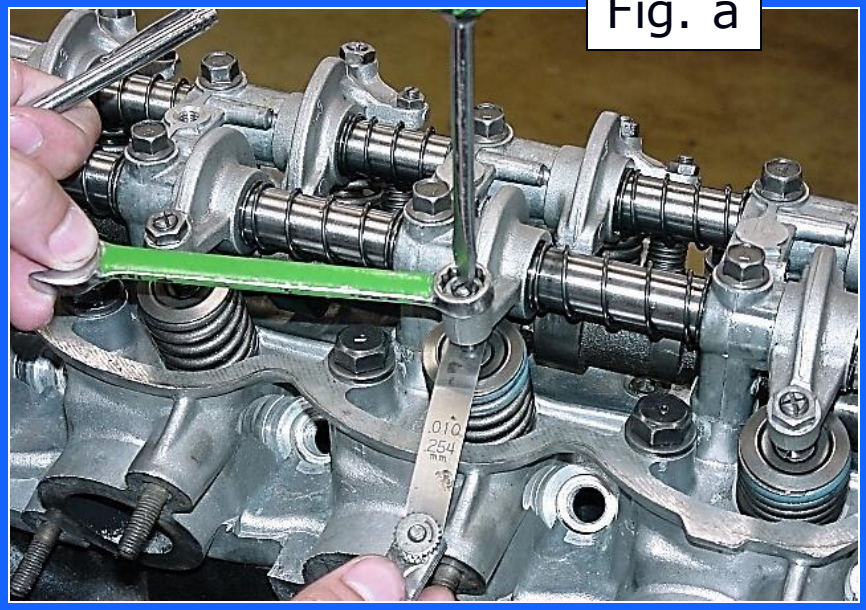
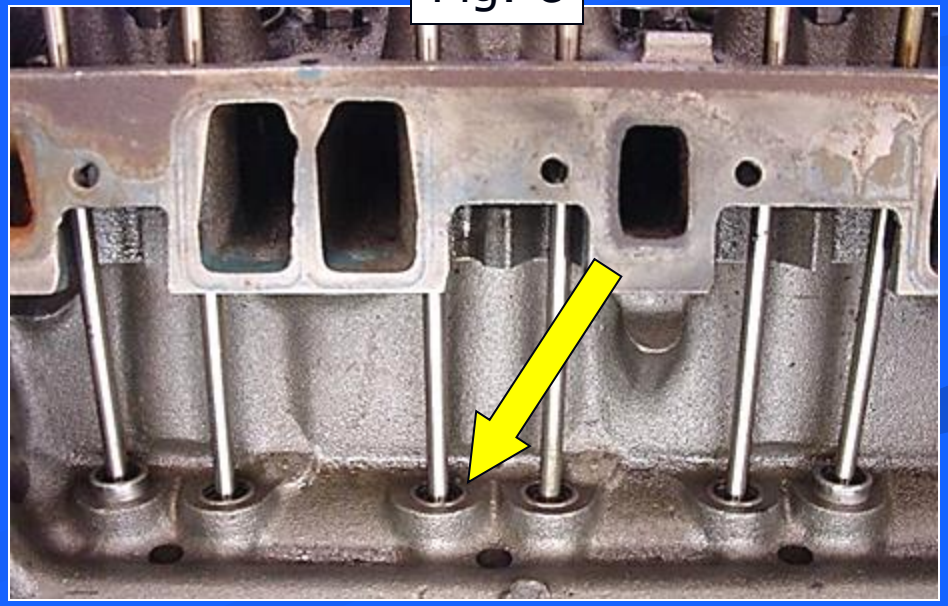
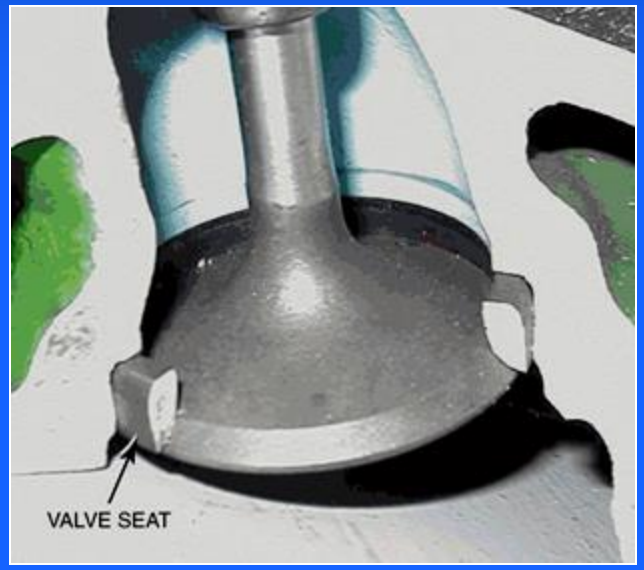


Fig. c



Poor Performance

- low compression
  - valve and seat problems
  - cylinder & compression ring wear



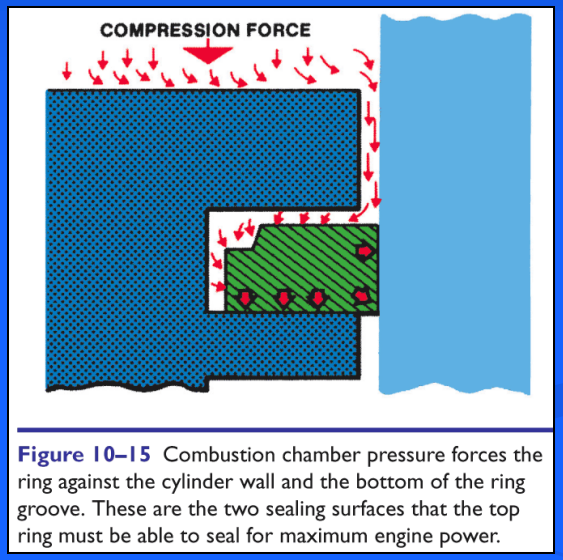


Figure 10–15 Combustion chamber pressure forces the ring against the cylinder wall and the bottom of the ring groove. These are the two sealing surfaces that the top ring must be able to seal for maximum engine power.

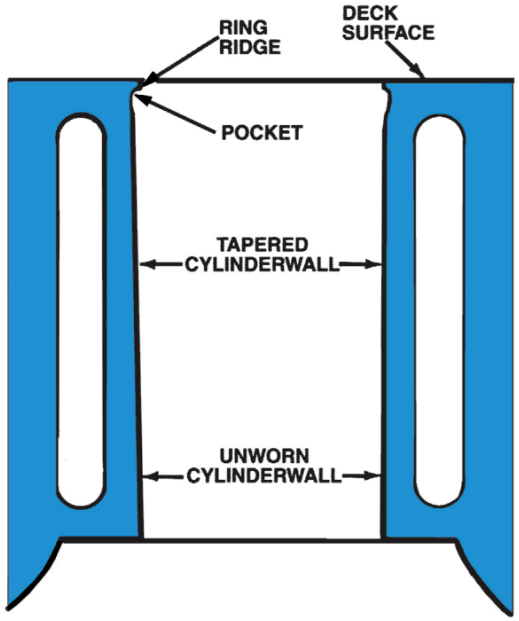
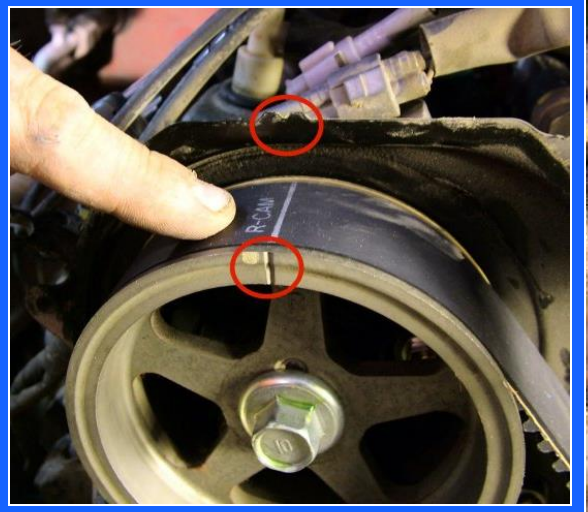
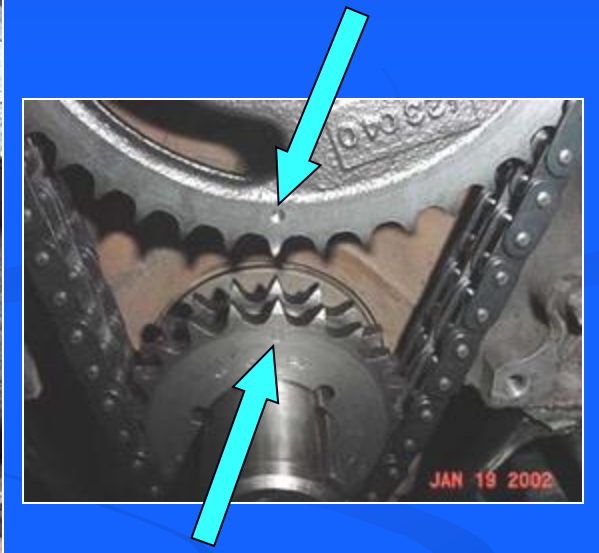


Figure 11–14 Cylinders wear in a taper, with most of the wear occurring at the top where the greatest amount of heat is created under the ridge that is not worn by the rings.

Poor Performance

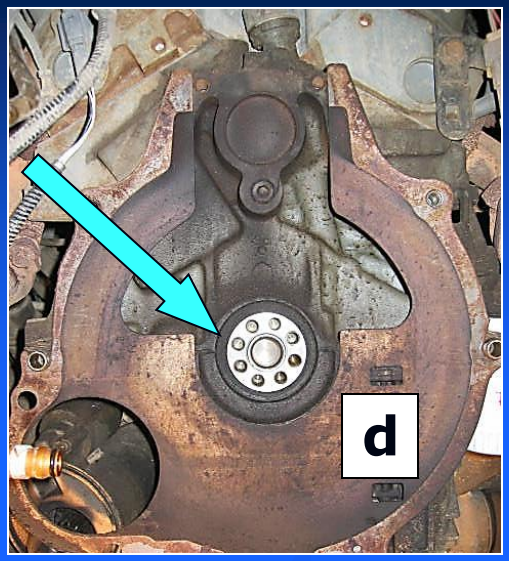
- can also be caused by…
  - camshaft drives that are out of time
    - usually caused by worn components that have “jumped a tooth”
  - Remember: cam and crank MUST be timed precisely on all engines!!!

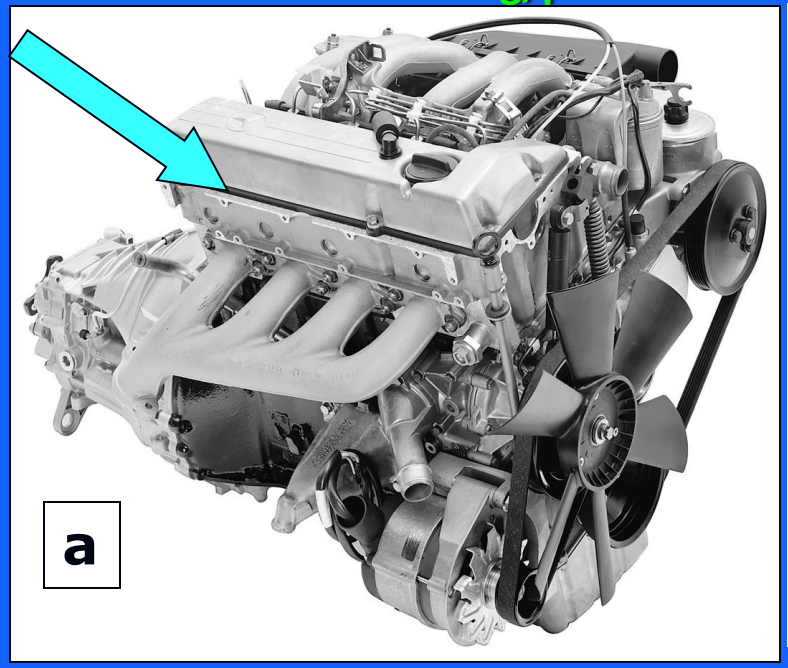


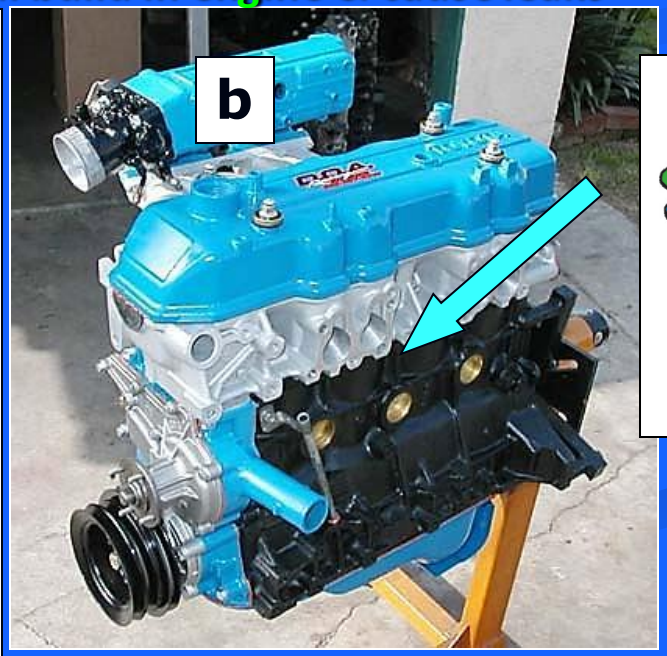


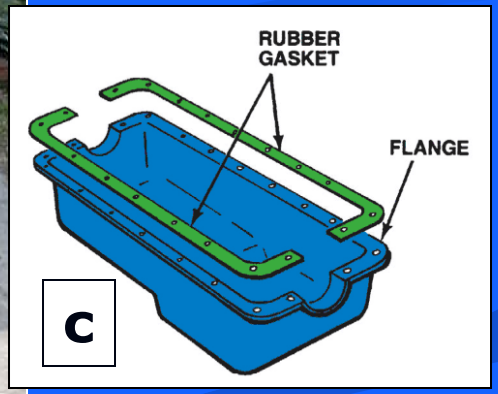
Engine Oil Leaks

- always investigate oil leaks "top down"
  - valve cover[s] (a)
    - students can confuse this for head gasket
  - cylinder head gasket (b)
  - oil pan gasket (c)
  - front crankshaft seal
  - rear crankshaft seal (d)
- steam clean the engine first
- test PCV system – valve, hose etc.
  - if it's not working, pressure will build in engine & cause leaks









Valve Service

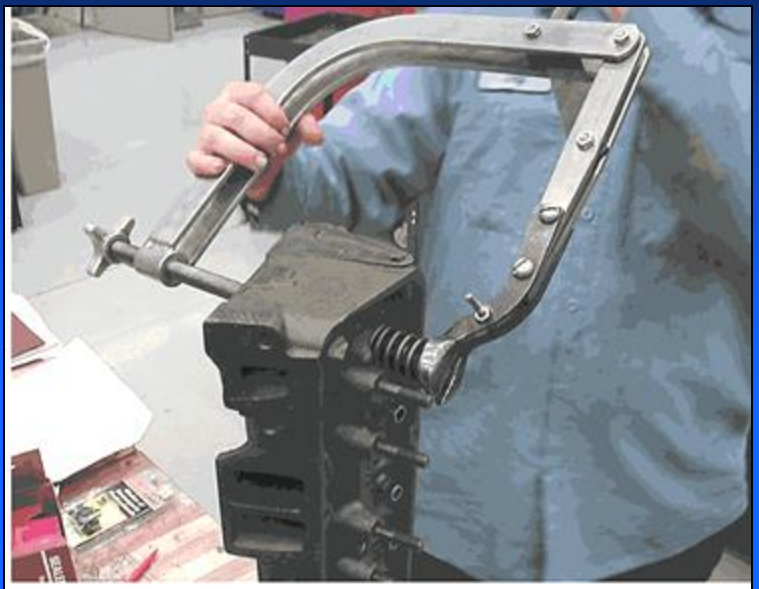


Figure 6–13 A valve spring compressor being used to remove the valve keepers (locks).

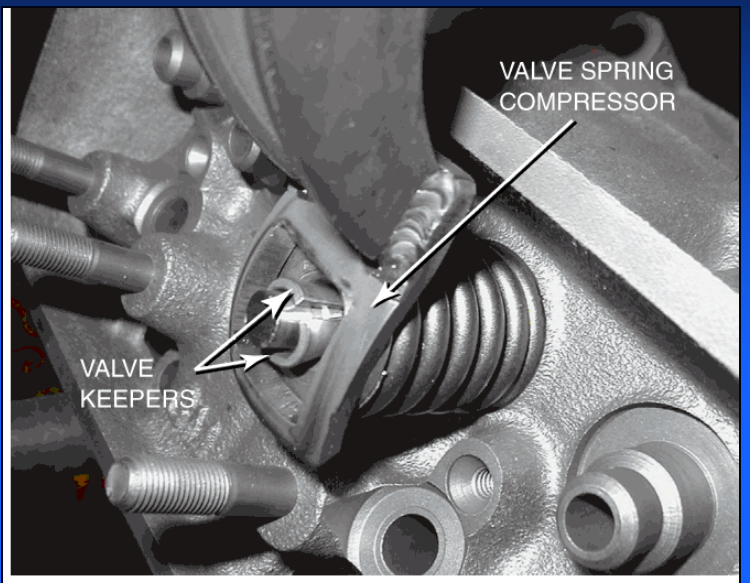


Figure 8–10 A valve spring compressor is used to compress the valve spring before removing the keepers (locks).

Figure 6–14 After removing this intake valve, it became obvious why this engine had been running so poorly.