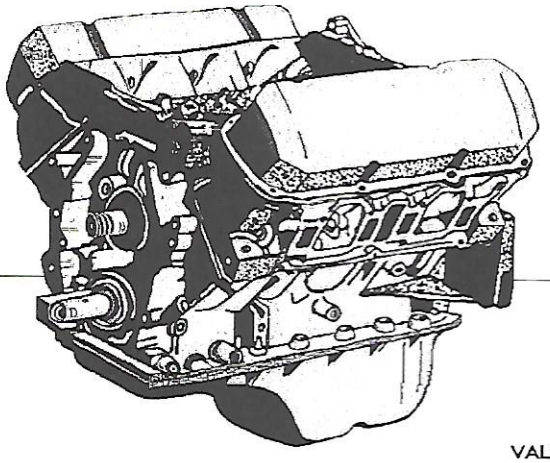
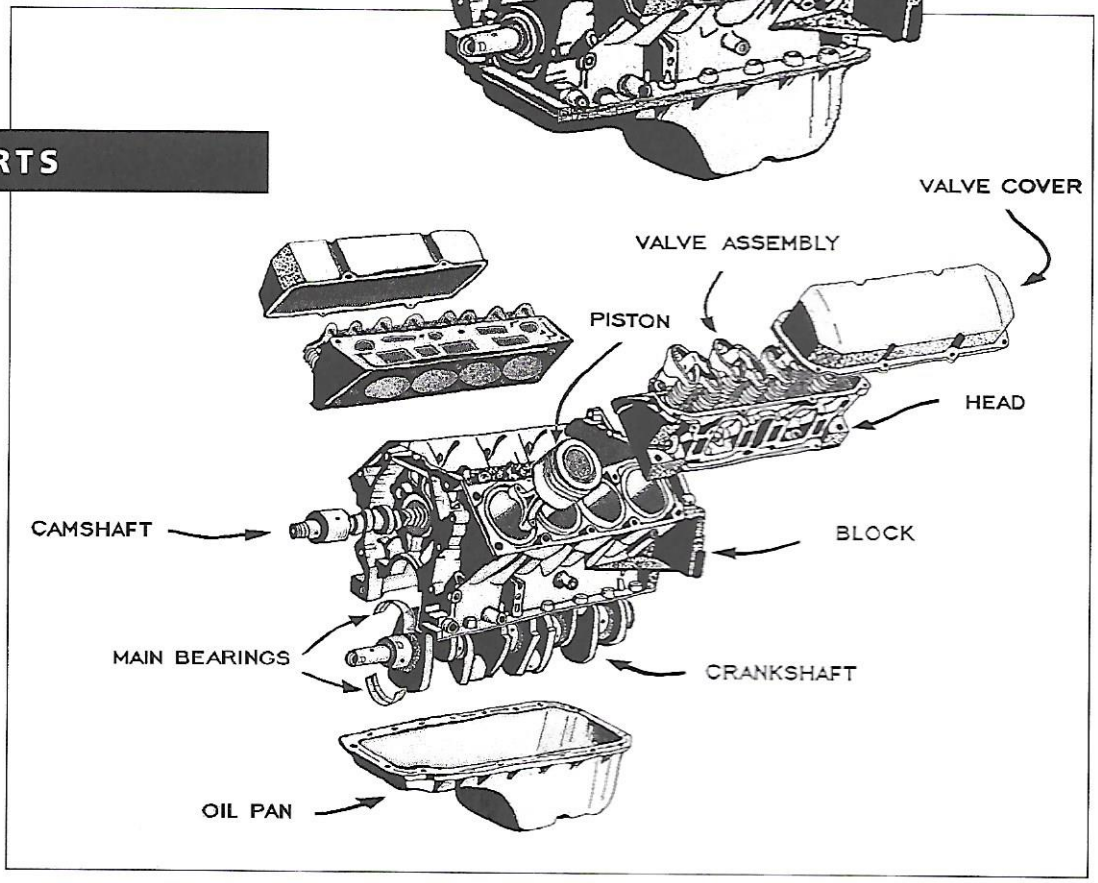
CHAPTER ONE

Engine

This chapter explains how automobile engines work. The illustration below shows the basic parts of a "V-8" *internal combustion* engine. Internal combustion means fuel burns inside an engine, in *combustion chambers*. Other types include the steam engine and the jet engine. Although there are many designs, the parts shown below are used in almost all automobile engines.



ENGINE PARTS

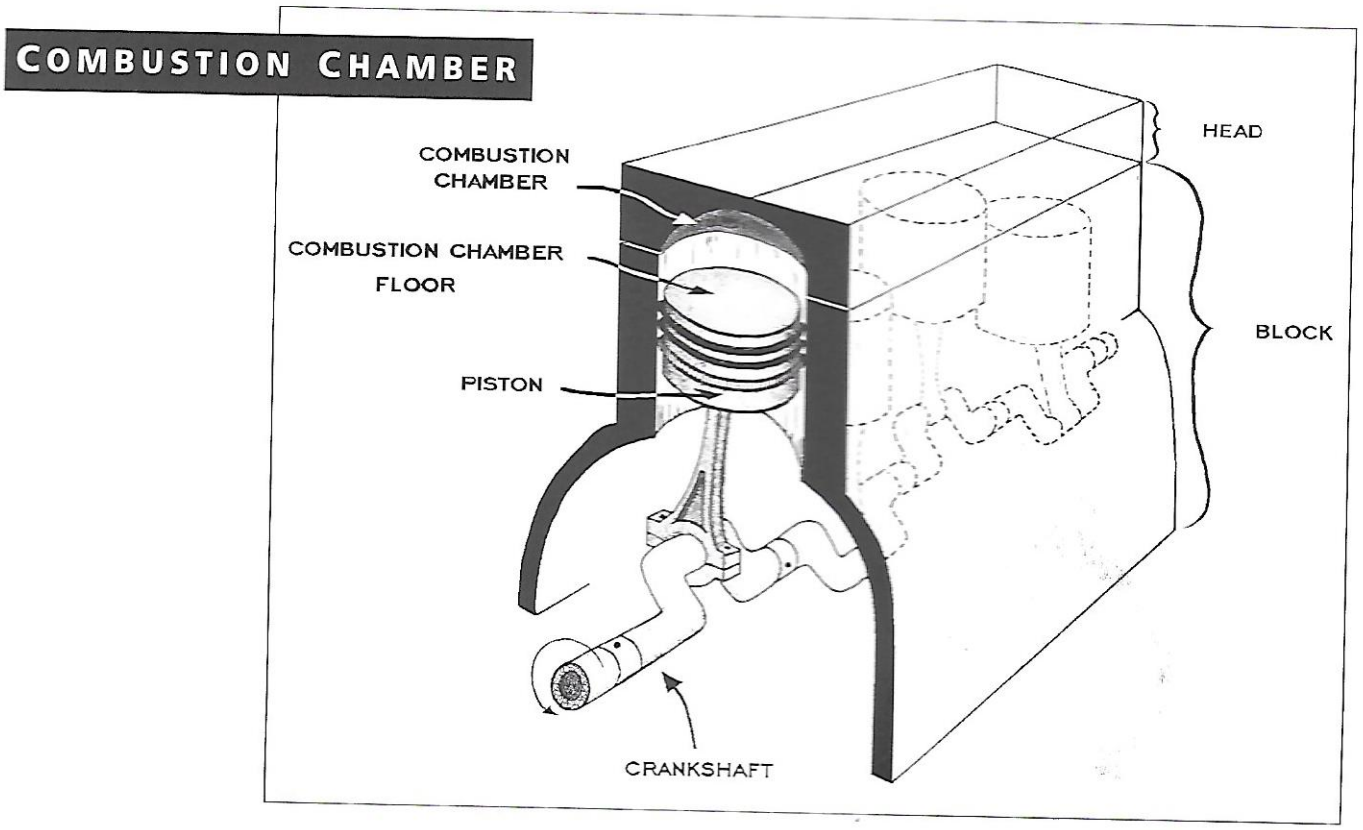


Combustion Chamber

Fuel burns in *combustion chambers* inside an engine. The walls and ceilings of these chambers are hollowed into an engine *head*. The floor of a combustion chamber is also the top of a *piston*, which moves up and down as an engine runs. One combustion chamber is directly above each *cylinder*, with a piston sliding in each cylinder. The explosive force created inside a combustion chamber pushes a piston down, creating the motion which moves a car.

As an engine runs, pistons pump up and down, one after another, in a carefully-arranged order. This up and down movement changes to spinning motion by the action of a *crankshaft*. The spin motion, or *angular momentum*, then rotates the wheels.

An automobile engine really has just one job—to create spinning motion.

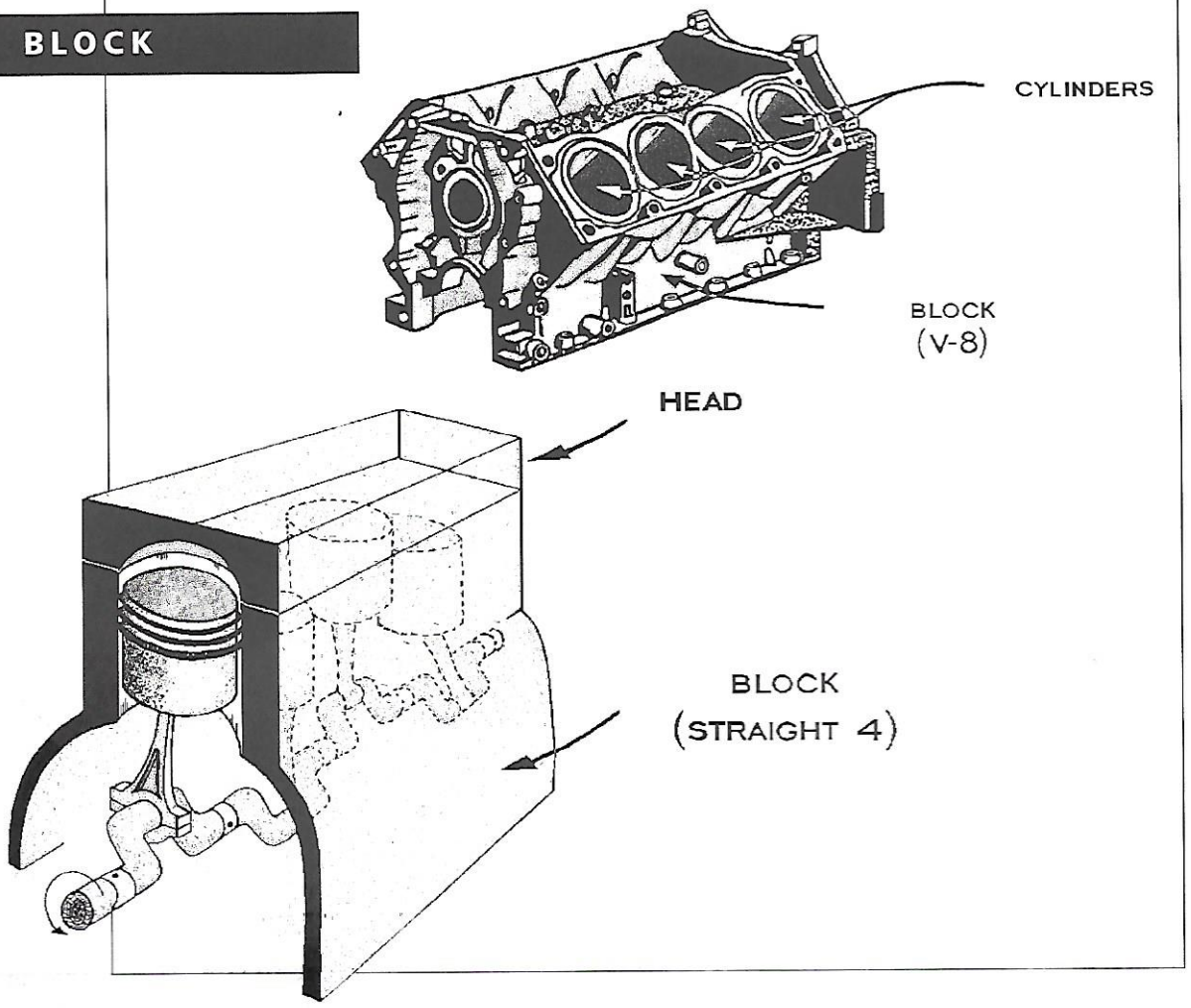


Block

An engine *block* is the most basic part of an engine. A block is a large casting of iron or aluminum with small passageways for oil and water circulation. A block itself, however, has no moving parts.

Several large holes or tubes, called *cylinders,* are built into each engine block. Pistons slide up and down in these cylinders and each engine will have the same number of cylinders, pistons, and combustion chambers. Automobile engines usually have four, six, or eight cylinders commonly arranged in either a straight line or a "V" shape (shown below).

ENGINE BLOCK



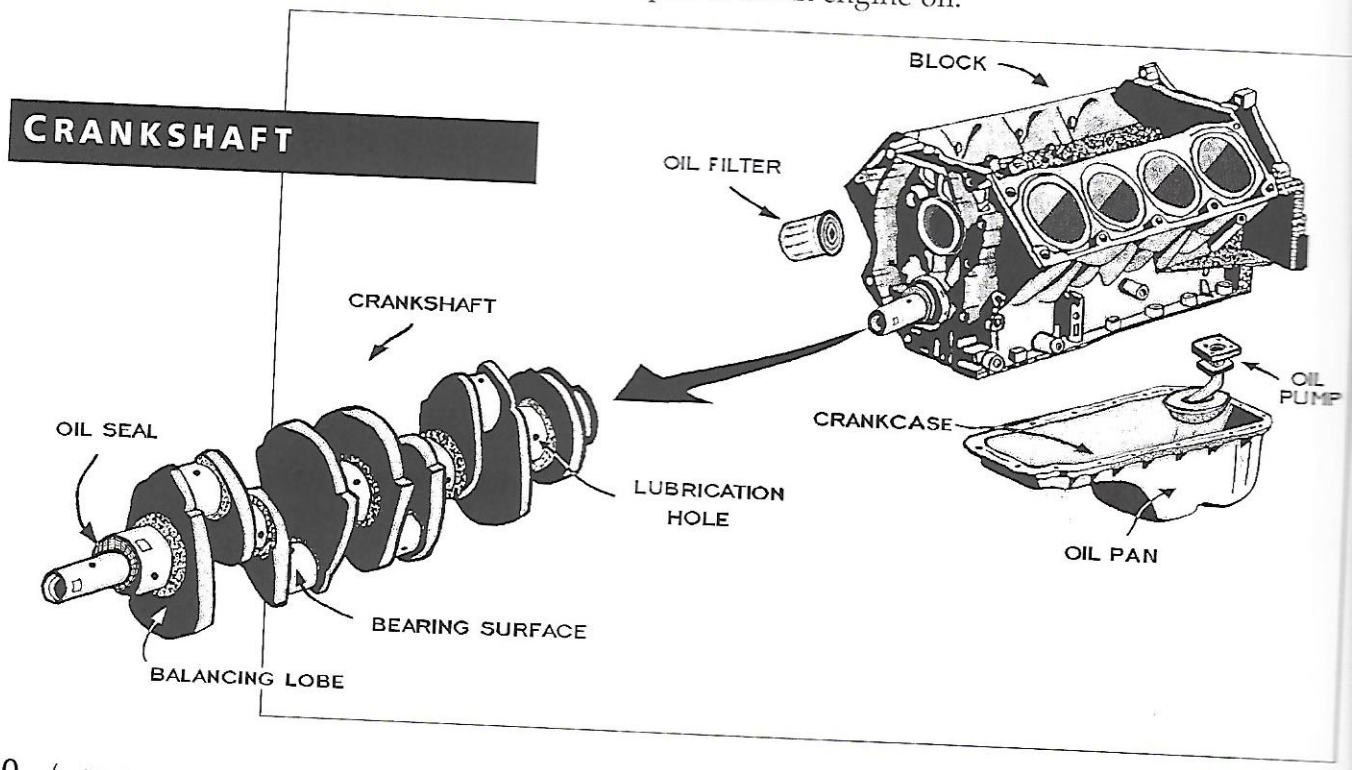
Crankshaft

A *crankshaft* changes the pumping motion of the pistons into spinning motion. A crankshaft also has smooth surfaces for connecting to a block and tiny passageways inside for delivering lubricating oil. *Balancing lobes* are used as counterweights to balance a crankshaft and prevent damage from wobbling.

A crankshaft fits lengthwise to the underside of an engine block, extending through that block at each end. At the front of an engine, rubber drive belts attach to the end of a crankshaft to deliver power to other car accessories. At the rear of a block, *drive train* parts attach to the crankshaft-end and transfer power to the wheels.

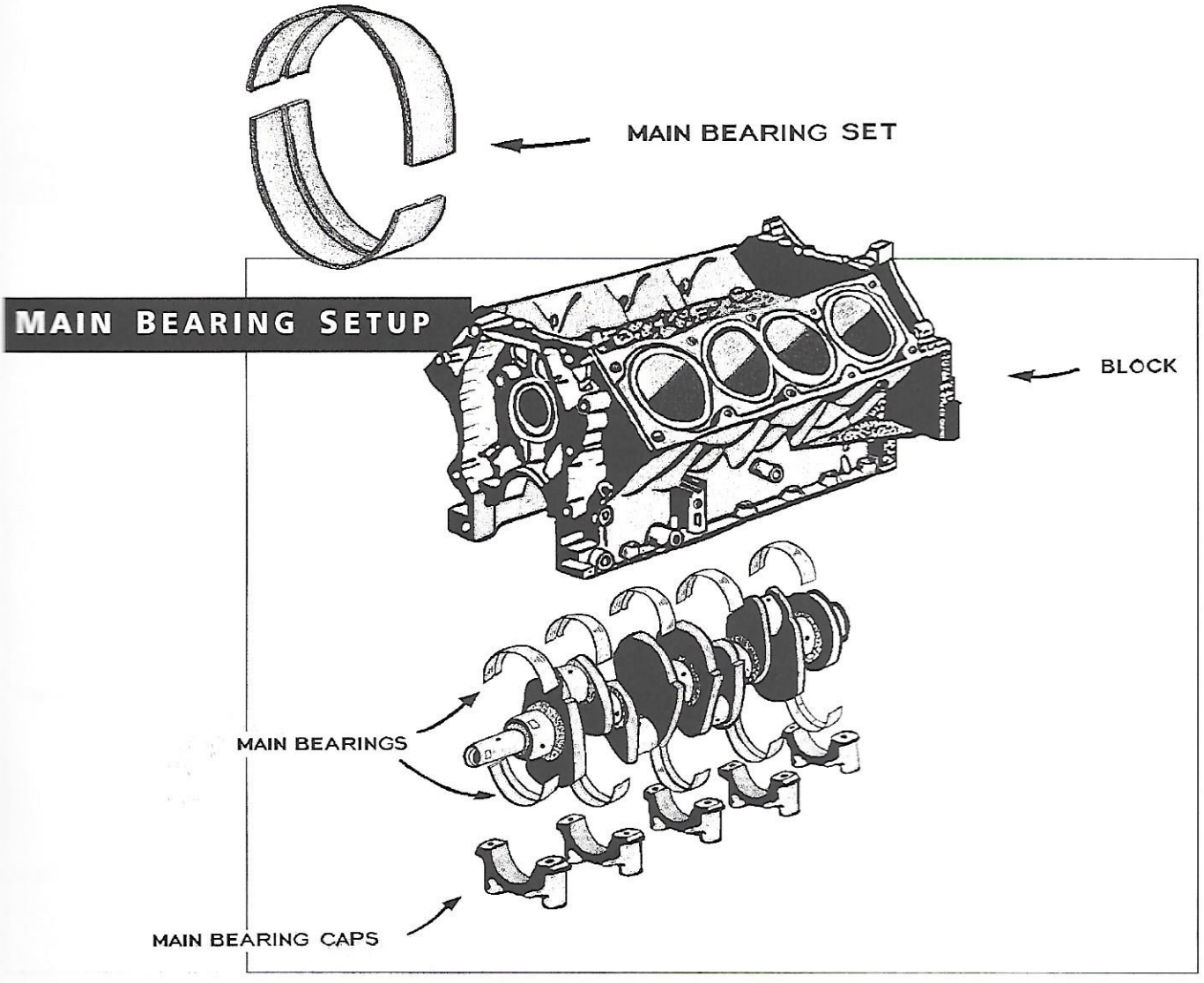
Oil seals prevent oil leaks where a crankshaft extends through a block. These rubber "O-rings" fit around the end of a crankshaft to prevent oil from leaking out, even while a crankshaft turns.

An *oil pan* covers and protects a crankshaft from road dirt and moisture. The area inside an oil pan is called the *crankcase* and holds the engine oil. An oil pan also encloses an *oil pump* which is usually bolted to the bottom of an engine where it can extend to the very bottom of a crankcase. An *oil plug* or *oil drain bolt* is threaded into the bottom of an oil pan to drain engine oil.



Main Bearings

Main bearings are smooth semi-circular metal straps which provide a smooth surface for the motion between a crankshaft and a block. Five or more main bearing sets hold a crankshaft in place. A heavy crankshaft must rotate fast and yet be held tightly to the block. The main bearings do this by providing a polished surface to reduce friction and a perfect fit to eliminate wobble.

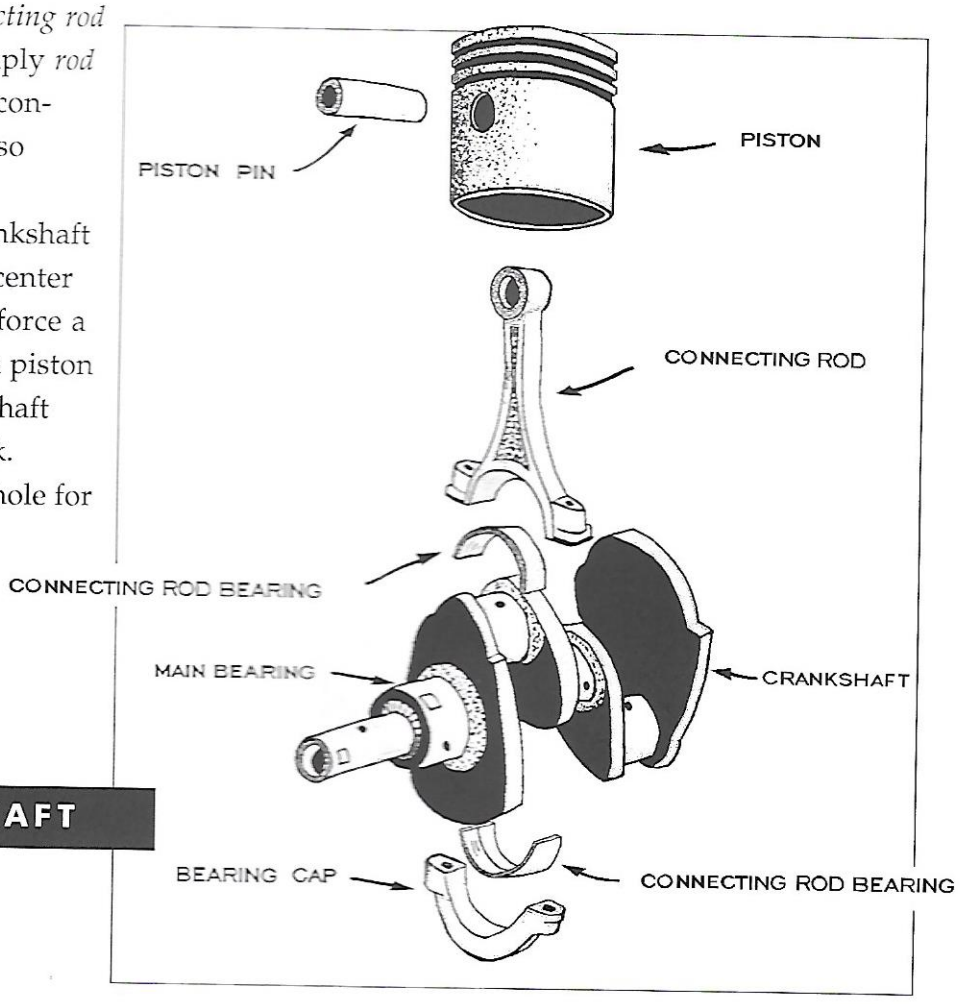


Piston

A *piston* resembles an empty soup can turned upside down. When fuel ignites, the explosive force pushes a piston down with bullet-like power. Each piston attaches to the crankshaft with a *connecting rod*, commonly called a *con rod*. A connecting rod attaches to the crankshaft in the same way a crankshaft connects to a block, with highly polished circular strap bearings. These bearings are called *connecting rod bearings*, *con rod bearings*, or simply *rod bearings*. A piston attaches to a connecting rod with a *piston pin*, also called a *wrist pin*.

The alignment between a crankshaft and piston must be slightly off-center to direct the strong downward force a little to one side. If the force of a piston rushing downwards hit a crankshaft squarely, something would break.

Interestingly, the attachment hole for a piston pin causes a piston to expand unevenly as an engine heats. A piston is consequently built in an oval shape. When heated to proper running temperature a piston expands to a circular shape, matching the engine cylinder. This is one reason why an automobile engine must reach proper operating temperature to run properly.

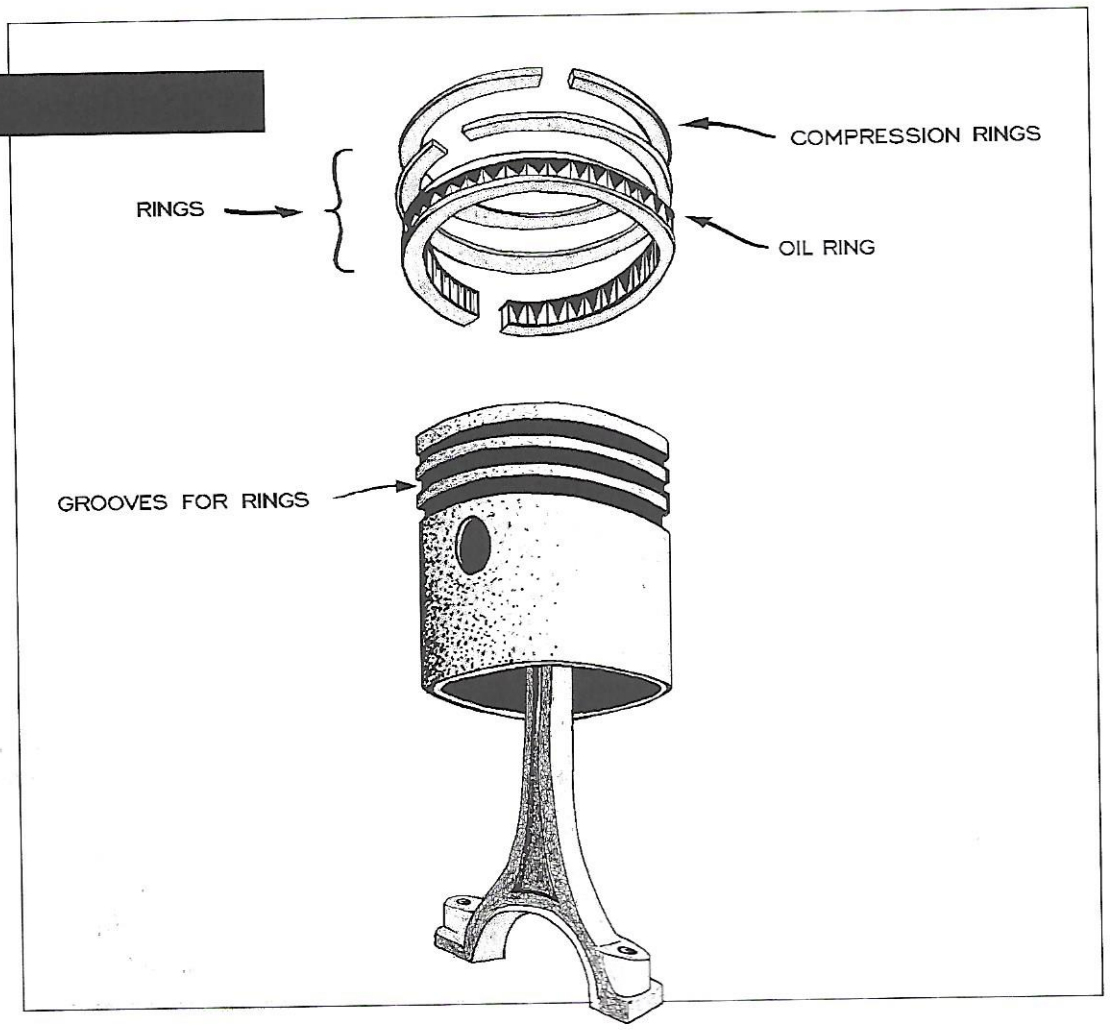


PISTON & CRANKSHAFT

Rings

Rings are like steel bracelets that fit in grooves around each piston. A set of three or four individual rings usually encircles each piston. Although pistons slide up and down in cylinders, they never actually touch the cylinder walls; only the rings touch the walls.

The upper rings or *compression rings* press outward against the wall of a cylinder to provide a seal strong enough to contain the explosive burning inside a combustion chamber. The lower ring or *oil ring* prevents oil in the crankcase from splashing and seeping into a combustion chamber from below. Oil rings wipe excess oil down from cylinder walls and back into a crankcase.

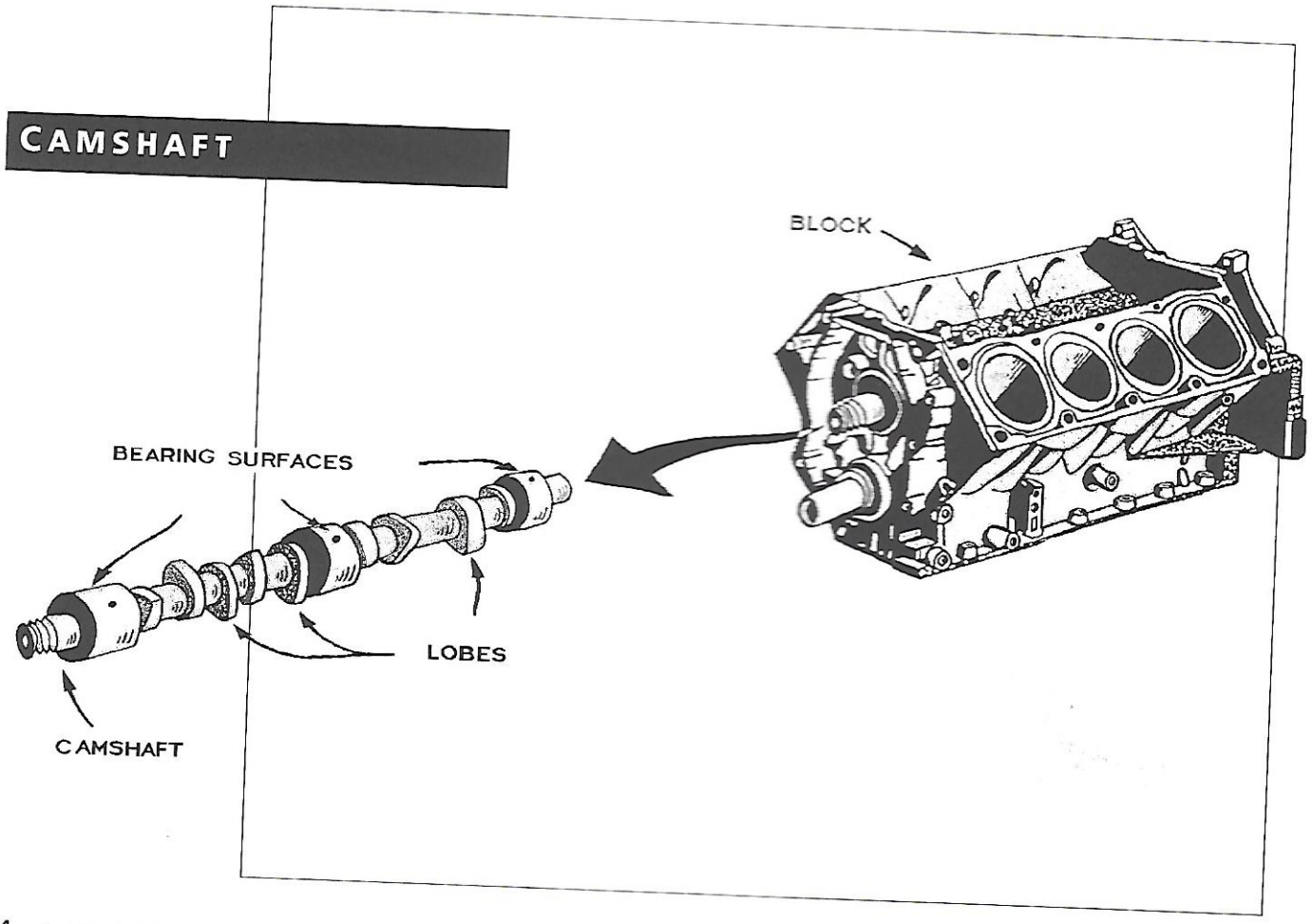


Camshaft

A *camshaft* is the mechanical brain of an engine, responsible for coordinating all the major parts. A camshaft uses egg-shaped *lobes* to control the *timing* of the opening and closing of engine *valves* which regulate the flow of fuel through an engine.

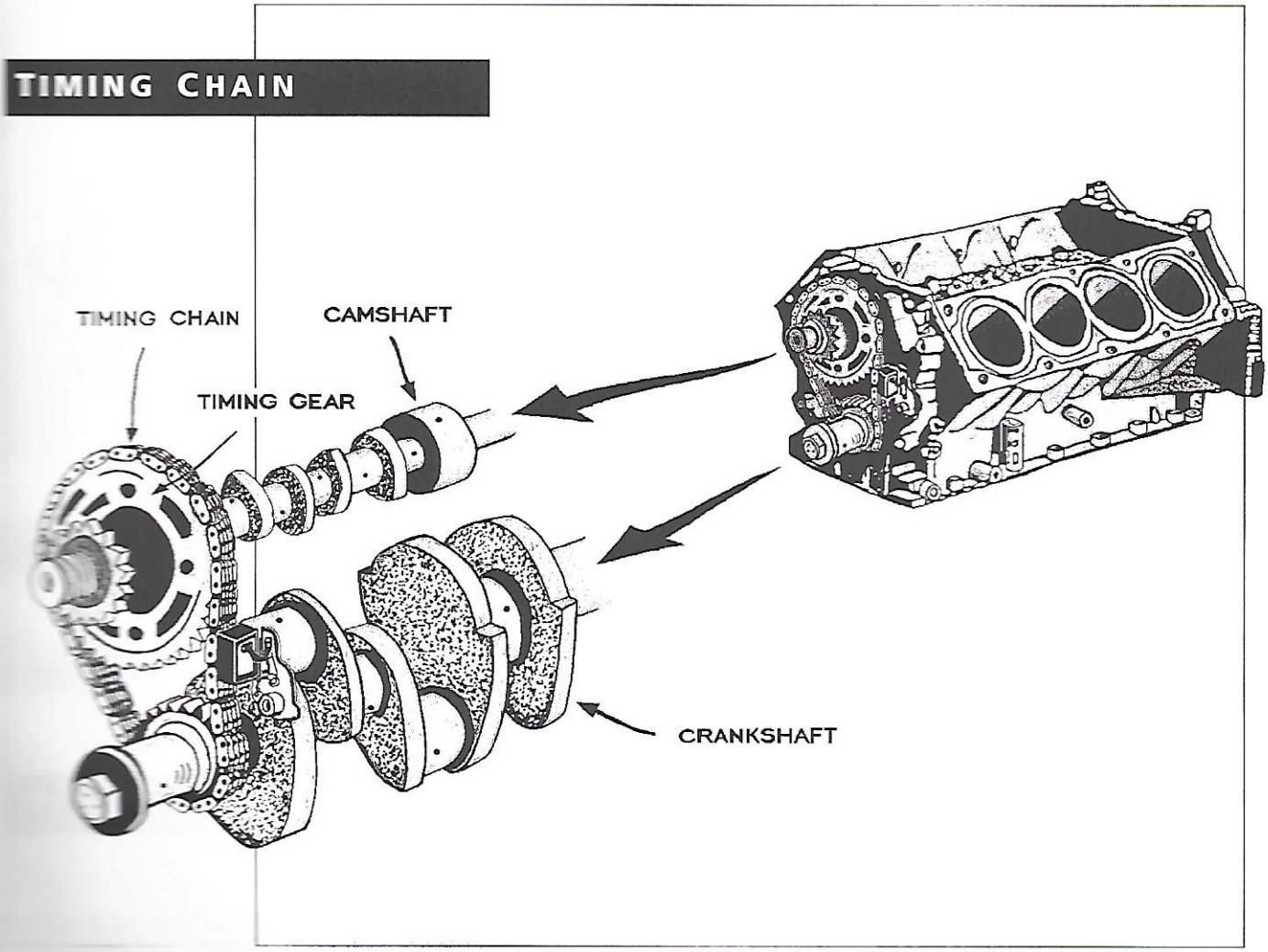
A camshaft looks similar to a crankshaft and may be located directly above a crankshaft, inside an engine block (shown below), or on top of an engine head, as in the *overhead camshaft* design (shown on page 17).

When an overhead camshaft is used in a "V"shaped engine, two separate camshafts are often used. This arrangement is called a *double overhead camshaft* (dohc).



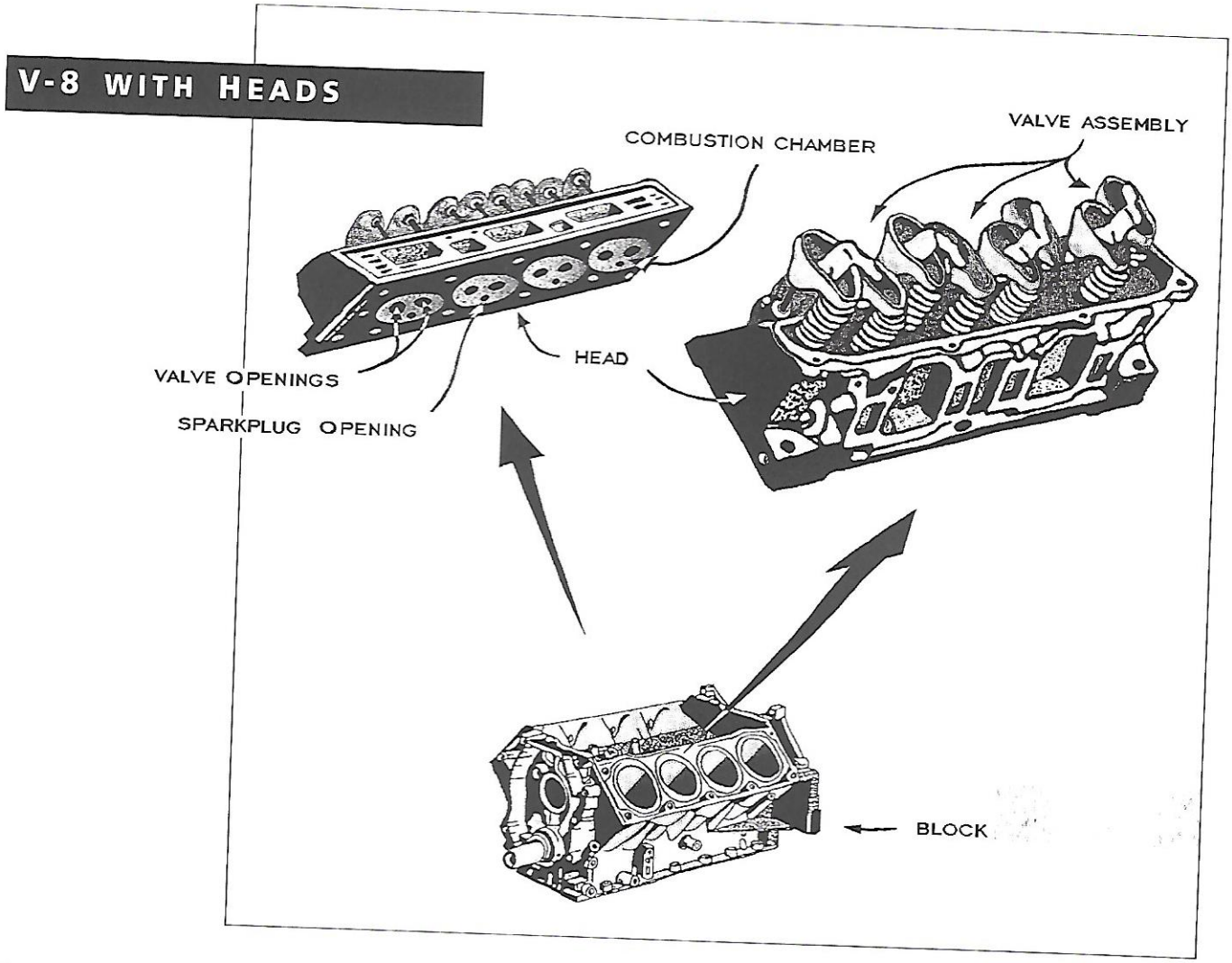
Timing Systems

A *timing chain* or *timing belt* connects a camshaft and a crankshaft, holding them in the same relative position to each other at all times. Older models used a direct gear to gear connection. *Timing marks* stamped into the two gears must be aligned to insure correct assembly. If a timing chain or belt skips just one gear *cog*, an engine will not work. A camshaft and crankshaft must always be positioned correctly to coordinate the workings of an engine. This coordination is part of the *timing* of an engine.



Head

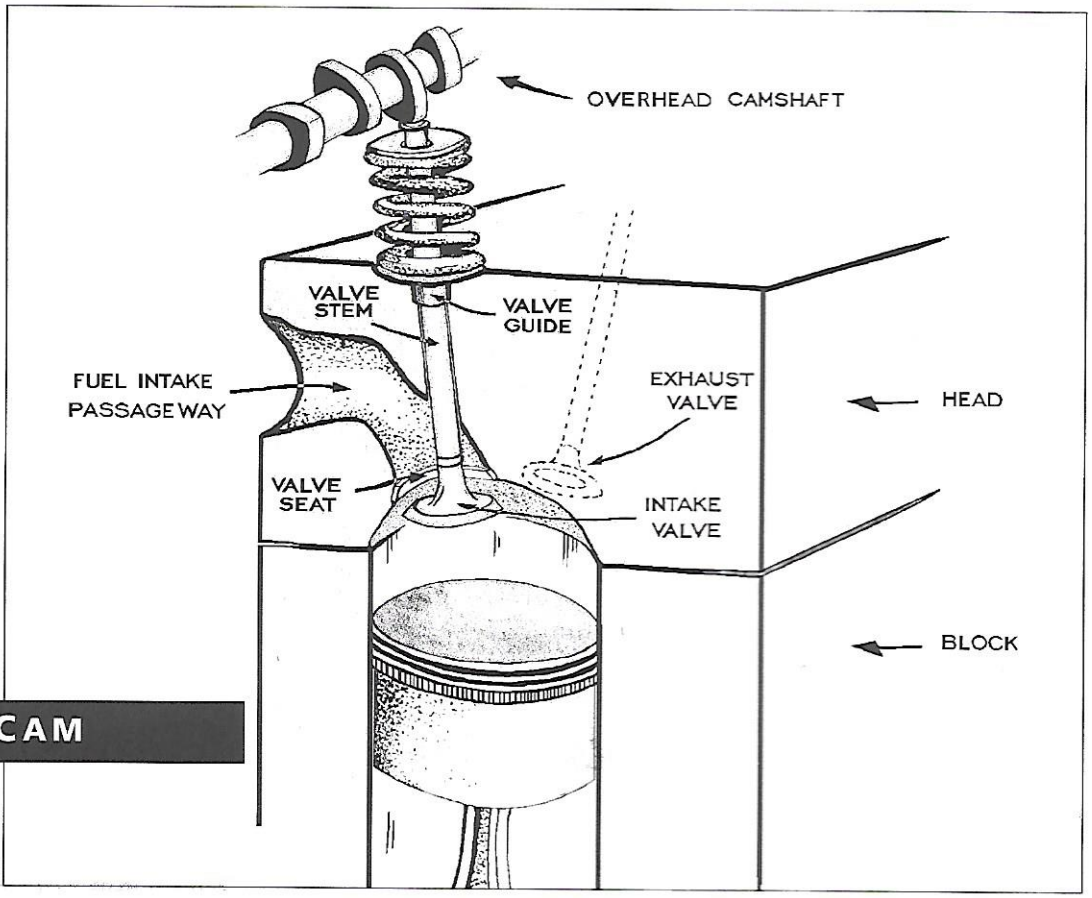
A *head* or *cylinder head* is a solid metal piece that fits on top of an engine block. Rounded indentations in a head provide space for the combustion chambers. A head also serves as the foundation for a *valve assembly*. A head also provides the openings where combustion chambers receive and discharge gasoline fumes and a threaded hole into each combustion chamber for a *sparkplug*. Two separate heads are used with a "V" shaped block, one for each side of the "V."



Valves

Engine *valves* are doors to the combustion chambers. An engine has at least two valves for each combustion chamber, one that opens to let the fuel mixture enter, called the *intake valve,* and another, the *exhaust valve,* to allow the exhaust fumes to be pushed out. Valves fit through a head in carefully-drilled holes. A *valve guide* provides a good seal and a smooth sliding surface for a *valve stem.*

Valves are controlled by a camshaft. With the overhead camshaft system (shown below), a camshaft is located above an engine head. The lobes of a camshaft push open the valves; strong springs push them closed. The shape of the lobes determines when, how far, and how long a valve will open. When closed, valves fit perfectly in their seats, sealing the combustion chambers. Valves rotate slightly each time they open to distribute wear evenly on the surfaces that touch.



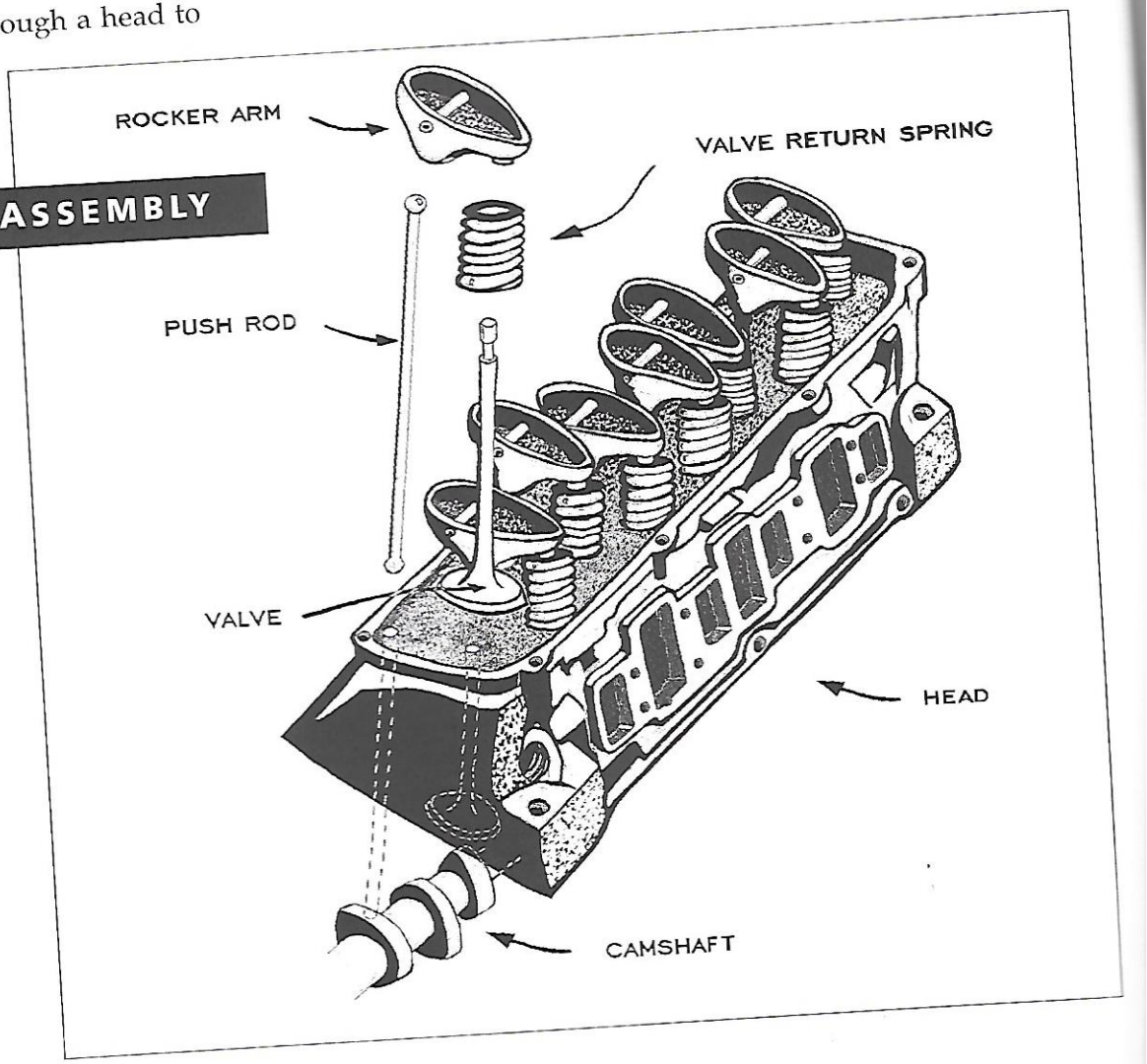
OVERHEAD CAM

Valve Assembly

A *valve assembly*, also called a *rocker arm assembly* or *valve train*, includes the parts that create contact between a valve and the camshaft lobes and the parts that hold and guide all the valves. A *push rod valve assembly* is shown below. Here the camshaft is located in an engine block and long *push rods* extend through a head to push *rocker arms* that, in turn, push open the valves. *Valve return springs* hold the valves closed.

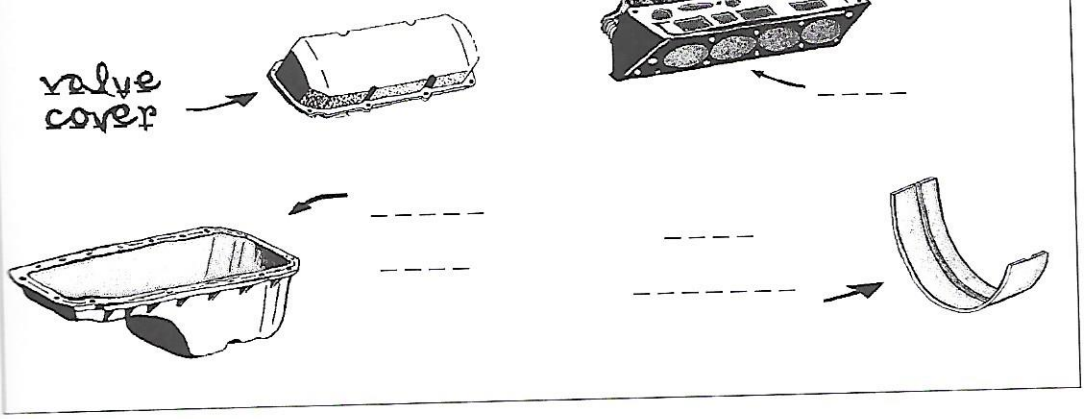
New valve assembly designs include *Variable Valve Timing* and *Electronic Lift Control* systems where complex cone shaped lobes are electronically positioned to increase engine efficiency.

PUSH ROD ASSEMBLY



ENGINE TEST

Identify the parts:



1. Fuel is burned in _____, inside an engine. *(Answer on p. 8)*
2. What does dohc stand for? *(p. 14)*
   _____
3. The top of a piston is also the _____ of a combustion chamber. *(p. 8)*
4. A camshaft controls the opening and closing of _____. *(p. 14)*
5. Angular momentum is the technical name for _____. *(p. 8)*
6. Why is the alignment between a crankshaft and a piston slightly off-center? *(p. 12)*
   _____
   _____
7. The lobes of a camshaft are egg shaped. (T) (F) *(p. 14)*
8. Engine valves are like _____ to the combustion chambers. *(p. 17)*
9. Rings never touch the walls of a cylinder. (T) (F) *(p. 13)*
10. A timing chain connects a _____ and a _____. *(p. 15)*
11. Why is a piston manufactured in an oval shape when it slides in a circular cylinder? *(p. 12)* _____
12. Bearings are used to _____ *(p. 11)*
13. Steam and jet engines are examples of _____ combustion engines. *(p. 7)*
14. Why is the total number of cylinders in an engine usually an even number?
    _____