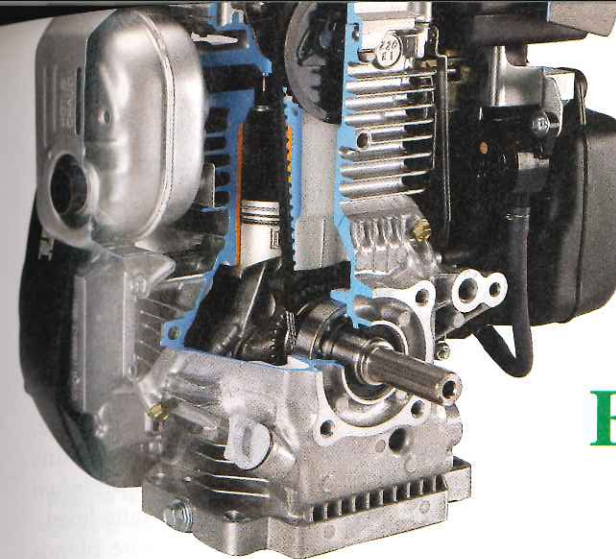




This curved-shaft trimmer is an example of how small gas engines are used. (Toro Company.)



CHAPTER 4

Engine Construction and Principles of Operation

After studying this chapter, you will be able to:

- ▼ Explain simple engine operation.
- ▼ List the qualities of gasoline that make it an efficient fuel for small engines.
- ▼ Explain why gasoline is atomized in the small engine.
- ▼ Identify the basic components of a small engine and describe the function of each part.

Gasoline Engines

A gasoline-fueled engine is a mechanism designed to transform the chemical energy of burning fuel into mechanical energy. In operation, it controls and applies this energy to mow lawns, cut trees, propel tractors, and perform many other laborsaving jobs.

A gasoline engine is an internal combustion engine. Gasoline is combined with air and burned inside the engine. In its simplest form, an engine consists of a ported cylinder, piston, connecting rod, and crankshaft. See **Figure 4-1**.

The piston is a *close fit* inside the cylinder, yet it is free to slide on the lubricated walls. One end of the connecting rod is attached to the piston; the other end is fastened to an offset crankpin, or journal, of the crankshaft. As the piston moves up and down, the connecting rod forces the journal to follow a circular path, rotating the crankshaft.

Simple Engine in Operation

When the engine is cranked, gasoline is atomized (reduced to minute particles) and mixed with air. This mixture is forced through an intake port and into the cylinder, where it is compressed by the piston on the upstroke and ignited by an electrical spark.

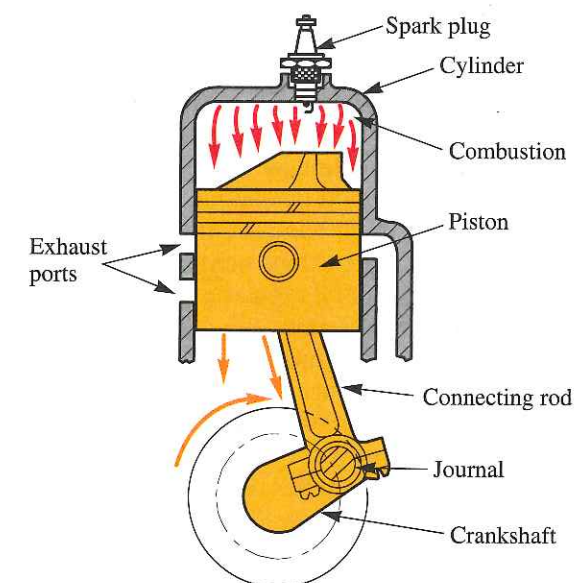


Figure 4-1. Combustion forces the piston down to rotate the crankshaft.

Burning rapidly, the heated gases trapped within the cylinder (combustion chamber) expand and apply pressure to the walls of the cylinder and to the top of the piston. This pressure drives the piston downward on the power stroke, causing the crankshaft to turn. See **Figure 4-1**.

As the piston and connecting rod push the crankshaft journal to the bottom of the stroke, the pressure of the burned gases is released through an exhaust port. Meanwhile, a fresh air-fuel charge enters the cylinder and the momentum of the power stroke turns the crankshaft journal through bottom dead center (BDC) and into the upstroke on another power cycle.

Gasoline

Gasoline is a hydrocarbon fuel (mixture of hydrogen and carbon), refined from petroleum. **Petroleum** is a dark, thick liquid that is extracted from the earth by oil wells. Luckily, petroleum is the second most plentiful liquid in the world; only water is available in greater quantity. Gasoline, however, cannot be recycled as water can. Therefore, it is imperative that we conserve gasoline and use it wisely.

Gasoline contains a great amount of energy. For engine use, it should:

- Ignite readily, burn cleanly, and resist detonation (violent explosion).
- Vaporize easily, without being subject to vapor lock (vaporizing in fuel lines, impeding flow of liquid fuel to carburetor).
- Be free of dirt, water, and abrasives.

Gasoline is assigned an **octane number** that corresponds to its ability to resist detonation. Premium grade gasoline burns slower than regular gasoline. It has a high octane number and is used in engines with high compression. Regular grade gasoline has a lower octane number and burns relatively fast. Generally, regular gasoline is used in small, low compression, one-cylinder and two-cylinder, gasoline engines.

Gasoline was once available in both leaded and unleaded varieties. The use of lead compounds was the most economical way to increase gasoline's octane number. For many years, most gasolines contained *tetraethyl lead*.

Since the mid 1970s unleaded gasoline has replaced leaded gasoline. Instead of lead compounds, *oxygenates (alcohols and ethers)* are commonly added to these fuels to increase octane

levels. The main reason that unleaded gas was introduced was to provide fuel for automobiles equipped with catalytic converters. These vehicles will not operate properly on leaded fuel.

Modern unleaded gasoline is a complex substance. Ongoing research is necessary to seek ways to produce fuels that offer efficient engine performance and meet air pollution standards.

In the 1970s, a 10% ethanol blend of gasoline, known as *gasohol*, was introduced. Today, this product is often sold as *super unleaded* or *premium unleaded* gasoline, depending on the octane level.

The main drawback to these gasoline blends is their ability to absorb moisture, which can pass through the fuel filter and into the combustion chamber. These fuels should never be stored in high humidity areas or used in engines that set idle for long periods of time. Gasoline containing alcohol can also corrode fuel tank linings, shrink carburetor floats and seals, increase carbon deposits, and pit metal parts. For maximum performance and engine life, only use the type of gasoline recommended by the engine manufacturer. See *Appendix* for gasoline recommendations.

Gasoline must burn quickly

Gasoline placed in a container and ignited will produce a hot flame, yet it will not burn fast enough to produce the rapid release of heat necessary to run an engine. Even though a considerable quantity of fuel may be involved, a large flame will not necessarily result. See **Figure 4-2**.



Under no circumstances should experiments illustrated in this chapter be performed. Gasoline can be a very dangerous fuel and must be handled with caution. Illustrations and examples discussed here are meant to demonstrate how gasoline is prepared and used in an engine.

In **Figure 4-2**, the surface area of the wick in the lighter is small. Vapor from the surface of the liquid, combined with oxygen, is what burns readily. If the surface of the liquid is small, relatively little vapor will be given off to provide combustion. Since the liquid must change to vapor before it is burned, it would take considerable time to use up the fuel at this rate.

By placing the same amount of fuel in a shallow, wide container, more surface area will contact air and the fuel will burn rapidly. See **Figure 4-3**.

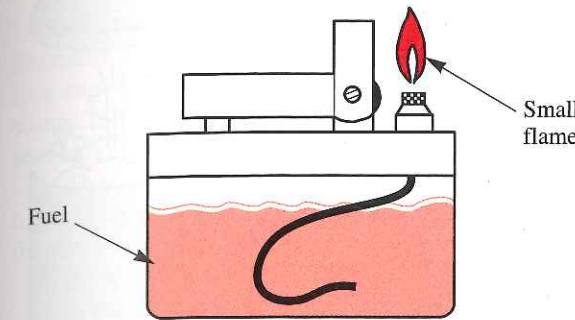


Figure 4-2. A small flame is produced, due to a small area of exposed fuel.

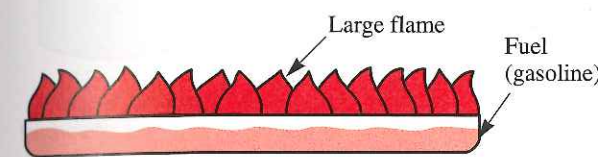
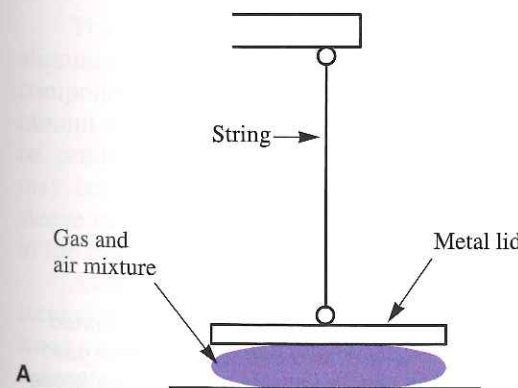


Figure 4-3. A large flame is produced by a large area of exposed fuel.

Fuel is atomized

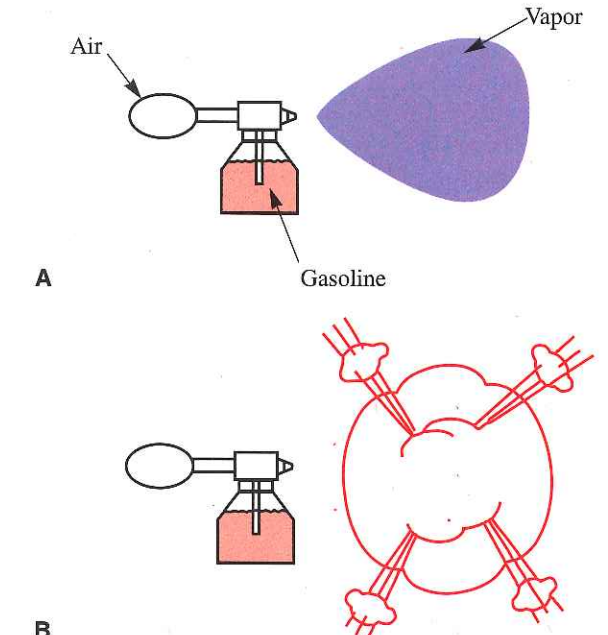
The more surface area of gasoline exposed to the air, the faster a given amount will burn. To produce the rapid burning required in an engine, gasoline must be broken up into tiny droplets and mixed with air. This is called **atomizing**.

Once the entire surface of each droplet of the air-fuel mixture is exposed to the surrounding air, a huge burning area becomes available. Given a spark, the entire amount of gasoline will flash into flame almost instantly. In effect, atomization causes a sudden, explosive release of heat energy. See **Figure 4-4**.



A

Figure 4-5. A—Atomized fuel is sprayed under a metal lid. B—When the fuel is ignited, the lid moves a short distance.



B

Figure 4-4. A—When atomized fuel is exposed to the surrounding air, a large burning area is available. B—When the atomized fuel is ignited, heat energy is released with an explosive force.

Explosion must be contained

To perform useful work, the explosive force caused by the burning gas must be contained and controlled. To illustrate this point, imagine that a metal lid is suspended on a string and held several inches from the ground. If a mixture of gasoline and air (atomized) were sprayed under it and ignited, the lid would be raised a short distance by the force of the explosion. See **Figure 4-5**.

The reason the lid hardly moved is because the explosion was not confined and directed

toward the lid. Instead, the explosion exerted force in all directions, and much of the force was lost. If the gasoline and air mixture is sprayed inside a metal container with a lid, the full force of the explosion will be directed against the lid when the mixture is ignited. This will blow the lid high into the air. See **Figure 4-6**.

Further improvement

Even though the burning air-fuel mixture is confined by the container, once the lid starts to lift, a large amount of the force escapes to the sides. To eliminate this loss, a long, cylindrical container may be used with the lid having a close, sliding fit. See **Figure 4-7**. With the fuel mixture slightly compressed in the bottom of the container by the weight of the lid, the fuel will burn and direct most of the pressure against the lid as it travels up through the container. When the lid reaches the top, it will be traveling at a high rate of speed. The expansion of the gas will be nearly complete and little force will be lost, even after the lid clears the container.

Basis for an Engine

An elementary engine can be formed by attaching a crankshaft and a connecting rod to the setup illustrated in **Figure 4-7**. The lid will serve as a piston and the container will act as a cylinder. See **Figure 4-8**. When the air-fuel mixture in the cylinder is ignited, it will drive the piston upward, causing the crankshaft to turn.

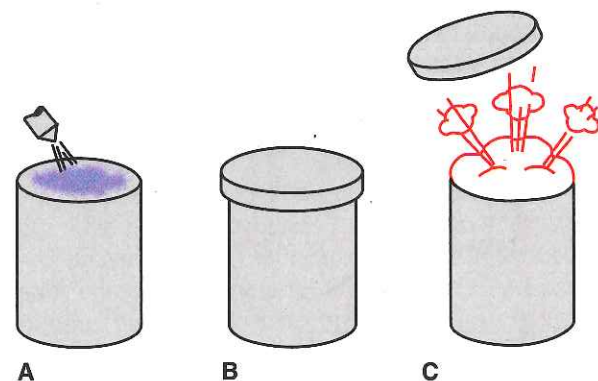


Figure 4-6. A—Mixture of fuel and air is sprayed into a container. B—A lid is placed on top. C—The full force of explosion is directed toward the base of the lid when the mixture is ignited, and the lid is driven high into air.

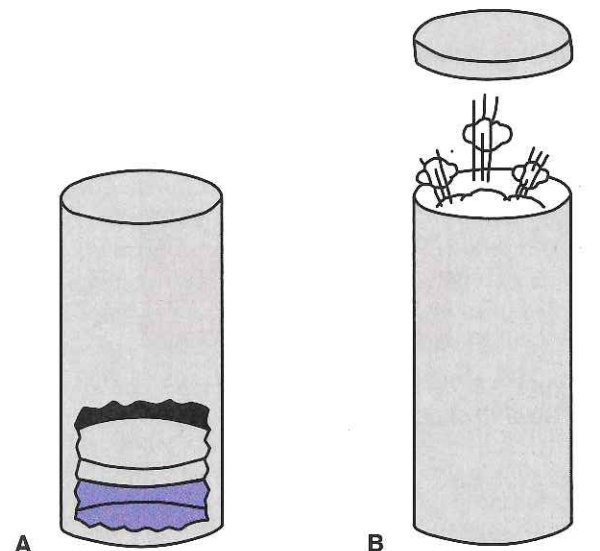


Figure 4-7. A—The lid is placed in a long container. B—Most of the energy of the burning fuel is absorbed by the lid, imparting greater speed to the lid when explosion occurs.

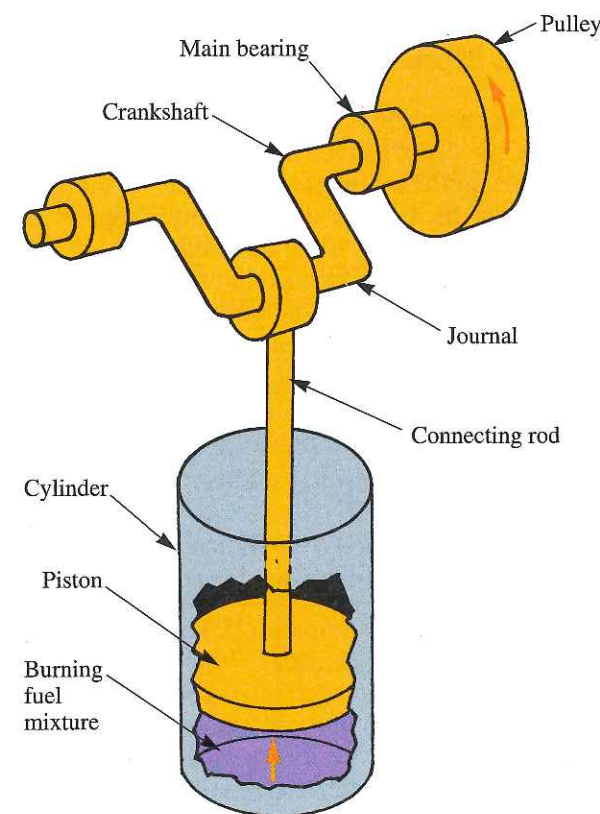


Figure 4-8. The principles of operation illustrated here are the same as those used in a modern gasoline engine. Note how the burning fuel mixture forces the lid (piston) upward to turn crankshaft and pulley.

Although it is crude, this elementary engine illustrates the operating principles of a modern gasoline engine. Study the names of the various parts shown in **Figure 4-8**. Become acquainted with the parts and their application to engine design.

There are many faults with the engine pictured in **Figure 4-8**. These faults are explored with the following questions:

- How will a fresh air-fuel charge be admitted to the cylinder?
- How will the charge be ignited?
- What holds the various parts in alignment?
- How will the engine be cooled and lubricated?
- What will *time* the firing of the air-fuel mixture so that the piston will push on the crankshaft when the journal is in the correct position?
- How will the burned charge be removed (exhausted) from the cylinder?
- What will keep the crankshaft rotating after the charge is fired, and until another charge can be admitted and fired?

The previous questions can be categorized into five basic areas:

1. **Mechanical** (engine design and construction)
2. **Carburetion** (mixing gasoline and air, and admitting it to the cylinder)
3. **Ignition** (firing the fuel charge)
4. **Cooling** (heat dissipation)
5. **Lubrication** (oiling of moving parts)

In this chapter, emphasis will be placed on the mechanical aspects of engine design and construction. It will provide you with an opportunity to develop a workable engine. We will assume that the gasoline and air are being mixed correctly, the fuel charge is being fired at the right time, and the engine is properly cooled and lubricated.

Cylinder block

The **cylinder block** keeps all engine parts in alignment. See **Figure 4-9**. This critical engine component is usually a casting of iron or an aluminum alloy. The cylinder formed in the block can be produced accurately by modern methods. It may be bored directly into the casting, or a steel sleeve may be inserted into an oversize hole bored in the block.

Aluminum cylinder blocks are cast around a steel sleeve. Aluminum, being a soft metal, would wear out quickly due to the friction of the piston. Advantages of aluminum are its light weight and ability to dissipate heat rapidly.

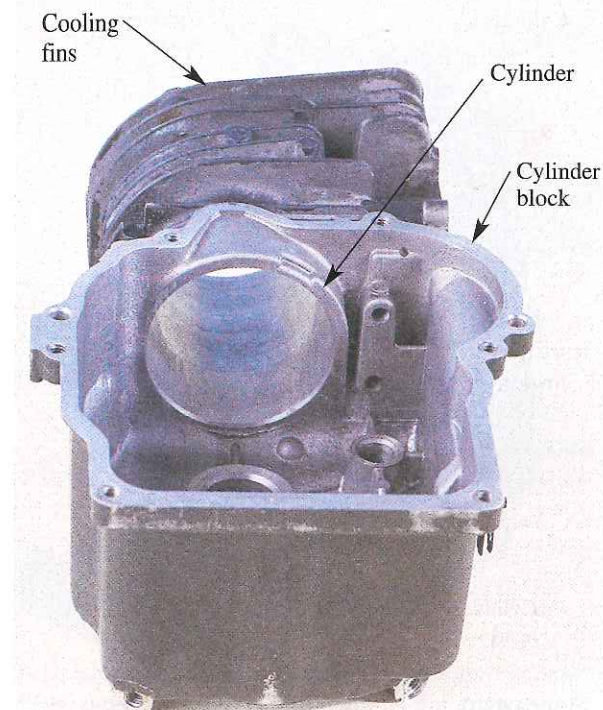


Figure 4-9. A cylinder block is important because it keeps all moving parts in alignment.

All air-cooled engines have **cooling fins** on the outside of the cylinder and cylinder head. The size, thickness, spacing, and direction of the cooling fins are carefully engineered for efficient air circulation and heat control.

The cylinder block must be rigid and strong enough to contain the power developed by the expanding gases. In some cases, the cylinder is a separate unit; in others, it is cast as part of the crankcase. Similarly, the cylinder head may be bolted to the block or it may be cast as one complete unit. The method employed depends on the intended application of the engine and the manufacturer's preference.

Figure 4-10 shows a combined cylinder block and crankcase with a separate, bolted cylinder head. Note the gasket that seals the unit. A sleeved, aluminum, die-cast cylinder is shown in **Figure 4-11**.

Crankshaft and crankcase

The **crankshaft** is the major rotating part of the engine. See **Figure 4-12**. Generally, it is forged or cast steel, with all bearing surfaces carefully

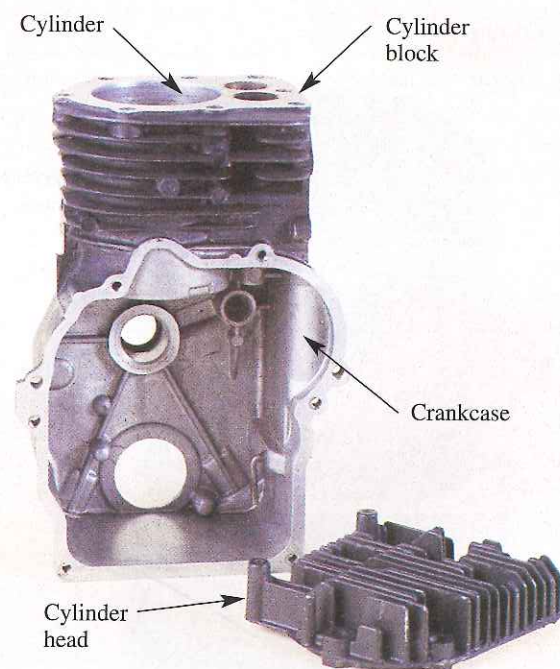


Figure 4-10. A combined cylinder block and crankcase. The cylinder head and sealing gasket are bolted to the cylinder block.

machined and precision ground. Counterweights are used to balance the weight of the connecting rod, which is fastened to the journal. Since

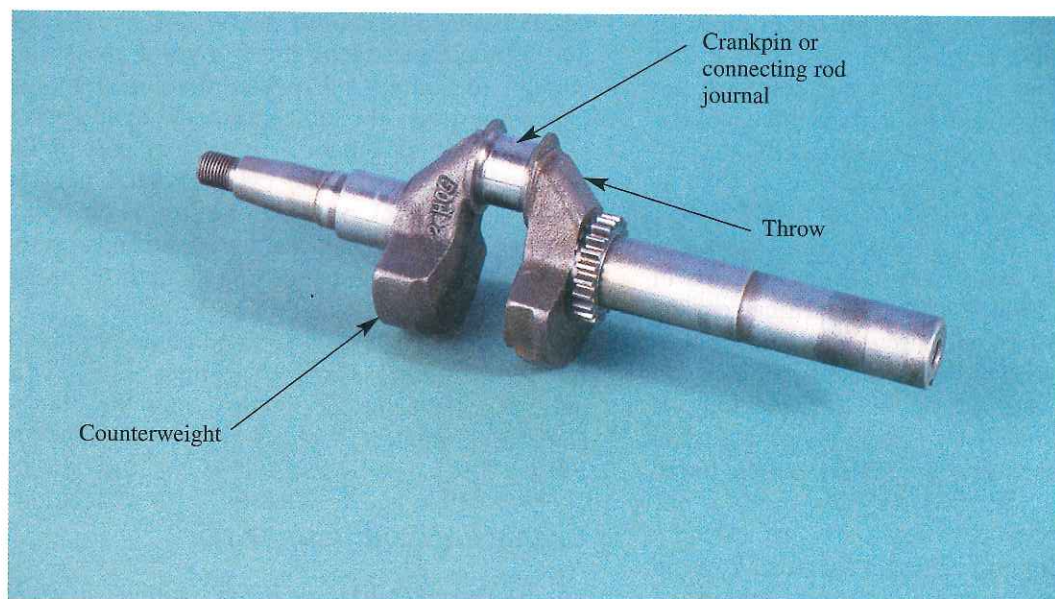


Figure 4-12. A crankshaft for a single cylinder engine. Large counterweights opposite the crank journal balance rotational forces.

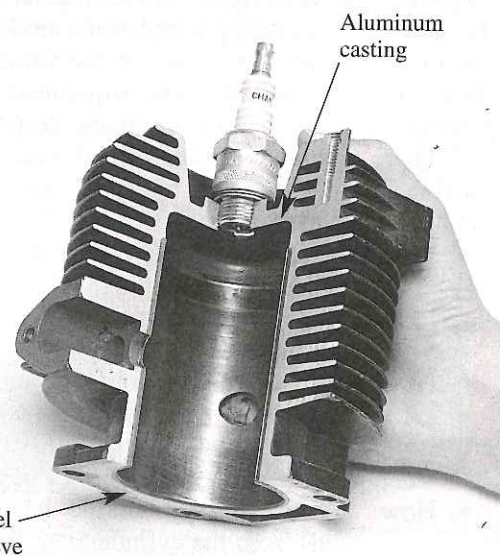


Figure 4-11. An aluminum cylinder block die cast around a steel sleeve. Note the fins for air cooling.

connecting rods are cast or forged from different weight materials, holes are often drilled in counterweights to balance the crankshaft and prevent vibration.

Figure 4-13 shows a crankshaft being installed in a crankcase. Note the tapered roller bearings. The flywheel is keyed to the end of the shaft with



Figure 4-13. The crankshaft must be clean and carefully installed in the crankcase. The tapered end fits into the flywheel, which is secured with a key, lock washer, and nut. (Tecumseh)

a Woodruff key. This type of key cannot slip out during operation. A lock washer and nut hold the flywheel in place.

The end of the crankshaft and the hole through the flywheel have matched tapers that provide good holding power. When roller bearings are used to support the crankshaft, highly polished, hardened alloy steel bearing races are pressed into the crankcase to reduce friction and provide good wearability.

The **crankcase** must be rigid and strong enough to withstand the rotational forces of the crankshaft, while keeping all parts in proper alignment. Oil for lubrication is contained in the crankcase on some engines. On others, a valve system is used that allows a fuel, air, and oil mixture to enter. The crankcase must be designed to protect the internal parts. Gaskets and oil seals are used to keep out dirt and keep in the clean oil.

The crankcase and the cylinder block may be cast as a unit or fastened together by bolts. **Casting** metal is the process of pouring molten metal into a form of a desired shape. **Figure 4-14** shows a two cylinder engine with the cylinder block being placed on the crankcase with the crankshaft already installed. Note the tapered end on the crankshaft, which receives the flywheel.

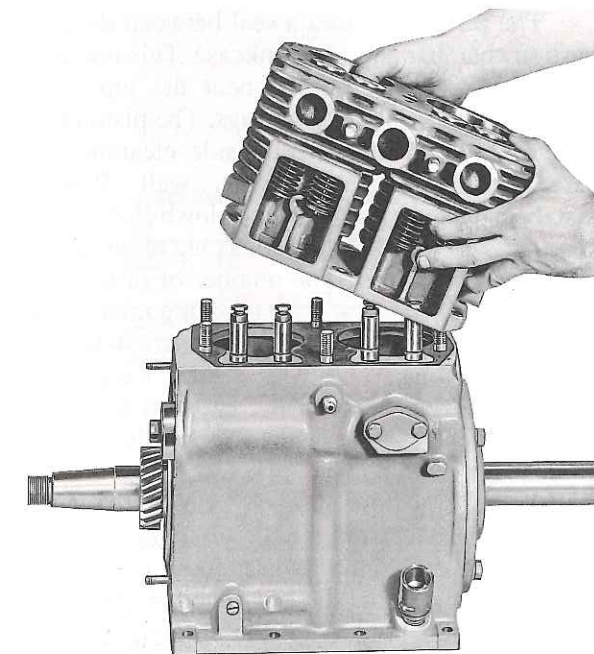


Figure 4-14. A two cylinder crankcase and cylinder block being assembled. Stud bolts in the crankcase will hold the cylinder block in place when the nuts are tightened.

In certain engine applications, the crankcase is not only an important part of the engine but also an integral part of the apparatus being driven. See **Figure 4-15**. A chain saw is a good example of this.

Pistons

The **piston** is the straight line driving member of the engine. It is subjected to the direct heat of combustion and must have adequate clearance in the cylinder to allow for expansion.



Figure 4-15. The assembled engine components become the driving members of this lightweight chain saw.

The piston provides a seal between the combustion chamber and the crankcase. This is accomplished by cutting grooves near the top of the piston and installing **piston rings**. The piston rings fit the grooves with a slight side clearance and exert tension on the cylinder wall. Properly installed, piston rings prevent blowby of exhaust gases into the crankcase and leakage of oil into the combustion chamber. The number of piston rings per piston depends upon the type of engine and its design. Note the piston rings in **Figure 4-16**.

The piston is hollow to reduce weight. The top may be flat, domed, or contoured to provide efficient flow of gases entering and leaving the combustion chamber.

There is a hole in each side of the piston through which a **piston pin**, or **wrist pin**, is placed. This pin acts as a hinge between the connecting rod and piston and holds the two together. Generally, spring retainers hold the piston pin in place.

Connecting piston to crankshaft

The sliding piston is connected to the rotating crankshaft with a metal link called a **connecting rod**. The big end of the connecting rod encircles the crankshaft journal and contains a bearing to permit free movement. The upper, or small end, of the connecting rod also must be movable. Note how the metal piston pin is passed through the connecting rod and piston. See **Figure 4-17**.

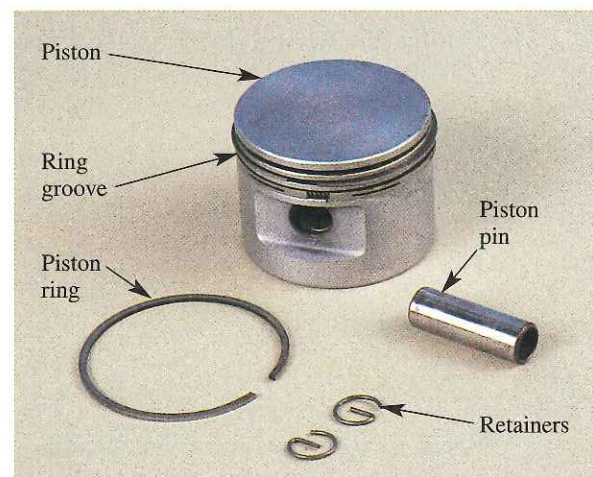


Figure 4-16. The piston is the largest sliding-reciprocating part in an engine. Piston rings seal the combustion chamber from the crankcase and must fit properly.

Also note the needle-type roller bearings, bearing race shells, and retainers, which must be installed in the large end of the connecting rod when it is placed on the crank journal. The bearing cap holds the assembly together with connecting rod bolts or screws. **Figure 4-18** shows the relative position of the connecting rod and cap.

Expanding gases push the piston toward the crankshaft, causing the connecting rod to turn the shaft. **Figure 4-19** shows how the reciprocating (up and down) movement of the piston is changed to rotary (revolving) motion by the crankshaft. Notice that the upper connecting rod bearing allows the connecting rod to swing back and forth while the lower bearing permits the crankshaft journal to rotate within the rod.

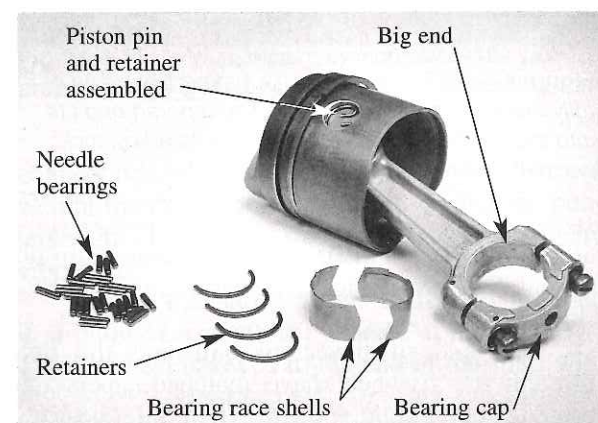


Figure 4-17. The big end of connecting rod is capped to fit around the crankshaft journal. Needle bearings are inserted to help reduce friction. The piston pin and retainers are shown assembled. (Jacobsen Mfg. Co.)



Figure 4-18. Shown are the relative positions of connecting rod parts.

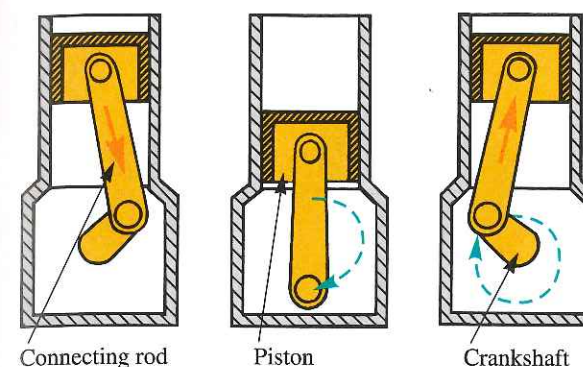


Figure 4-19. The connecting rod must be free to pivot on the piston pin, while the crank journal follows a rotary path. The connecting rod must withstand severe stress in operation.

Intake and exhaust ports

In developing an engine, we need to provide a way in which a fresh air-fuel mixture can be admitted to the engine and, once burned, the waste products exhausted. This can be done by using **ports** (openings) that are alternately covered and exposed by the piston (two-stroke cycle design) or by using **poppet valves** to open and close the port openings (four-stroke cycle design). Both two-stroke and four-stroke designs are commonly used. Each has definite advantages and disadvantages. The four-stroke cycle engine will be discussed here.

Poppet valves

For a four-stroke cycle engine (see Chapter 5 for additional information on fundamentals), passages leading to and from the cylinder area must be constructed. **Figure 4-20** shows two ports cast into the cylinder block, one intake and one exhaust. The cylinder head is recessed to provide a passage from the ports to the cylinder.

By installing a valve in each port, it is possible to control the flow of fresh fuel mixture into the cylinder and provide a means of exhausting the burned gases. During the period of expansion of the burning gases that drive the piston downward, both valves are tightly closed. See **Figure 4-21**.

The angled face of each valve will close tightly against a smooth seat cut around each port opening. To align the valve and assure accurate raising and lowering in relation to the seat, the valve stem passes through a machined hole in block. This hole is called a **valve guide**.

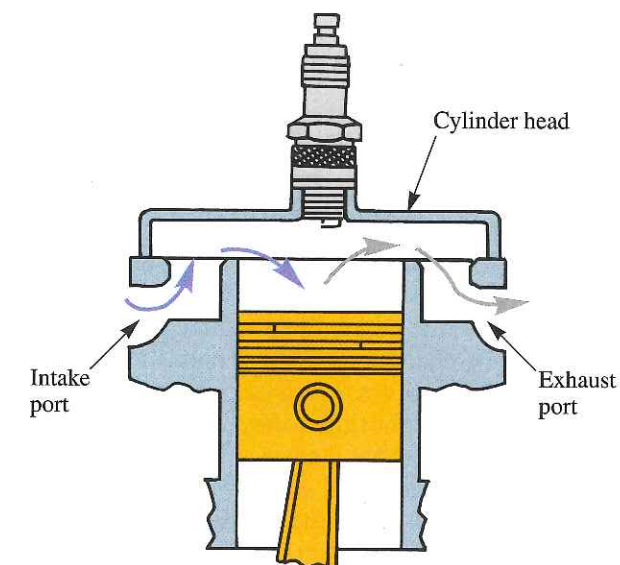


Figure 4-20. The intake port permits the air-fuel mixture to enter. The exhaust port allows the burned gases to escape.

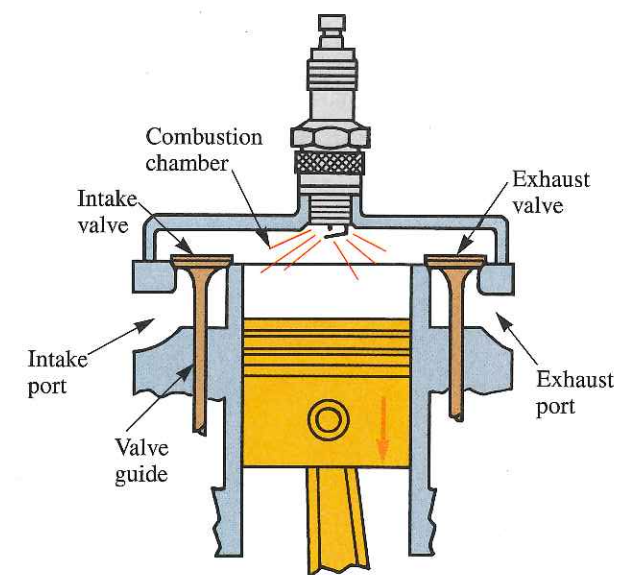


Figure 4-21. Poppet valves seal the intake and exhaust ports during the power stroke. Valve guides keep the valves aligned with the valve seats.

Valve spring assembly

A **valve spring** must be used on each valve to hold it firmly against the seat. Placed over the valve stem, the spring is compressed to provide tension. It is connected to the valve stem by means of a washer and keeper (lock).

The spring allows the valve to be opened when necessary and will close it when pressure is removed from the valve stem. **Figure 4-22** shows the location of the spring and keeper assembled on the valve. An enlarged view of the *horseshoe* valve lock system is shown in **Figure 4-23**.

A valve in the open position is illustrated in **Figure 4-24**. When pressure is removed from the end of the valve stem, the spring will draw the valve down against the seat and seal off the port from the combustion chamber. For the engine to function properly, the valves must be opened the right amount at the right time. They must remain open for a specific period and close at the correct instant.

By using a shaft with two thick sections spaced to align with the valve stems, a basic device for opening and closing the valves is provided. By grinding the thick sections into a cam shape, the **camshaft** is formed. When the shaft is revolved, the cam lobe will cause the valve to rise and fall, opening and closing the ports. This process is shown in **Figure 4-25**.

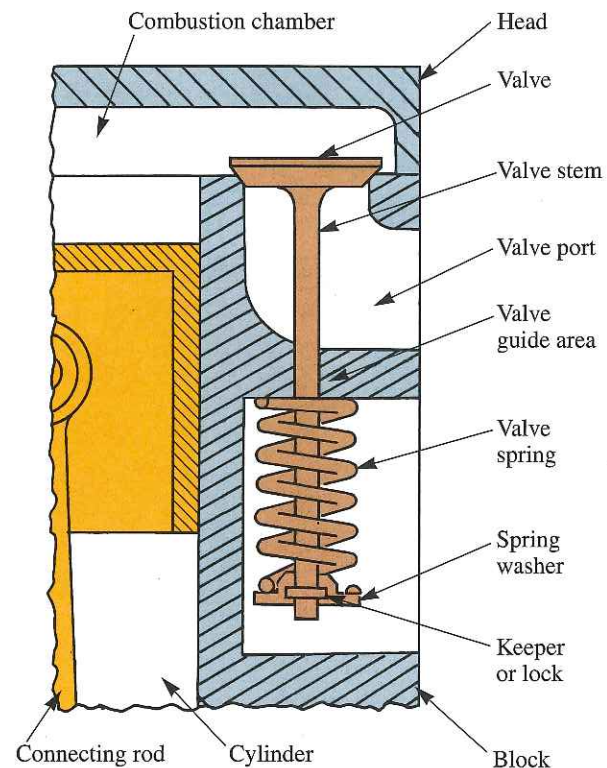


Figure 4-22. The valve spring keeps tension on the valve to ensure proper seating. The valve spring keeper and washer hold the spring in place and permit removal when necessary.

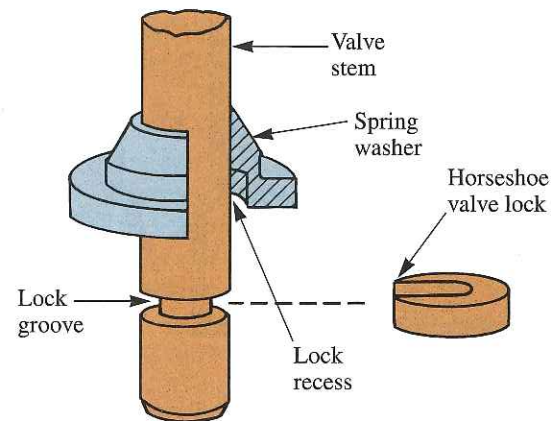


Figure 4-23. Typical method of retaining the valve spring on the valve stem. A special tool generally is used to compress the spring prior to removing the horseshoe valve lock.

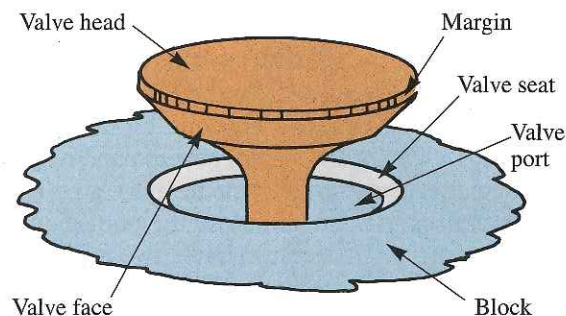


Figure 4-24. The valve face and valve seat must be ground to correct angles, and concentric to the centerline of the guide, to seal properly.

Valve lifter or tappet

In actual practice, the cam lobe does not contact the valve stem directly. By locating the camshaft some distance below the valve stem end, it is possible to insert a **valve lifter** between the lobe and stem. The valve lifter may have an adjustment screw in the upper end to provide a means of adjusting valve stem-to-lifter clearance. Without this adjustment, proper clearance must be obtained by grinding the end of the lifter or valve stem. The base of the lifter may be made wider than the body to provide a larger cam lobe-to-lifter contact area. See **Figure 4-26**.

By drilling a hole in the block above the camshaft, a guide is formed in which the lifter can operate. See **Figure 4-27**. The base of the lifter rides on the cam and the adjusting screw almost

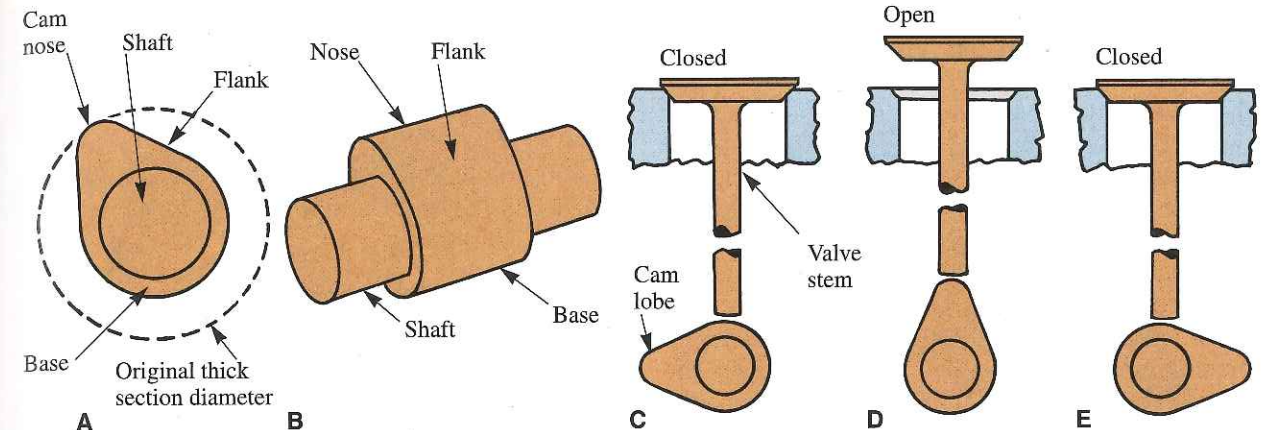


Figure 4-25. A, B—By grinding a round shaft into a cam shape, a camshaft is formed. C, D, E—When the camshaft is revolved, the cam lobe opens the valve.

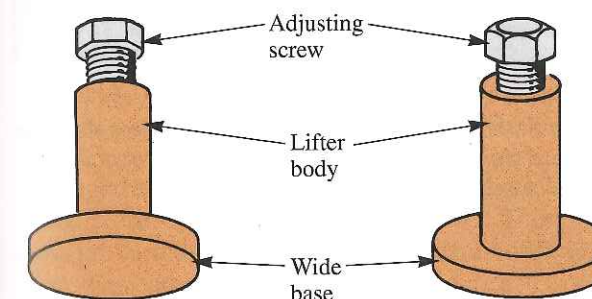


Figure 4-26. A valve lifter may be called a tappet or cam follower. An adjustment screw allows setting of the proper valve clearance. A wide base provides a larger contact area.

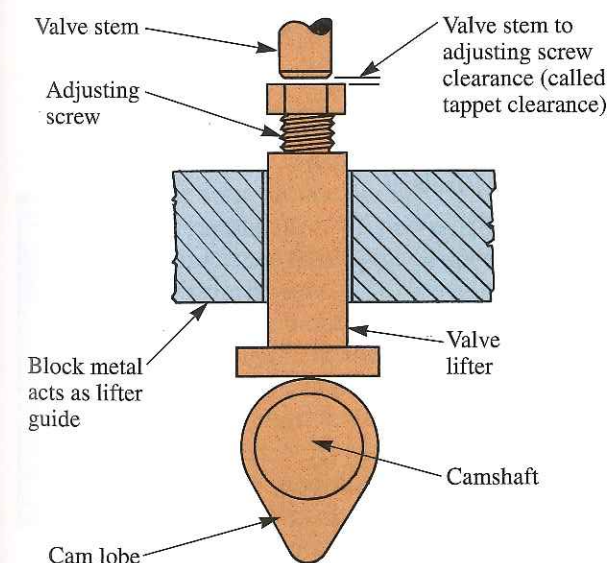


Figure 4-27. As the camshaft turns, the cam lobe will operate the valve lifter to open the valve, then allow it to close.

touches the end of the valve stem. As the camshaft revolves, the lifter rises and falls, opening and closing the valve.

Camshaft

The camshaft consists of a shaft with two or more lobes machined onto it; a gear, sprocket, or pulley; and machined surfaces that ride on the bearings that support the camshaft. In many engine designs, the camshaft is located in the crankcase, **Figure 4-28**. The camshaft in this type

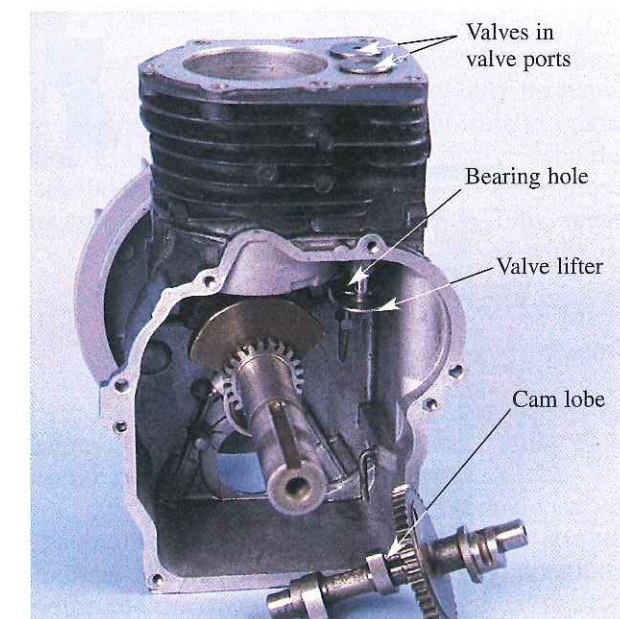


Figure 4-28. The cam lobes are located directly under the valve lifters. The camshaft turns in lubricated bearing holes.

of configuration is generally driven by a mating gear on the crankshaft. The gear on the camshaft is twice the size of the gear on the crankshaft, so that the camshaft turns one complete revolution for every two revolutions of the crankshaft, **Figure 4-29**. This gear ratio will be explained in more detail in Chapter 5.

Other engine designs position the camshaft above the valves, in the cylinder head. In this type of arrangement, the camshaft is usually driven by a chain or belt that connects a sprocket or pulley on the crankshaft to one on the camshaft. As with the gear drive, the pulley or sprocket on the camshaft is twice the size of the one on the crankshaft.

Valve train configurations

The **valve train** consists of all of the components that work together to transform the rotation of the crankshaft into the opening and closing of the valves. There are three main types of valve train configurations used in modern small gas engines. See **Figure 4-30**.

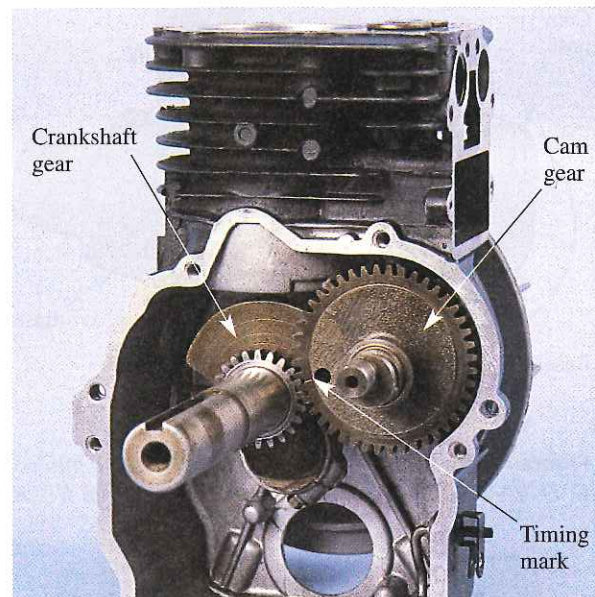


Figure 4-29. The camshaft is gear driven from the crankshaft. The camshaft gear is always twice as large as the crankshaft gear for proper timing. During assembly, timing marks must be matched.

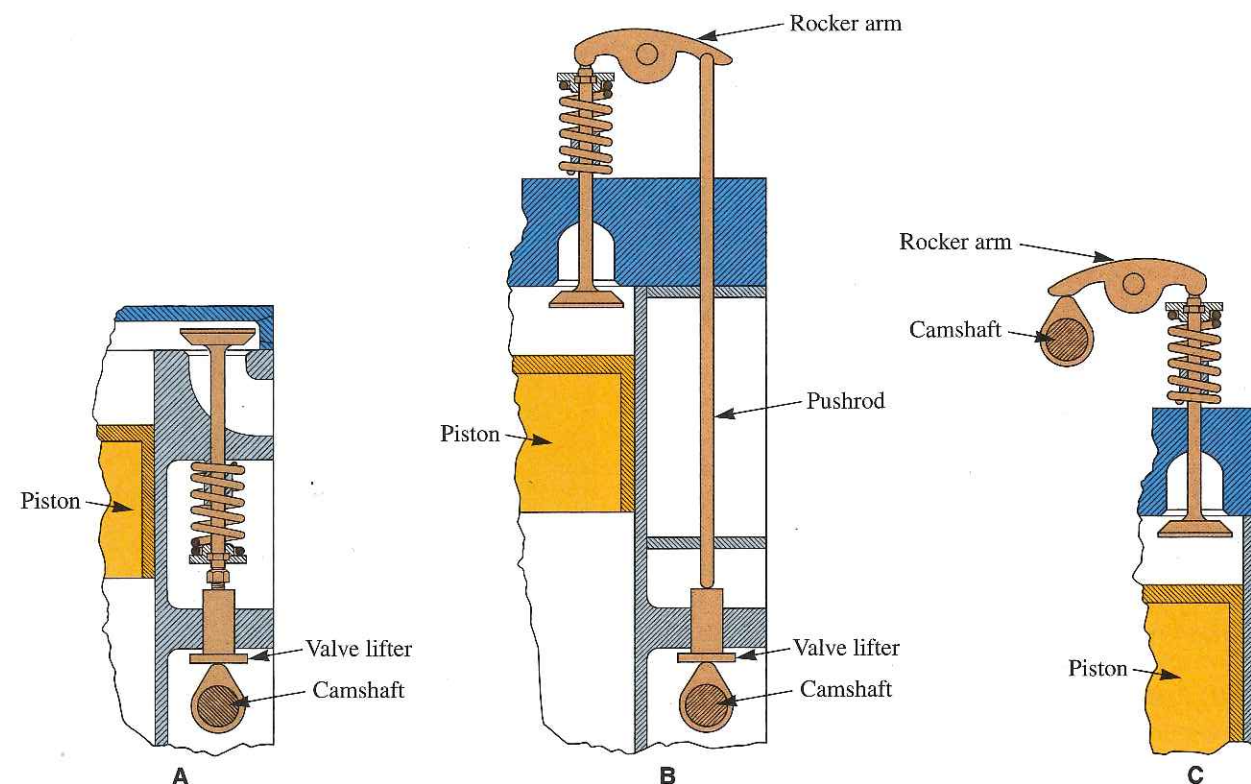


Figure 4-30. The three valve train configurations are shown here. A—Valve-in-block, or side valve configuration. B—Overhead valve (OHV) configuration. C—Overhead cam (OHC) configuration.

In the **valve-in-block** arrangement, **Figure 4-30A**, the camshaft is located in the crankcase and the valves are located in the cylinder block, directly above the camshaft lobes. As the camshaft rotates, the valve lifters act directly on the valve stems. Engines using this design are often referred to as flatheads, because the cylinder head is relatively flat and thin. This arrangement may also be referred to as an L-head or side-valve engine.

The **overhead valve (OHV)** arrangement has grown in popularity over recent years. In this arrangement, the camshaft is installed in the crankcase, but the valves are installed in the cylinder head. Pushrods transfer motion from the valve lifters, which are in the block, to one end of the rocker arms, which are installed in the cylinder head. The rocker arms are basically levers. When the pushrod pushes up on one end of the rocker arm, the other end of the rocker arm pushes down on the valve stem. See **Figure 4-30B**.

Some manufacturers use an **overhead cam (OHC)** design, **Figure 4-30C**. In this valve train arrangement, both the camshaft and valve assemblies are installed in the cylinder head. There are several variations of the overhead cam configuration. The camshaft may be positioned directly over the valves or offset. If the camshaft is offset, rocker arms are added to the design to transfer motion from the camshaft to the valves. Since the camshaft is located away from the crankshaft in all overhead cam designs, it is usually driven by a chain or belt rather than gears.

Flywheel

Even though the crankshaft moves fast during the power stroke, it is relatively light and tends to slow down or stop before the next power stroke. This periodic application of power, followed by coasting, would cause the engine to speed up, slow down, and/or run roughly.

To improve the running quality of the engine, an additional weight in the form of a round **flywheel** is fastened to one end of the crankshaft. See **Figure 4-31**. During the nonpower strokes, the inertia of the heavy flywheel keeps the crankshaft spinning and smoothes engine operation. Metal fins on the flywheel act as a fan that forces air over the cylinder to cool the engine. Magnets cast into the flywheel produce electrical current for the ignition system.



Figure 4-31. The flywheel is fastened to the crankshaft. When rotating, its weight smoothes engine operation.

Summary

A gasoline engine is designed to transform the chemical energy of burning fuel into mechanical energy. For engine use, gasoline should ignite readily, burn cleanly, and vaporize easily. It should also be free from dirt and oil and resist detonation.

For efficient small engine use, gasoline must be broken into small particles and mixed with air. This process is called atomizing.

To perform useful work, the explosive force caused by burning gasoline must be contained and controlled by a piston and a cylinder.

The cylinder block keeps all engine parts in alignment. Air-cooled engines have cooling fins on the outside of the cylinder block.

The crankshaft is the major rotating part in the engine. The crankcase is designed to protect internal engine parts and must be rigid enough to withstand the rotational forces of the crankshaft.

The piston is the straight line driving member of the engine. It provides a seal between the

combustion chamber and the crankcase. The piston is connected to the crankshaft by the connecting rod.

Air-fuel mixture is admitted and burned gases are exhausted through ports in the engine. In some engines, valves are installed in the ports to help control intake and exhaust. A camshaft and lifters are used to open and close the valves.



Know These Terms

gasoline	connecting rod
petroleum	ports
octane number	poppet valves
atomizing	valve guide
cylinder block	valve spring
cooling fins	camshaft
crankshaft	valve lifter
crankcase	valve train
casting	valve-in-block
piston	overhead valve (OHV)
piston rings	overhead cam (OHC)
piston pin	flywheel
wrist pin	



Chapter 4 Review Questions

Answer the following questions on a separate sheet of paper.

1. Why must fuel be atomized before it is ignited in the engine?
2. Force on the piston is transmitted to the crankshaft by the _____.
3. Name five desirable characteristics of gasoline for use in small engines.
4. Small gasoline engines generally use _____.
 - a. high octane fuel
 - b. low octane fuel
5. What effect did lead (tetraethyl lead) have when introduced into gasoline?
6. What was the main reason that unleaded gasoline was introduced?

7. What adverse effects can result from using gasoline with alcohol blends?
8. The cylinder block is generally made of _____ or _____.
9. When are sleeved cylinders used?
10. Why are sleeved cylinders used?
11. Why are metal fins made as a part of the cylinder?
12. _____ are designed into the crankshaft to provide for engine balancing.
13. Why do some pistons have a contoured face?
14. The _____ will cause the valve to rise and fall, opening and closing the ports.
15. The angled face of each valve will close tightly against a smooth _____ cut around each port opening.
16. Which is larger, the camshaft gear or the crankshaft gear? How much larger?
17. What are three tasks that are performed by the flywheel?



Suggested Activities

1. Visit a local gasoline station and find out the following:
 - a. Various fuel prices.
 - b. Octane ratings of the fuels sold.
 - c. Kind of containers fuel may be sold in.
 - d. Quantities that legally may be stored at home.
2. Disassemble an engine and identify the parts discussed in this chapter. Carefully analyze the function of each part as it relates to the others.
3. If the engine used for disassembly is a used one, look for possible defects such as worn bearings, burned valves, broken or worn piston rings, a scored cylinder, or a loose piston pin.
4. Write to manufacturers of small gasoline engines requesting specifications for the models they produce. Write a report on the types of pistons, connecting rods, and crankshafts they use.
5. Prepare a display of the major components of a small gasoline engine. Use actual parts, photos, drawings, and cutaways to show the principal use of each part.