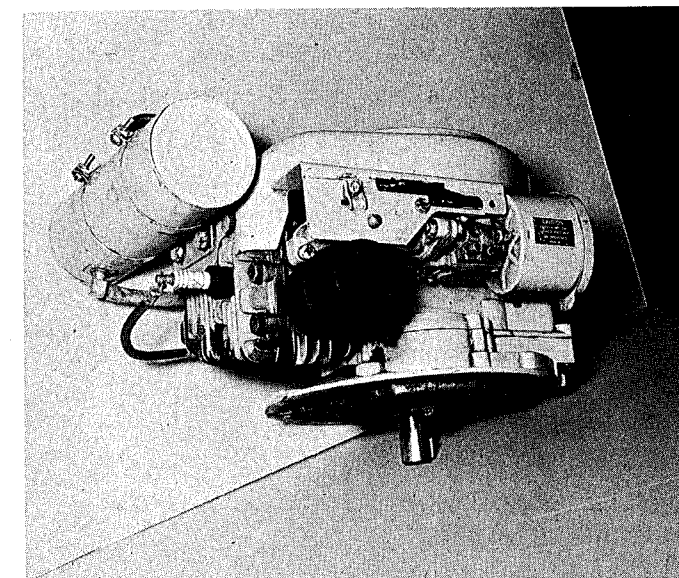
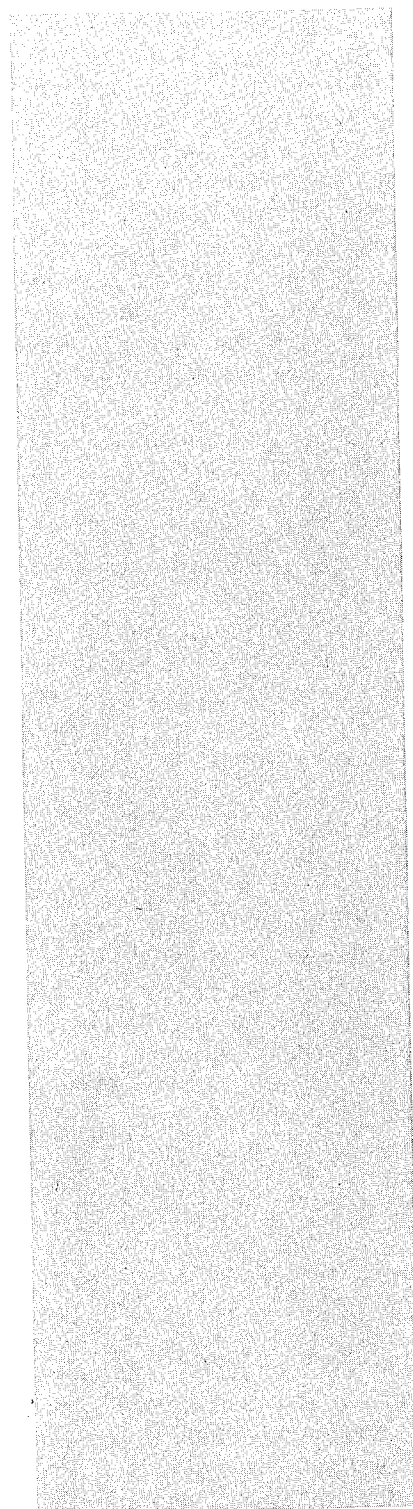


textbook and your teacher will help you to begin acquiring the knowledge and skills needed. The trade is always expanding; perhaps a new use for small engines, such as powering ultralight aircraft, will capture your imagination and send you on the road to certification in this interesting field of technology.



CHAPTER 1

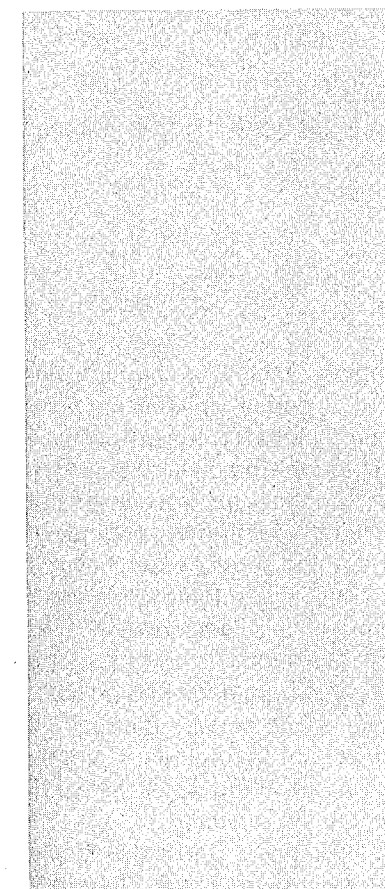
THE SMALL ENGINE

Words to Learn

<i>cylinder block</i>	<i>camshaft</i>	<i>electrode</i>
<i>crankcase</i>	<i>timing gears</i>	<i>terminal</i>
<i>cylinder head</i>	<i>valve lifter</i>	<i>porcelain</i>
<i>connecting rod</i>	<i>valve</i>	<i>insulator</i>
<i>piston</i>	<i>magneto</i>	<i>carburetor</i>
<i>crankshaft</i>	<i>spark plug</i>	<i>flywheel</i>

How to Use These Words

1. The *cylinder head* is bolted to the *cylinder block* of many small engines.
2. The *crankshaft* is located in the *crankcase*.
3. The *piston* fits inside the cylinder.
4. The *connecting rod* joins the piston to the *crankshaft*.
5. A set of *timing gears* is used to make the *camshaft* turn half as fast as the *crankshaft*.
6. The intake and exhaust *valves* are opened by *valve lifters* that rest on the cams of the *camshaft*.
7. A *magneto* and *spark plug* make up the electrical system of a small engine.
8. When electricity jumps between the two spark plug *electrodes*, a spark occurs.
9. A thick wire connects the coil to the spark plug *terminal*.





10. *Porcelain* does not conduct electricity, so it is a good electrical *insulator*.
11. A *carburetor* mixes fuel and air in correct amounts.
12. The *flywheel* is fastened to one end of the *crankshaft*.

Look for Answers to These Questions:

1. What type of seals are used between a piston and its cylinder walls?
2. What type of small engine often has the cylinder head and upper cylinder block cast in one piece?
3. What type of valves are used in small four stroke cycle engines?
4. How is the up and down motion of the piston made to revolve the crankshaft?
5. What causes the camshaft to revolve?
6. How does a camshaft open the valves?
7. What causes the valves to close tightly?
8. What does the magneto do to make an engine run?
9. What two jobs does the carburetor perform for an engine?
10. What job does the spark plug do for an engine?

INTRODUCTION

Be careful: Do not run engines in a closed workshop. Exhaust fumes contain carbon monoxide gas. You can't see it, smell it, or taste it, but it can kill you.

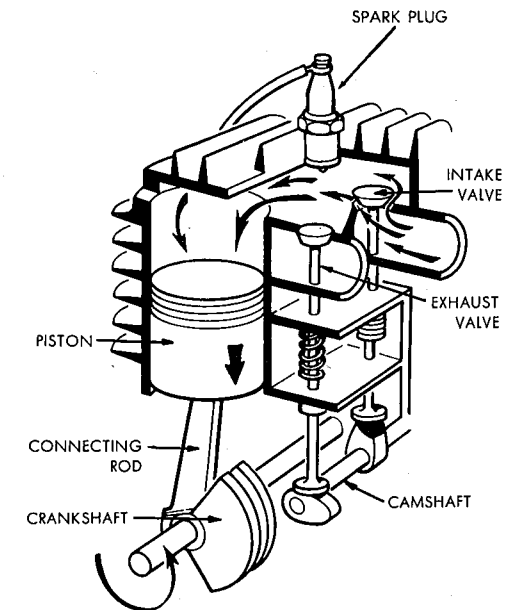
Small engines, like automobile engines, must have regular care if they are to remain in good operating condition. Most car owners carefully follow the maker's suggestions for the proper care of their cars. They do this by seeing that the oil is changed at the proper time and that greasing and tune-ups are carried out regularly. Yet, the same owners often forget that the engines of their lawnmowers or outboards need the *same* care if they are to give them long and reliable service. Any engine will reward its owner with long and trouble-free service if its needs are cared for regularly. Service advice can be found in the operator's manual that the manufacturer gives out with each engine sold.

It is also possible to get very complete service manuals at low cost from the manufacturers of small engines. A small-engine mechanic should buy the service manuals for the types of engines he or she is most likely to be servicing.

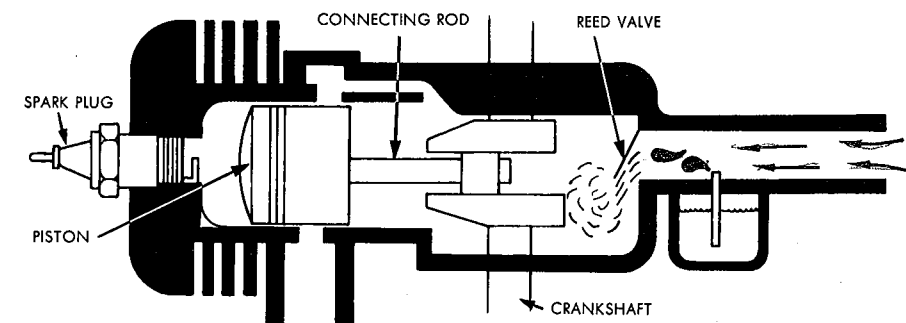
There are two basic types of small engines. One is the simple two stroke cycle engine with very few moving parts. The other

type is the more complicated four stroke cycle engine with more moving parts and a smoother delivery of power. Both kinds of engines are used on gasoline-powered lawnmowers, outboard motors for small boats, and for many other units such as portable pumps and chain saws. Many air compressors for paint spraying outfits and rotary trowels to smooth concrete floors are also operated by small engines.

Be careful: Protect your hearing. Wear ear plugs or muffs when working in a noisy shop or near loud engine exhaust.



Four stroke cycle engine, cutaway drawing



Courtesy Outboard Marine Corp. of Canada, Ltd.

Two stroke cycle engine, cutaway drawing

The Parts of the Engine

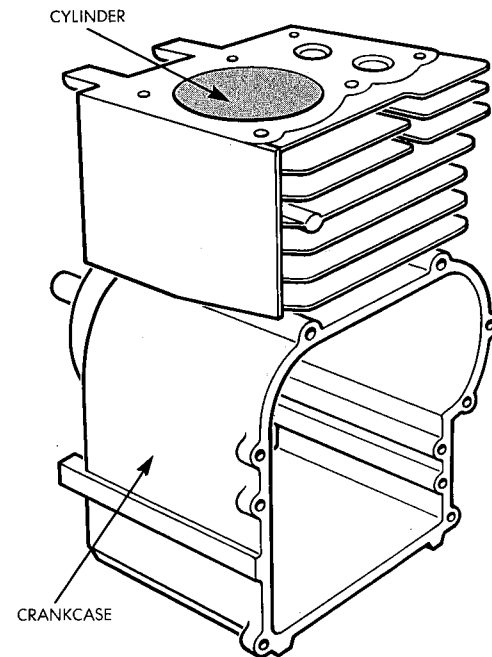
Cylinder block: the large, main part of any engine.

THE CYLINDER BLOCK

The cylinder block is the basic part of an engine. All other parts either fasten to it or are fastened inside it. The shape is often complicated, and the block is cast in a mould to obtain the necessary shape. Small engine blocks are sometimes made from cast iron, but most are cast from aluminum or other light metals.

THE CYLINDER

The cylinder is the name given to the large hole bored in the block. This hole receives the piston, which slides up and down in the cylinder bore after it has been smoothed and polished inside. The cylinder is not a separate part of the engine but it is important to the operation of the engine.



Cylinder and crankcase

Crankcase: the part of the cylinder block where the crankshaft revolves.

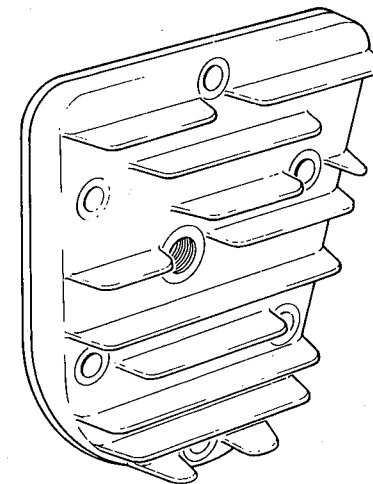
Cylinder head: a metal cover bolted to the top of the cylinder block.

THE CRANKCASE

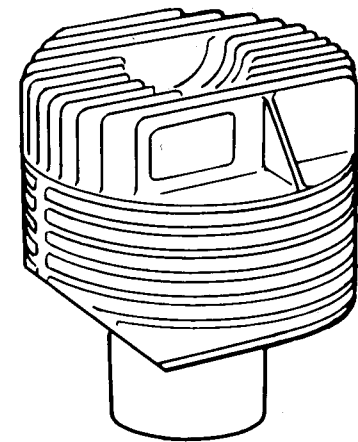
The crankcase is the lower part of the cylinder block, in which the crankshaft revolves. Some small engines have separate crankcase sections. These sections bolt to the cylinder block.

THE CYLINDER HEAD

The cylinder head is a piece of metal shaped and bolted to the top of the cylinder block to cover the cylinder. It usually has a threaded hole for the spark plug and is hollowed out on the underside to form a combustion chamber. Sometimes, the cylinder head is cast with cooling fins attached, so that the air passing over the fins keeps the cylinder head cool. On small two stroke cycle engines, the cylinder head is often cast as one piece with the cylinder block.



Cylinder head

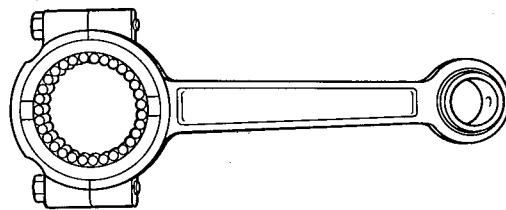


A one-piece cylinder head and upper cylinder block

Connecting rod: the connecting rod connects the piston to the crankshaft.

THE CONNECTING ROD

The connecting rod joins the piston to the crankshaft. One end of the rod is connected to the inside of the piston by means of a piston pin. The piston pin passes through both the piston and the top of the rod. The lower end of the connecting rod has a removable cap so the rod can be fastened to the crankshaft.

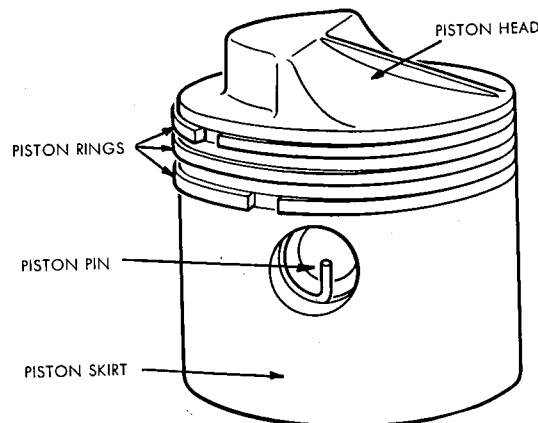


Connecting rod

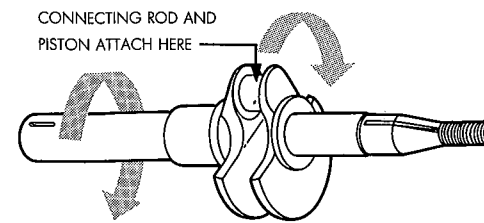
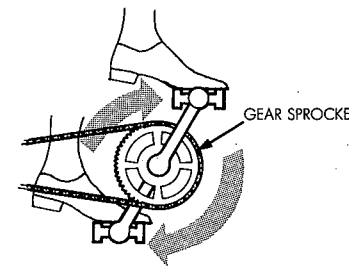
THE PISTON

Piston: a round cylindrical piece of metal which fits in the cylinder of the engine block and moves up and down.

The piston is a cast piece of steel or aluminum made to fit very exactly into the cylinder. The piston has two or more steel piston rings around it to provide a seal between the piston and the cylinder walls. The piston moves up and down in the cylinder and is forced down in the cylinder by the pressure made by burning fuel.



The piston



Crankshaft

Crankshaft: the rotating, main shaft in an engine. The pistons make it rotate.

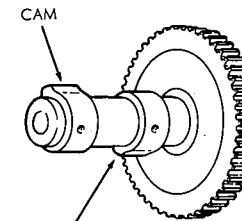
THE CRANKSHAFT

The crankshaft changes the up and down motion of the and connecting rod to rotating motion, just as pedals a rider to propel a bicycle by changing the up and down motion of the rider's legs to the circular motion of the pedals and the sprocket. The bicycle rider's legs power the chain sprocket, the piston and connecting rod power the crankshaft.

Camshaft: the shaft in an engine which pushes open the intake and exhaust valves.

THE CAMSHAFT

The camshaft has two lobes, or cams, for each cylinder in an engine. Cams are off-centre lobes which open the intake and exhaust valves one after the other. The camshaft is driven by the crankshaft. The crankshaft has a small gear on one end which connects to a large gear on the end of the camshaft. As the crankshaft rotates, its gear turns the gear on the camshaft and causes it to rotate, too. These gears are called valve gears. Some engines use a chain and sprockets instead of gears. The chain is called a valve timing chain.

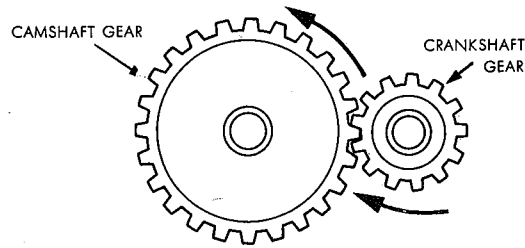


Camshaft

Timing gears: gears used to turn the camshaft and open and close the valves at the right time.

THE TIMING GEARS

The timing gears control the opening and closing of the valves so that each valve operates at the right time. The gear on the camshaft has twice as many teeth as the crankshaft gear; therefore, the camshaft turns half as fast as the crankshaft.

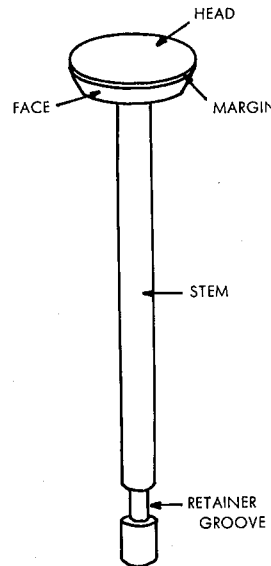


Timing gears

THE VALVES

Valve: a device used to control the flow of air, gas, or liquid through a hole.

The valves are mushroom shaped, with long stems. They are made of steel. The intake valve, when open, allows fuel to enter the cylinder. The exhaust valve, when open, allows burnt gases to escape. When both valves are closed, nothing can get in or out of the cylinder.

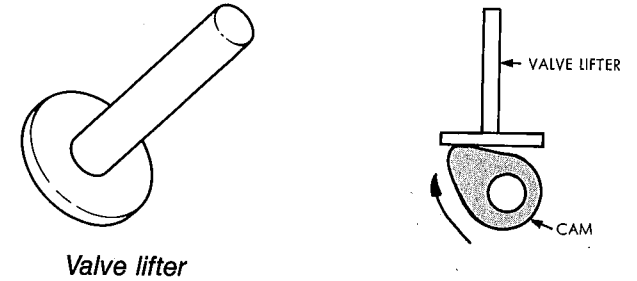


Valve structure

Valve lifters: small rods with one flat end. Valve lifters push valves open.

THE VALVE LIFTERS

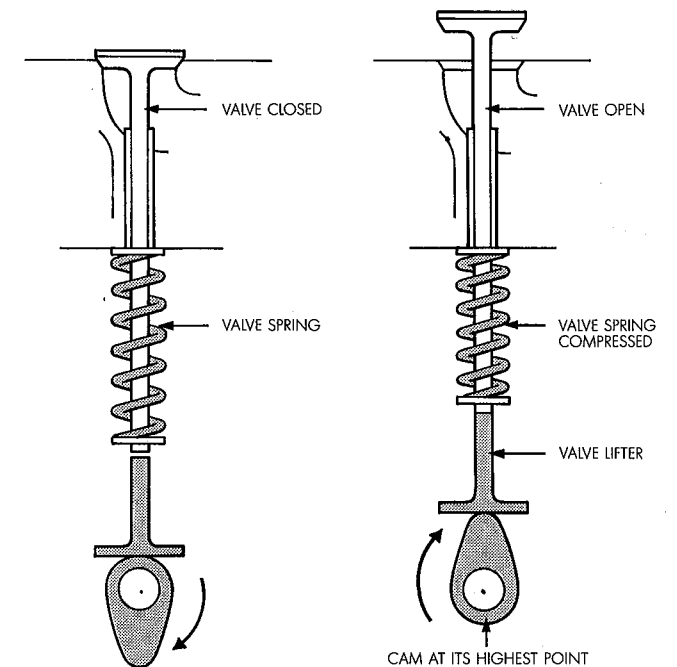
Each valve lifter rests on a cam on the camshaft and presses on the end of the valve stem to lift and open each of the valves at the right time.



Valve lifter

THE VALVE SPRINGS

The valve springs are always pushing down on the valve stems, keeping the valves in the closed position, until a valve lifter pushes them open. For this reason, each valve closes tightly as soon as the highest point on the cam passes and the lifter releases pressure on the valve stem.



Valve springs

THE SPARK PLUG

Spark plug: a device designed to make a powerful spark jump across a small gap in order to ignite fuel.

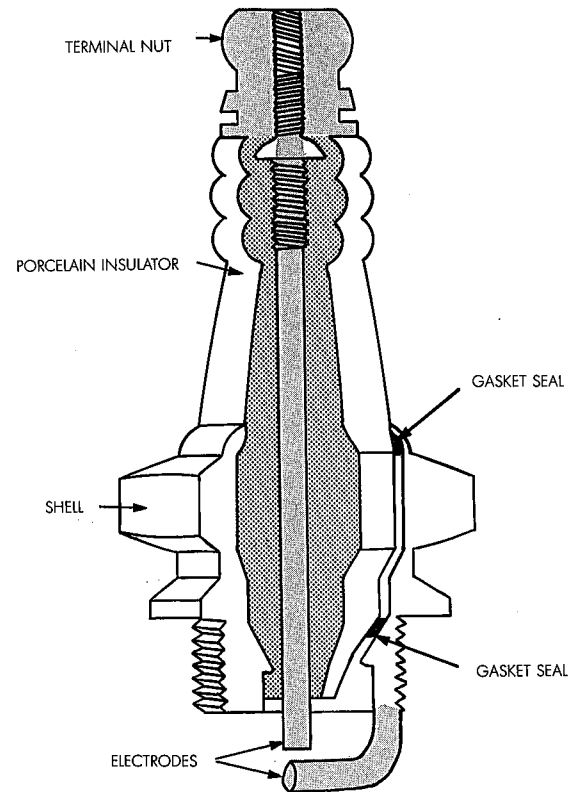
Electrodes: two wire-like parts of a spark plug that extend into the cylinder to provide a gap for an electric spark.

Porcelain: a hard, brittle material like china. Its surface is usually smooth and white.

Insulator: a substance which does not conduct electricity. Insulators are used to keep electricity from escaping from a line, and to shield other parts from electrical shock or current.

Terminal: a name given to all points in electrical devices where wires may be connected.

The spark plug screws into a hole in the cylinder head. It is designed to provide a gap for an electric spark to jump between two pieces of steel, called electrodes. The threaded shell part of the plug is steel and the upper part is made from a material called porcelain, which is like the material used to make china plates and cups. Porcelain does not conduct electricity, so it is used as an electrical insulator. The lower electrode is fastened to the threaded part of the plug. The centre electrode passes through the porcelain and has a threaded end at the top. A round nut screws onto this threaded end to form a wire terminal. A heavy wire that comes from the magneto is pushed onto this round nut.

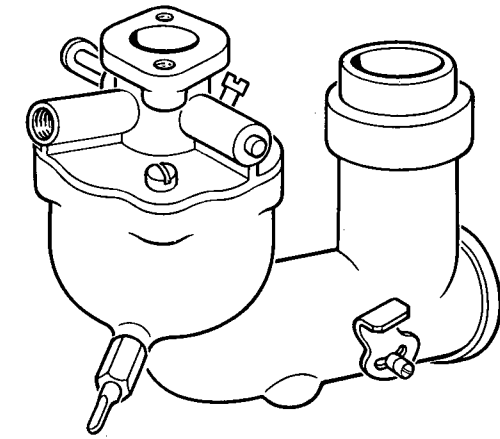


Cutaway drawing of a spark plug

Carburetor: carburetors are used on gasoline engines to mix fuel and air in the right amounts.

THE CARBURETOR

The carburetor is a mixing place for fuel and air. The carburetor breaks up the fuel into a fine spray and mixes it with the right amount of air to make a mixture which will burn properly in the cylinder. The carburetor controls the crankshaft speed by the amount of fuel/air mixture it allows into the cylinder.

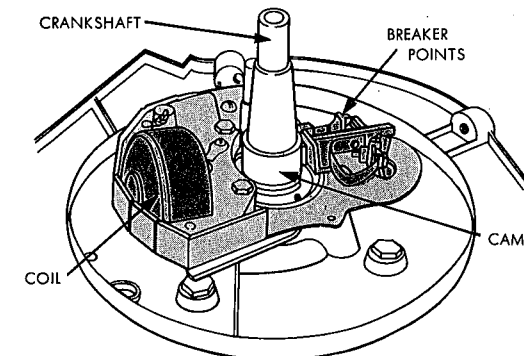


Carburetor

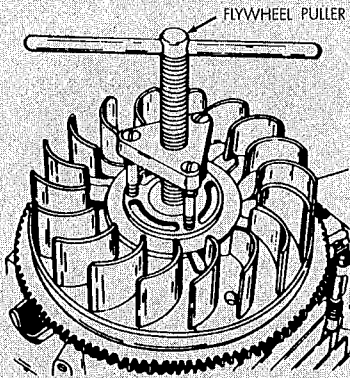
THE MAGNETO

Magneto: a device used to make an electric spark to ignite the fuel in the cylinder.

The magneto is made up of many smaller parts. We will look at it more closely in another chapter. All the parts of the magneto work together to make an electrical spark between the two points of the spark plug. The magneto makes the spark at the right time to ignite the fuel, which has just been sucked into the cylinder and compressed.



Flywheel: a wheel that attaches to the crankshaft. It is used to help start the engine and keep it running smoothly.

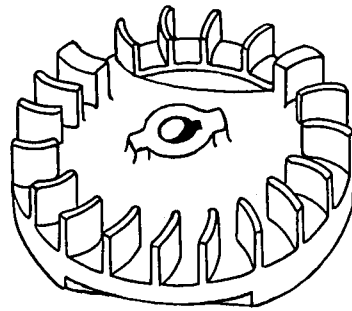


Courtesy Tecumseh Products Canada, Ltd.

Using a flywheel puller to remove a flywheel

THE FLYWHEEL

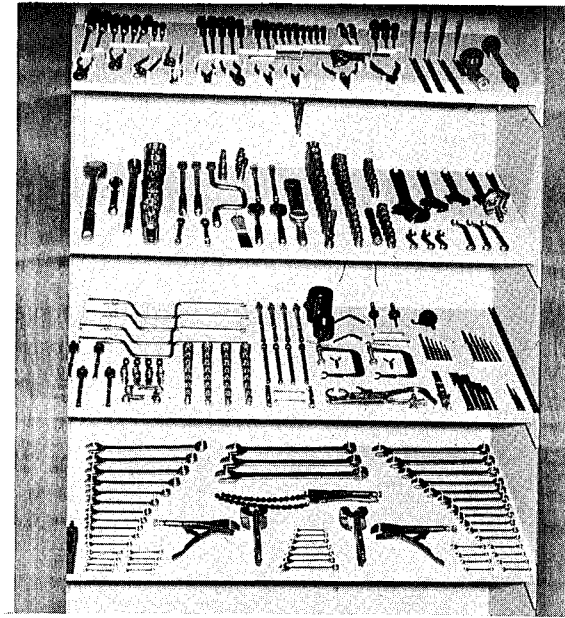
The flywheel is a heavy, round metal casting that, on many engines, must do three or four jobs. It is fastened to one end of the crankshaft where its heavy mass helps make the crankshaft turn around evenly and smoothly between power strokes. The fins on the flywheel make it work like a fan to blow cooling air past the cylinder head and block. When a magnet is cast into the rim of the flywheel, it becomes part of the magneto. Whatever type of cranking device is used to start an engine, the flywheel is part of it. Sometimes the starter is only a rope wound around a pulley on the flywheel. Sometimes it is a heavy spring that may be wound tight and released to engage the flywheel. Many small engines today have electric starters. Electric starter motors crank an engine by spinning the flywheel.



Flywheel

Things to Do

1. Use a cutaway drawing of a small engine to locate the parts listed and described in this chapter.
2. Compare the parts of a four stroke engine to those of a two stroke engine.
3. Make a list of as many uses for small engines as you can find.
4. Study the Words to Learn section and then write a list of parts of a four stroke engine.
5. Make a list of the parts of a two stroke engine.
6. Make a drawing of a piston and its connecting rod. Label the drawing.
7. Make a drawing of a crankshaft with timing gear at one end and a flywheel at the other end.



CHAPTER 2

AN ENGINE MECHANIC'S HAND TOOLS

Watch for These Words

<i>swivel</i>	<i>gauge</i>
<i>ratchet</i>	<i>hone</i>
<i>extension</i>	<i>torque</i>
<i>universal</i>	<i>warp</i>

How to Use These Words

1. A hinge joint in a wrench handle allows it to *swivel*.
2. A *ratchet* allows a wrench to turn a nut in only one direction, without having to turn the wrench handle completely around.
3. An *extension* will give a socket wrench more reach.
4. A *universal* joint allows torque to pass from one shaft to another shaft, even if the two shafts meet at an angle.
5. A *gauge* is an accurate measuring tool.
6. Fine grit stones are used in a cylinder *hone*.
7. A *torque* wrench measures the tightness of nuts and bolts.
8. You may *warp* a cylinder head by careless tightening of the head bolts.

Chapter 1: The Small Engine

1. What type of seals are used between a piston and its cylinder walls?
2. What causes the camshaft to revolve?
3. How does the camshaft open the valves?
4. What two jobs does the carburetor perform for an engine?