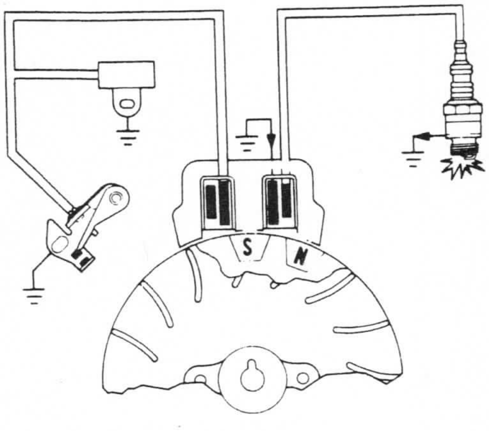

unit 8
ignition systems

An engine develops power when the heat of a burning air-fuel mixture pushes the piston down. An electric spark starts the air-fuel mixture burning. The spark comes from a system on the engine called the *magneto.*

A magneto needs several parts to make a spark. The engine in Figure 8-1 shows the basic parts of a magneto: a magnet, armature, coil, spark plug, breaker points, and condenser. In this unit we will study how a magneto ignition system works.

LET'S FIND OUT **When you finish reading and studying this unit, you should be able to:**

1. **Define the terms *electricity* and *magnetism*.**
2. **Identify the parts of a magneto ignition system.**
3. **Describe the operation of the magento breaker points and condenser.**
4. **Explain the operation of the magneto magnets and coil.**
5. **Describe the parts and operation of a spark plug.**

ELECTRICITY

In order to understand how a magneto works, you need to know a little about electricity and magnetism. The current theory or way of thinking about electricity is called *the electron theory.* We still do not know everything about electricity. Using the electron theory we can, however, understand how electricity behaves and how to use it. In order to understand the electron theory, it is necessary to look briefly at what the scientists call the composition of matter.

Everything in the universe except the complete voids that exist between the sun, stars and planets is called matter. Anything that has weight and takes up space is matter. Even things that cannot be seen, such as air, are matter. Matter may be in the form of a solid, a liquid or a gas. All matter is

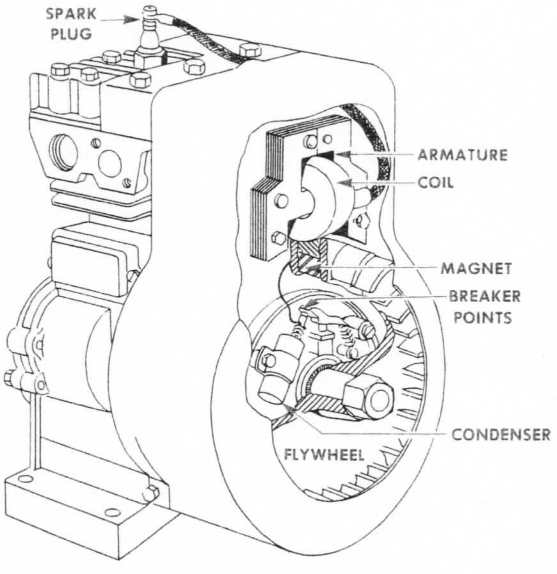

Figure 8-1. The basic parts of a magneto. (Briggs & Stratton Corp.)

composed of very, very small particles called *atoms*. An atom is so small that it is not visible except under the most powerful electron microscope. Atoms are made up of even smaller particles.

An atom is constructed much like our solar system, Figure 8-2. Think of the sun and the various planets which revolve around it. An atom has a center or core composed of particles called *protons* and *neutrons*. This core is called a *nucleus*. In our example of the solar system, the sun is like the nucleus. Other small particles called *electrons* circle in orbits around the nucleus, much as the planets circle the sun. Electrons travel at a tremendous rate of speed.

The particles which make up the atom have positive and negative electrical charges. Why atoms have this quality is not known but this is where electricity comes from. *Positive and negative charges* means simply that the two charges are completely opposite. The symbol + is used to show a positively charged particle and the symbol – to show one with a negative charge. Almost everyone has experimented with a set of magnets and observed that the magnets can be placed so that they repel each other or so that they attract each other. Electrical charges act in much the same way. Two particles that are positively charged will repel each other; two negatively charged particles will repel each other. A positively charged particle and a negatively charged particle attract each other. This positive-negative attraction is what holds the atoms together.

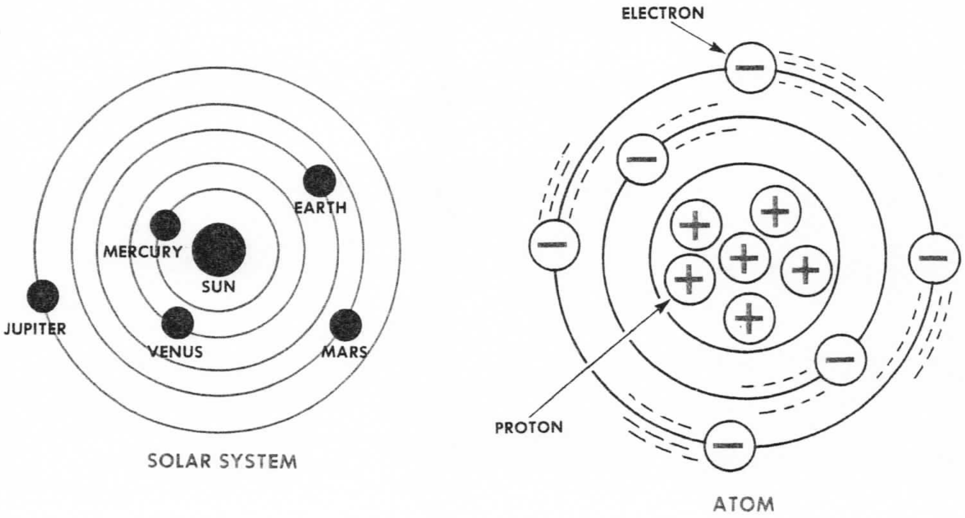

Figure 8-2. An atom is constructed like our solar system.

The core, or nucleus, of an atom is made up of positively charged particles. The electrons that orbit in a fixed pattern around the nucleus are negatively charged particles. The only difference among the atoms of different kinds of matter is the number of particles in the nucleus and the number and spacing of the electrons that orbit the nucleus.

The nucleus of the atom is composed of protons with a positive charge and neutrons with a neutral charge. The electrons with a negative charge orbit a specific distance away from the nucleus. An atom may have one, two or three rings of electrons depending on the number of electrons it contains. Each of these rings requires a specific number of electrons.

The Flow of Electricity

If we again compare the atom to our solar system, the electrons orbit the nucleus as the planets orbit the sun. The electrons remain in their orbit around the nucleus because of the electrical attraction the electrons have for the nucleus. This is similiar to the gravitational pull of the sun on the earth. The electrons that orbit closest to the nucleus are strongly attracted to it. These are called *bound* electrons. The electrons that are farther away from the pull of the nucleus can be forced out of their orbits. These are called *free* electrons. Free electrons can move from one atom to another. The movement of the free electrons from one atom to another is known as *electron flow*.

According to the electron theory, electricity is the movement or flow of electrons from one atom to another, Figure 8-3. In order to have a movement of electrons, it is necessary to have a condition of imbalance. In a normal atom, the positively charged nucleus balances the negatively charged electrons and holds them in orbit. If an atom loses electrons, it will become positive in charge. It will attract more electrons in order to regain its balance.

The flow of electricity is made possible by causing electrons to leave their atoms and gather in a certain area, leaving behind atoms without their normal number of electrons. Science has discovered a number of ways to create an unbalanced condition to start an electron flow.

Language of Electricity

Electricity has a language all its own. A mechanic must understand the meaning and relationship of a number of electrical terms in order to understand magnetos. The terms described below are relatively simple but they are the foundation for all electrical troubleshooting and servicing.

Voltage (volt) (E). In order to have a flow of water in a fire hose, pressure is necessary. In order to have an electron flow in an electrical system, pressure is necessary. In electricity the force or potential that pushes electrons is called *voltage*.

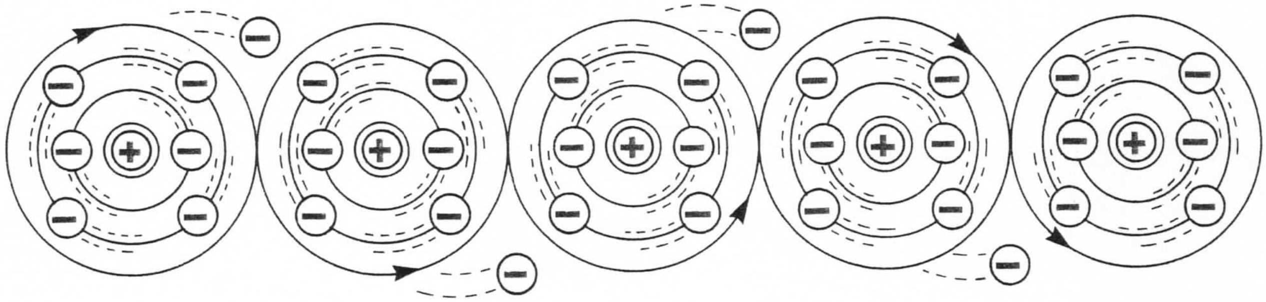

Figure 8-3. Electricity is the movement of electrons from one atom to another.

Water pressure is measured in pounds per square inch; electrical pressure is measured in volts. The letter symbol for the volt is E (for electromotive force) or V.

Voltage may be considered a source of potential energy that exists when unequal numbers of electrons are present in a system. *Voltage* or *volts* always describes a potential difference between two parts of an electrical system. The voltage of your house wiring may be 110. This voltage is present even though no household appliance is turned on. The voltage "stands by" until an appliance is turned on. It is important to understand that voltage can exist without electron flow although electron flow cannot exist without voltage.

Current (ampere) (I). Returning to the example of the fire hose, the rate of water flow may be measured in gallons per minute. In an electrical system, we are interested in the rate of electron flow. The flow of electrons is called *current*. Current is measured in amperes. The letter symbol for current is I. The flow of current is measured by a specific number of electrons passing a given point in one second. One ampere is equal to 6.28 billion electrons per second. As was mentioned previously, current cannot flow unless there is pressure or voltage.

Resistance (ohm) (R). The diameter of the fire hose will determine the amount of water that will be able to flow through it in a given amount of time. A smaller hose will provide more resistance to the flow. There is also a resistance to electron flow in an electrical system. Resistance is the opposition offered by a material to the free flow of electrons. The unit of resistance is called an ohm. The letter symbol is R.

When current runs into resistance, two things occur: first, the electrons must work harder to get through, and this creates heat. Second, the rate of their flow is reduced because some of the energy is used up as heat. The heat built up by resistance is sometimes used to do work. For example, in an ordinary household toaster, current is directed through a strong resistance. The heat produced in the resistance is used to toast the bread.

Conductor. A conductor is any material that allows a good electron flow. In a small-engine electrical system, copper and aluminum wires are used to conduct electricity because they allow good electron flow. To be a good conductor, a material must be made of atoms that give off free electrons easily. Also, the atoms must be close enough to each other so that their free-electron orbits overlap. Of all the metals, silver is the best conductor but it is too expensive for general electrical use.

Insulator. Insulators are materials whose atoms will not part with any of their free electrons. These materials will not conduct current. The copper wire in a small-engine electrical system is covered with an insulator. The insulation prevents the current from leaking out before it gets to its destination. Examples of materials which make good insulators are plastic and rubber.

Circuit. A circuit is a path or network of paths that will allow current to flow to do some work. Any circuit, no matter how complicated, is made up of several essential parts. A circuit is shown in Figure 8-4. There must always be a source of electrical pressure or voltage. In this illustration, the voltage source is a battery. In this circuit the current flow is used to light a light bulb. The light bulb will offer resistance to the current flow. A switch is necessary to turn the current flow on or off in the circuit. Wires or conductors connect the battery, switch and light bulb. Our circuit, then, has a voltage source (battery), a resistance unit (light bulb) and a switch connected by conductors (wires). In order for current to flow in a circuit, the path must be unbroken. In fact, the term *circuit* means *circle*.

Ground Circuit. Not only can electricity flow through wires, it also can flow through metal

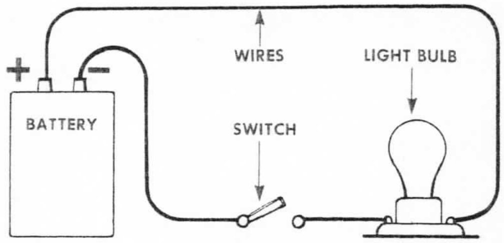

Figure 8-4. Parts of a circuit.

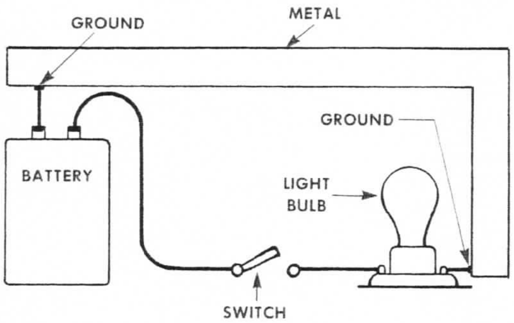

Figure 8-5. Electrical parts can be connected to metal instead of to a wire to make a complete circuit.

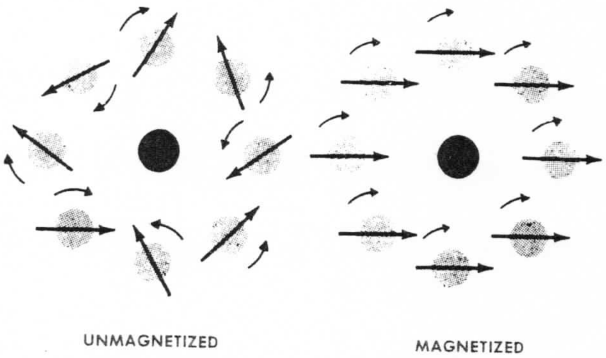

Figure 8-6. Magnetism is the alignment of electron orbits. (Clinton Engines Corp.)

parts on the engine. We can use these metal parts in place of one of the wires in a circuit. Look at the example in Figure 8-5. Instead of a wire from the light bulb to the battery, we could connect a short wire from the battery to a metal part on the engine. We could connect a short wire from the light to the same metal part. Electricity will flow across the closed switch into the light. Current will flow through the light into the metal on the engine and back to the battery. This completes the circuit and the light lights up. The part of the circuit connected to the metal is called *ground* or *grounded.* We call this a grounded circuit or ground circuit. Most electrical parts have one connection grounded. This means we only need one wire to have a complete circuit between two electrical parts.

MAGNETISM

Magnetism is a force that is involved in the operation of the magneto. The word *magneto,* in fact, comes from the word *magnet* or *magnetism.* Exactly what magnetism is and how it uses its force is still not completely understood. One theory is based upon the electron. This theory says that each electron has a circle of magnetic force around it. In an unmagnetized piece of iron, the electron orbits are not arranged in any pattern. In a magnetized piece of iron, the electron orbits are lined up so that their circles of magnetic force are added together, Figure 8-6. When all the magnetic forces work together, the piece of iron has a strong magnetic field.

INDUCTION

Induction involves the transfer of energy from one object to another without the objects touching each other. Induction is used in the magneto coil.

When current flows through a coil, a magnetic field is created in the coil. If the coil with current flowing in it is placed near another coil without current, the two coils will influence each other. If two coils are placed next to each other as shown in Figure 8-7, the bulb connected to the second coil will not light. If the switch is opened, the field around the first coil will collapse and jump over to the second coil. This collapsing magnetic field will cause current to flow in the second coil. The light connected to the second coil will light, but just for a fraction of a second. If the first coil is charged, then collapsed again, the light will light again. The kind of induction is used in magneto ignition coils.

MAGNETO MAGNETS

As we said earlier, the word *magneto* comes from the word *magnet.* All magnetos have magnets. Magnetism may be used to help make electricity. The magneto magnet is attached to the engine's flywheel. The magnet may be attached to the inside of the flywheel, as shown in Figure 8-8. On other engines it is attached to the outside of the flywheel. The magnet may be cast into the

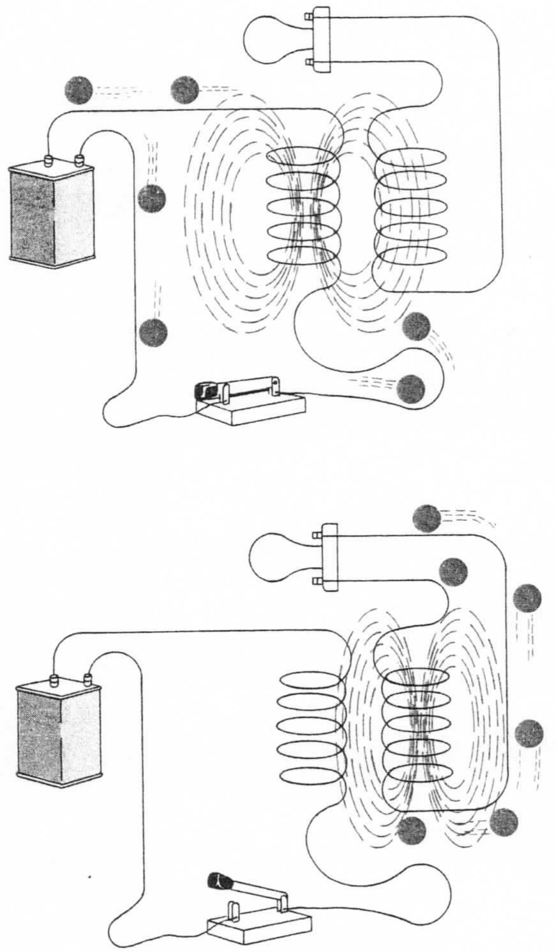

Figure 8-7. A collapse in a magnetic field can cause current to flow in another coil.

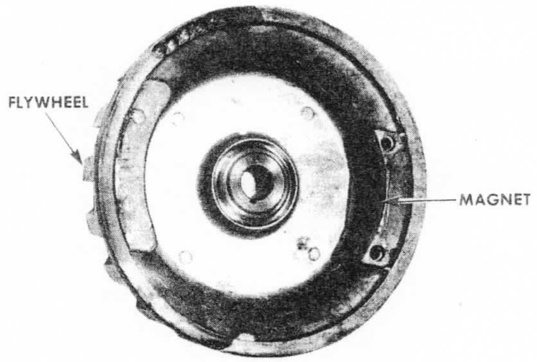

Figure 8-8. A magnet is attached to the flywheel.

flywheel, or it may be mounted to the flywheel with bolts. The magnet goes around with the flywheel. We use this revolving magnet to make electricity.

Armature and Coil

We cannot make electricity with just a magnet. We need an armature and a coil. An armature and coil are shown in Figure 8-9. The armature is made from several thin strips of soft iron. The strips are squeezed tightly together. The armature is used to make a path for the magnetism.

The coil is attached to the armature. Inside the coil is a fairly thick wire. This wire is wrapped, or coiled, around part of the armature, as shown in Figure 8-10. It is called the *primary wire*. One end of the primary wire is attached to the armature. The other end goes to a switch called the *breaker points*. We will see how these work later.

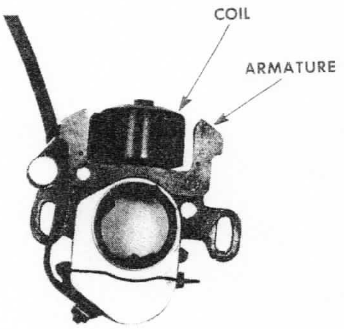

Figure 8-9. An armature and coil are part of the magneto.

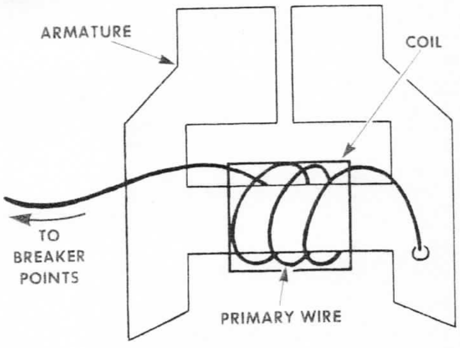

Figure 8-10. There is a thick wire, called a primary wire, inside the coil.

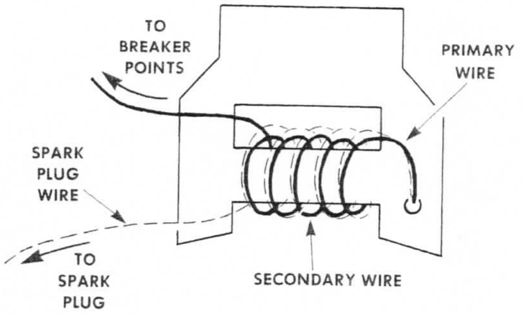

Figure 8-11. There is a thin wire in the coil, called the secondary wire.

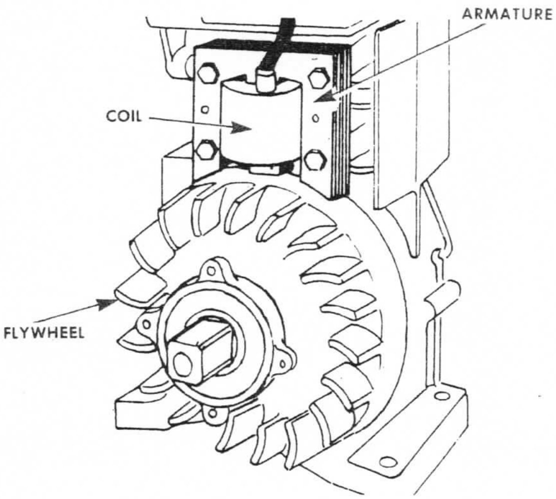

Figure 8-12. The armature and coil are mounted next to the flywheel and magnet. (Briggs & Stratton Corp.)

There is another wire inside the coil. It is called the *secondary wire.* The secondary wire is wrapped around the primary wire. The secondary wire is much thinner than the primary, and is wrapped around the armature many more times.

One end of the secondary wire is hooked to the armature. The other end is hooked to the thick wire that goes to the spark plug, Figure 8-11.

The armature and coil are mounted next to the flywheel. In Figure 8-12 the magnet is attached to the outside of the flywheel. The armature and coil are mounted right above the flywheel. On some engines, the magnet is mounted inside the flywheel, and the coil and armature are mounted under the flywheel.

Magnet and Coil Operation

Let's see how a magneto makes electricity. The magnet goes around with the flywheel. As the flywheel turns, the magnet goes under the armature, as shown in Figure 8-13. Magnetism from the magnet moves from one end of the magnet and into the armature. The magnetism travels through the armature and back into the magnet.

The flywheel turns some more. The magnet lines up under another part of the armature, as shown in Figure 8-14. The magnetism now passes through the armature in the opposite direction. When magnetism changes direction next to a coil, a small amount of electricity builds up in the coil's primary wire.

The amount of electricity we get in the primary wire is not enough to get the air-fuel mixture in the cylinder burning. To burn the air-fuel mixture we need a lot of electricity. We have to change the small amount of electricity in the primary wire to

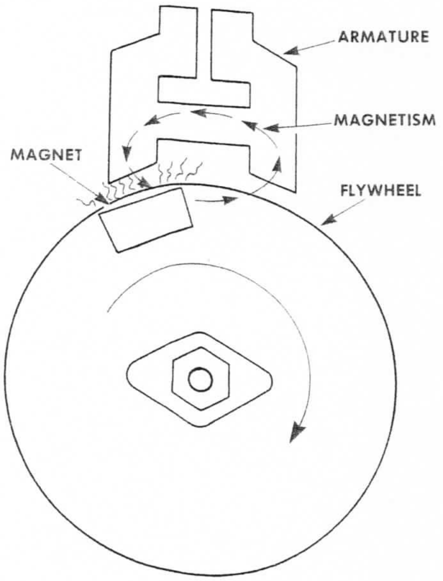

Figure 8-13. As the magnet lines up under the armature, magnetism goes in one direction.

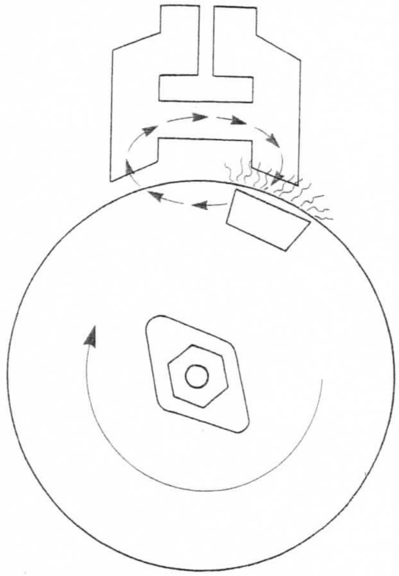

Figure 8-14. As the magnet turns, more magnetism goes in the other direction.

high-voltage electricity in the secondary wire. To do this we need some more parts. We will continue our study of the magneto operation in the next section.

BREAKER POINTS

The breaker points are a switch that is opened and closed by the crankshaft or camshaft. The breaker points are usually under the flywheel, as shown in Figure 8-15.

The breaker points are two small, round points. One of the points is called the *moving point.* It is connected to a moving arm. A small, round rod is used to move the arm. This rod is called a *plunger*. The other point does not move. It is called the *stationary point*, Figure 8-16.

The breaker points fit right next to the crankshaft. The crankshaft opens and closes the breaker points. The plunger rides on the crankshaft. The crankshaft has a small, flat spot on it. When the plunger is on the flat spot, the contact points are closed. A small spring helps hold the points closed. Closed breaker points are shown in Figure 8-17.

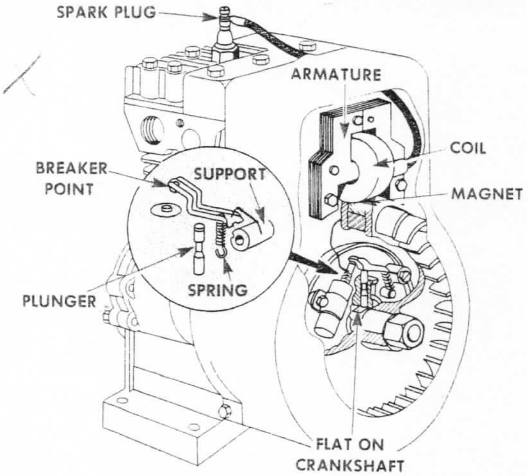

Figure 8-15. The breaker points fit behind the flywheel. (Briggs & Stratton Corp.)

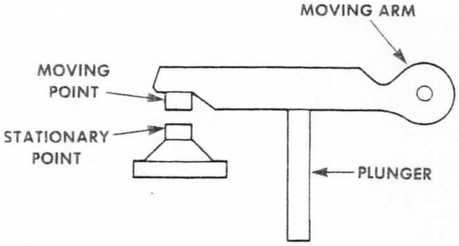

Figure 8-16. The parts of the breaker points.

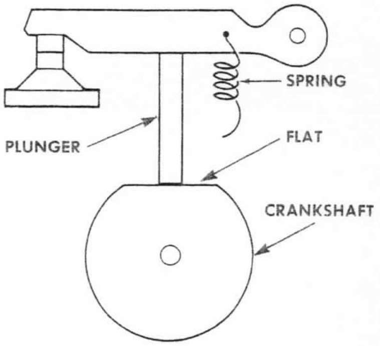

Figure 8-17. A flat spot on the crankshaft allows the breaker points to close.

As the crankshaft turns, the flat spot moves away from the plunger. The plunger pushes up on the moving point arm. The breaker points open, as shown in Figure 8-18.

Some engines have breaker points that are

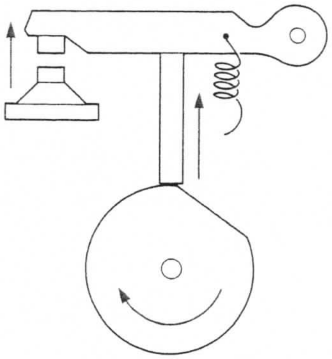

Figure 8-18. The round part of the crankshaft pushes the plunger up and opens the breaker points.

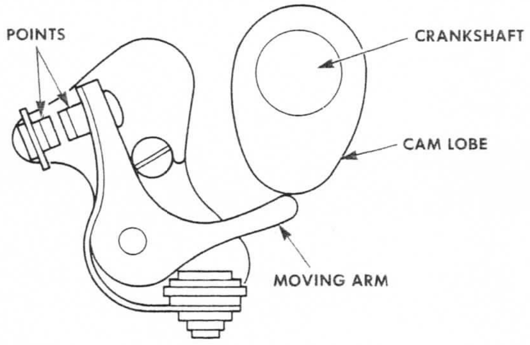

Figure 8-19. A cam can be used to open the breaker points.

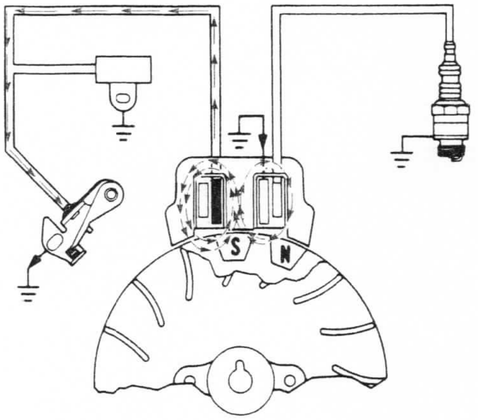

Figure 8-20. When the breaker points are closed, electricity flows in the primary wire. (McCulloch Corp.)

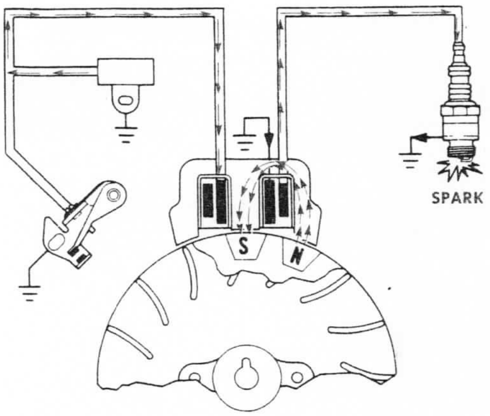

Figure 8-21. When the breaker points open, high-voltage electricity flows in the secondary wire. (McCulloch Corp.)

opened by a cam. A cam lobe is attached to the crankshaft. The cam turns with the crankshaft. When the cam lobe hits the moving arm, the breaker points are opened, Figure 8-19.

Breaker Point Operation

Now let's see how the breaker points work to help build high-voltage electricity. The magnet on the flywheel generates a small amount of electricity as it goes by the armature. The electricity is made in the primary wire.

One end of the primary wire is attached to the armature. The other end is attached to the moving point arm. Electricity can flow through the primary wire and into the moving arm. The breaker points are closed. Electricity can now flow across from the moving point to the stationary point, Figure 8-20.

When the flywheel has turned a little more, the breaker points open, Figure 8-21. Electricity cannot flow through the open points. The electricity flowing in the primary wire stops quickly. This causes a flow of magnetism to rush through the secondary wire. The magnetic flow creates a very high-voltage electricity in the secondary wire. This voltage may be as high as 25,000 volts. This is enough electricity to get our air-fuel mixture burning.

THE CONDENSER

Electricity must stop flowing the instant the breaker points open. If it does not, we cannot build up high-voltage electricity. Electricity will try to arc, or jump across the open breaker points, as shown in Figure 8-22. If this happens, we do not get a magnetic flow in the coil. We cannot build up a high-voltage electricity.

Electricity jumping across the breaker points causes another problem. The points will be burned and soon be destroyed. They would no longer work.

A condenser is used to stop electricity from jumping across open points. A condenser is a small electrical part shaped like a tiny can. It has a small wire that comes out of one end. A little bracket allows it to be attached to the magneto.

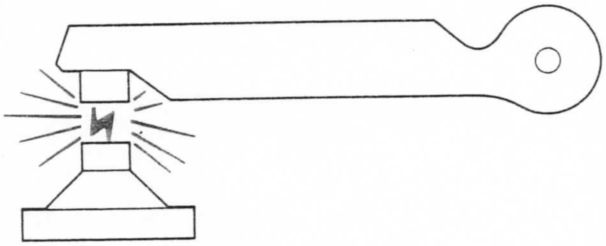

Figure 8-22. When the breaker points open, electricity tries to jump across the points.

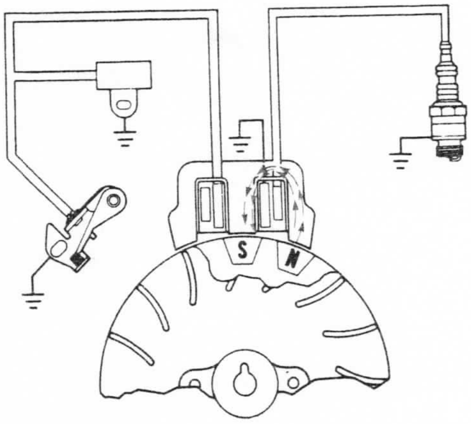

Figure 8-23. The condenser wire is hooked to the moving point. (McCulloch Corp.)

The condenser is mounted next to the breaker points. The condenser wire is hooked to the moving point. A condenser and breaker points are shown in Figure 8-23.

A condenser is shown in cross section in Figure 8-24. Inside, the condenser consists of two long sheets of conductor foil separated by several sheets of insulated paper. The foil and the insulation are wound into a tight roll. The roll of insulated and conductor paper is installed in a small metal canister. An insulated end-piece through which a small insulated wire lead, or pigtail, is routed, is placed on top of the canister. The end of the canister is crimped over the insulated end-piece. A gasket is located between the end-piece and the foil sheets. A spring sometimes is used at the bottom of the canister to maintain pressure on the end-piece gasket.

Very small amounts of moisture can have a very bad effect on the paper insulation inside a condenser. Moisture can lead to early condenser failure. For this reason, air and moisture are removed with heat and vacuum in a process known as hermetric sealing. The spring, gasket and tight-fitting end-piece are designed to maintain the hermetic seal through the service life of the condenser.

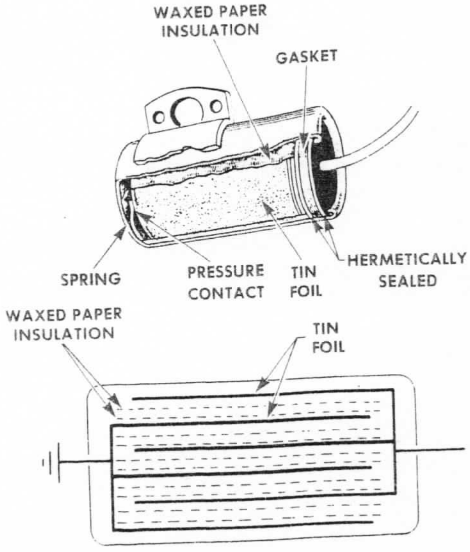

Figure 8-24. The parts of a condenser.

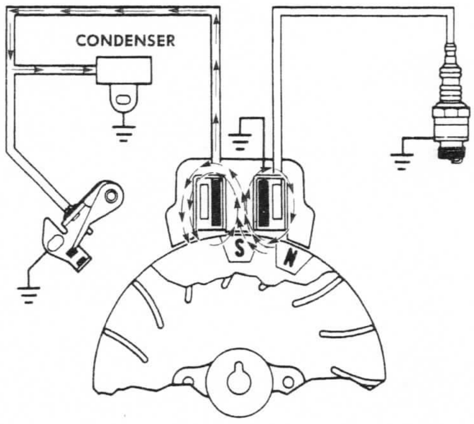

Figure 8-25. When the points open, electricity flows into the condenser. (McCulloch Corp.)

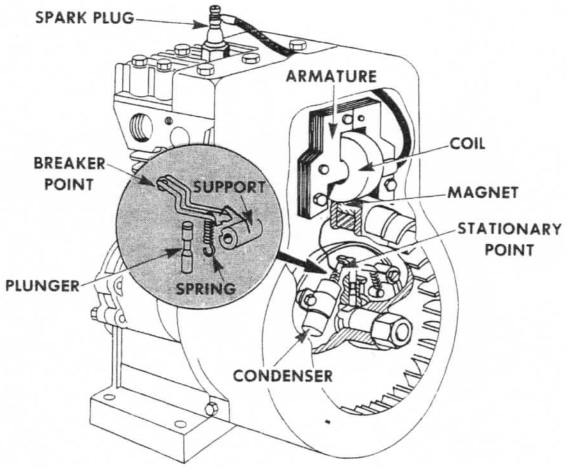

Figure 8-26. The condenser and stationary point may be one part. (Briggs & Stratton Corp.)

The condenser works like a tiny storage tank. The breaker points open. Electricity wants to jump across the opening. The electricity has another place to go. It goes through the condenser wire and into the condenser, Figure 8-25.

The condenser stores electricity inside. Electricity does not jump across the open points. The points do not burn as quickly.

Some engines have a condenser without a wire. The stationary point is hooked directly to the condenser. An engine with this type of one-piece condenser is shown in Figure 8-26.

IGNITION CABLES

The high voltage developed in the coil's secondary wire must be sent to the spark plug. The wire used for this job is called a secondary wire high-voltage wire, spark plug wire, high tension wire or ignition cable. Ignition cables must be able to handle high voltage without leakage. They must also be able to withstand water, oil, vibration and abrasion. Usually the wire is soldered into the coil at one end. It has a terminal connection for the spark plug at the other end, Figure 8-27.

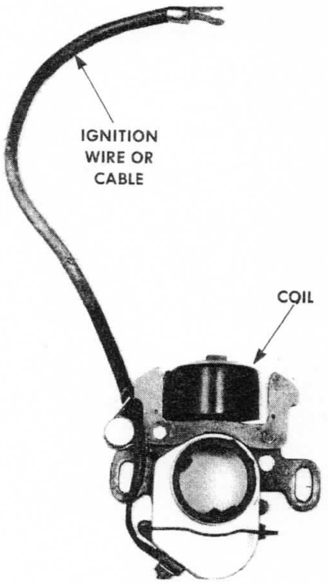

Figure 8-27. The high voltage from the coil goes to the spark plug through an ignition cable.

SPARK PLUG

The spark plug gets the high-voltage electricity from the magneto. Its job is to make a spark to get the air-fuel mixture burning. The outside parts of a spark plug are shown in Figure 8-28. The top of the spark plug has a terminal. This is where the spark plug wire is connected. The terminal is connected to a wire that goes through the middle of the spark plug. This is the wire that allows high-

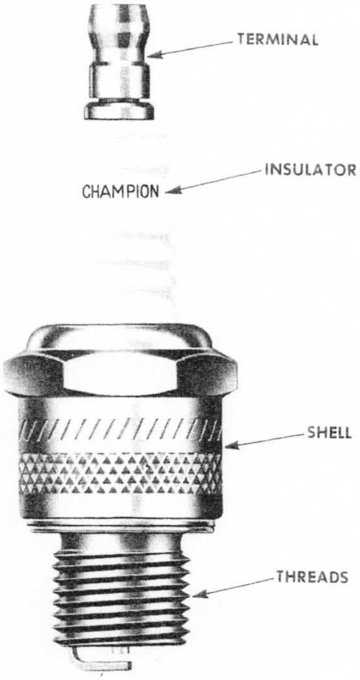

Figure 8-28. The parts of a spark plug. (Champion Spark Plug Co.)

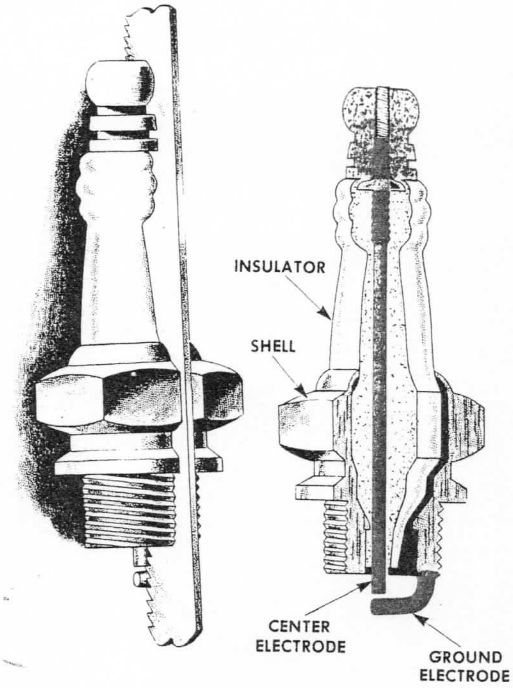

Figure 8-29. Sectional view of a spark plug. (General Motors Corp.)

voltage electricity to get into the combustion chamber.

The high-voltage electricity must not be allowed to leak away. An insulator fits around the wire. The insulator makes sure the electricity goes through the middle of the spark plug. A metal part called a shell makes up the bottom of the spark plug. The shell has threads. The threads allow the spark plug to be screwed into the cylinder head. The shell also gives us a place to fit a wrench. Hex shaped flats on the outside of the shell allow a wrench to be used on the spark plug for installation and removal.

Basically, a spark plug is a wire with an air gap at the bottom, that will fit into the engine's combustion chamber. A sectional view of a spark plug is shown in Figure 8-29. The wire which conducts high voltage into the cylinder is called the center electrode. There is terminal at the top of the center electrode to attach a connector from an ignition cable.

Since the center electrode must carry high voltage into the cylinder, it must be well insulated. A ceramic insulator surrounds the center electrode. The ceramic insulator has ribs on its outside diameter to increase the distance between the terminal and the nearest ground. This helps eliminate current leakage, or flashover, especially when the outside of the ceramic is dirty or wet.

The center electrode and ceramic insulator assembly are joined to a metal shell. The shell, insulated from the center electrode by the ceramic, has threads rolled on it to allow the spark plug to be screwed into the combustion chamber. A side electrode is attached to the shell and placed a small distance away from the center electrode. This distance is the air gap or spark plug gap that the current jumps to create a spark.

The spark plug, mounted in the combustion chamber, is subjected to extremely high pressure. Seals are used between the shell and ceramic insulator and between the center electrode and the ceramic to prevent the leakage of combustion pressure. Either a copper gasket or a special taper seat is used to prevent leakage of combustion pressure around the shell threads.

Spark Plug Operation

Secondary high voltage flows from the magneto coil through the high-voltage ignition cables. The voltage enters the spark plug at the terminal end of the center electrode. Voltage flows down the center electrode to the air gap located in the engine's combustion chamber. The current overcomes the resistance of the air-fuel mixture and jumps the air gap to the side electrode. The spark created as the current jumps the gap ignites the combustible mixture of air and fuel.

The voltage required to overcome the gap and the resistance of the air-fuel mixture is different under different conditions. The wider the air gap, the higher the required voltage. The condition of the spark plug electrodes also is very important. Much less voltage is required to jump from clean, sharp electrodes than from dirty, eroded ones. The higher the compression pressure, the higher the voltage required to overcome the air gap.

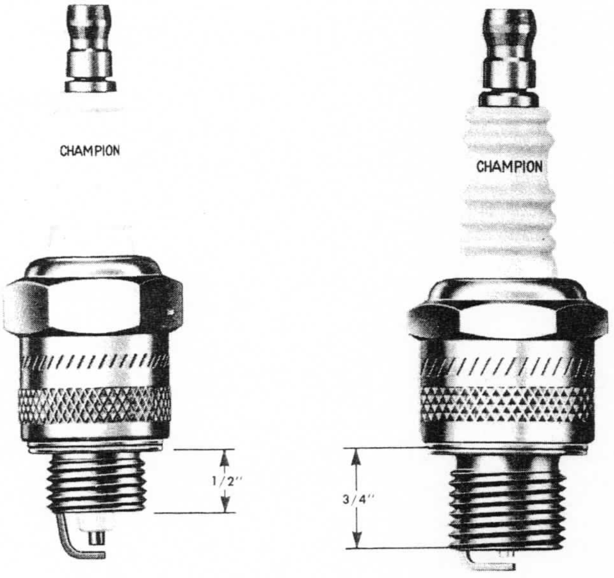

Figure 8-31. Spark plugs have different reaches. (Champion Spark Plug Co.)

Spark Plug Sizes

If it is to work properly, the spark plug must be the right size for the combustion chamber into which it is installed. Different sizes of spark plugs are required for different engine designs. Spark plugs are made with different shell thread diameters, Figure 8-30. The threads are made in metric sizes measured in millimeters. The metric thread allows the plugs to be used in both imported and American engines.

The threaded section of the shell is made in different lengths. This dimension is called the *reach*. There are several common reach dimensions manufactured. Figure 8-31 shows two. The

Figure 8-30. Spark plugs are made with different thread sizes. (Champion Spark Plug Co.)

thickness of the combustion chamber determines what reach is necessary.

Heat Range

The spark plug tip, or electrode area, mounted in the engine's combustion chamber, is subjected to temperatures that may exceed 2,000° F. The firing end of the spark plug is designed to remove this heat through the engine's cylinder head. The path of heat flow away from the firing end is shown in Figure 8-32. Heat moves up the ceramic insulator to the metal shell and then out into the engine's cylinder head.

Spark plugs are designed to operate within a specific temperature range. The term *heat range* describes the ability of a spark plug to conduct heat away from the firing end. The heat range of a spark plug is determined by the distance the heat must flow from the firing end to the shell. This is determined by the length of the insulator firing end. If the path is a long one, the firing end will remain at a high temperature and it is referred to as a *hot spark plug*. If the path for heat flow is short, heat is removed more easily from the firing end and the spark plug is cooler in operation. This type of spark plug is referred to as a *cold spark plug*. The heat paths for a cold and a hot spark plug are shown in Figure 8-33.

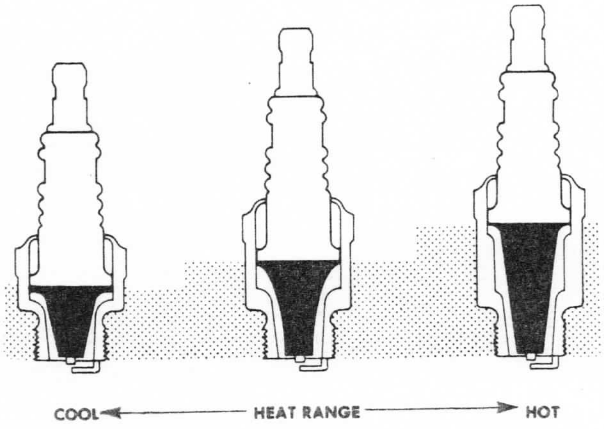

Figure 8-32. Heat flow away from a spark plug firing end.

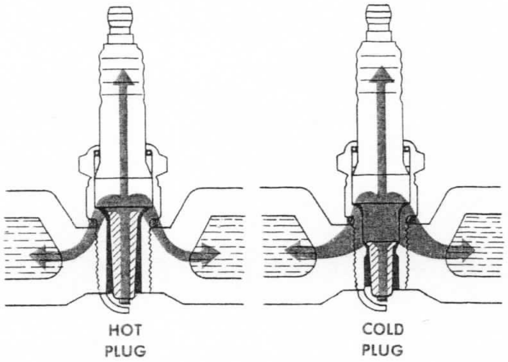

Figure 8-33. Heat flow in a hot and cold spark plug. (NGK)

Electrode Design

Several different kinds of electrode designs are used with small engines. The common electrode designs are shown in Figure 8-34. The automotive-type electrodes are used in many four-stroke lawn mower and motorcycle engines. The dual gap design is used in many two-stroke-cycle engines where fouling is a potential problem. The retracted gap also is popular in two-stroke engines. The surface gap is used with many solid-state magneto systems.

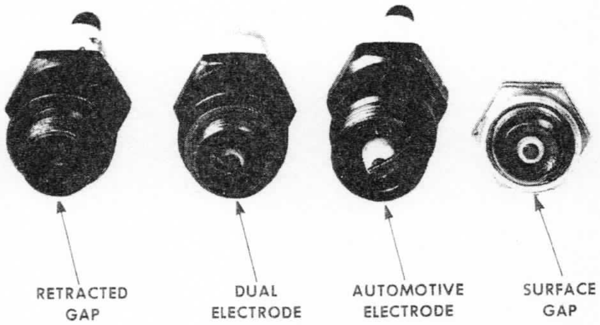

Figure 8-34. Types of spark plug electrodes.

Spark Plug Codes

In order to be correctly matched to an engine, a spark plug must have the correct thread diameter, gasket or tapered seat, heat range, electrode type and reach. Spark plug manufacturers identify these items on their spark plugs with a code system. The code is printed on the ceramic insulator of the spark plug, Figure 8-35.

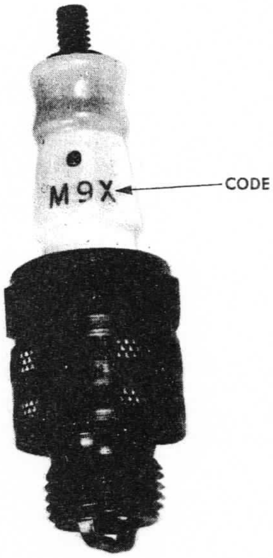

Figure 8-35. Spark plugs are matched to the engine by a code on the insulator.

STOP SWITCH

There must be a way to stop a running engine. Engines are stopped by a stop switch. The stop switch opens the circuit and grounds out the ignition system. The grounding may be done at the magneto primary wire or at the spark plug wire. On many engines, a wire is connected to the movable contact point. This wire runs outside the engine to a grounded switch. When the switch is closed, primary magneto current cannot flow and the engine stops.

Another popular stop switch consists of a thin metal strip attached to the top of the engine, Figure 8-36. When the engine is to be stopped, the metal is pushed against the spark plug terminal. This grounds out the ignition secondary current and stops the engine.

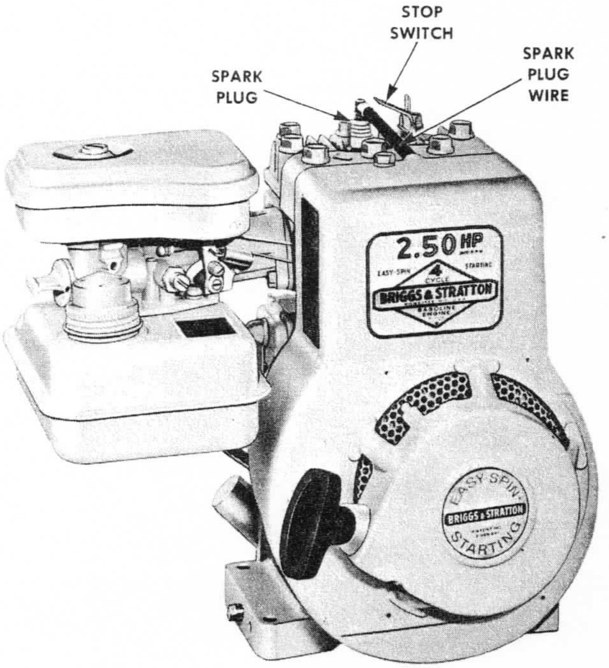

Figure 8-36. When the stop switch is pushed against the spark plug terminal, the secondary is grounded. (Briggs & Stratton Corp.)

CAPACITIVE DISCHARGE IGNITION

An ignition system that uses contact points has some limitations. Contact points wear as the engine runs. Eventually the contact points will be so worn that the engine will be hard to start and will not run well. The contact points must be changed to get the engine back into running condition.

A new type of ignition system is now being used on some small engines. This system, called the *capacitive discharge* or *CD system,* does not use contact points in the magneto. The capacitive discharge ignition system uses the principle of storing and discharging energy from a condenser or capacitor.

As was described earlier under conventional ignition systems, a condenser (or capacitor) is made of two parallel plates separated by an insulator. When current enters the capacitor, electrons build up on one plate, and their negative charge repels a like number of electrons on the other plate. In this condition, the capacitor is said to be charged. Energy is stored in the capacitor; when the current flow is stopped, the energy remains in the capacitor. Only when a conductor is connected across the two plates will it discharge, or regain electron balance. A small capacitor is capable of storing a large electron charge and providing a big discharge.

In a capacitive discharge system, a charged capacitor is placed across the primary winding of an ignition coil. As the capacitor discharges into the primary winding, a strong magnetic field is established and cuts the secondary winding, inducing a high voltage. Energy is not stored in the coil; it is used only to step up the voltage from the capacitor. The energy developed in this way is greater than that possible in a conventional ignition system. The capacitor is then disconnected from the coil and recharged, so that the discharge into the primary can occur again for the next firing cycle.

The parts of a CD magneto ignition system are shown in Figure 8-37. A simplified diagram of the system is shown in Figure 8-38. Magnets on the

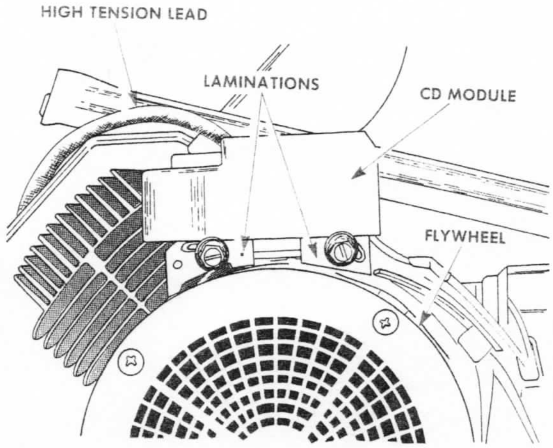

Figure 8-37. Parts of a CD magneto system.

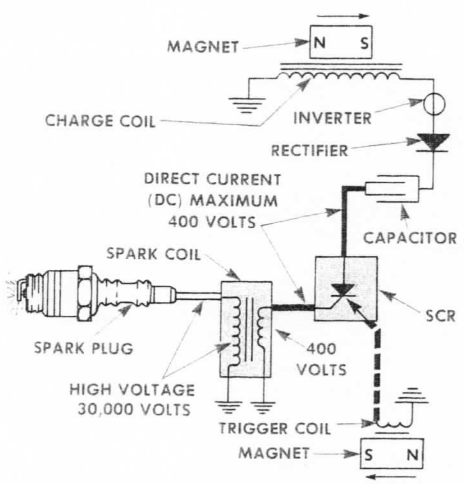

Figure 8-38. A CD ignition system.

flywheel are used just as in a conventional system. As they move under the armature, a small current is developed in a coil called the *charge coil.*

It is necessary to use a device called an *inverter* to quickly build up a charge in the energy storage capacitor. The inverter changes the low-voltage direct current available from the charge coil into alternating current. The alternating current transformed by the inverter is changed back to direct current by the bridge rectifier. The output of the inverter and rectifier needed to charge the energy storage capacitor is approximately 400 volts.

The 400 volts stored in the capacitor must be discharged into the coil primary at just the right time for ignition. The flywheel magnets are used to develop a small signal current in a coil called the *trigger coil.* The signal from the trigger coil goes to a switching device called a *silicon controlled rectifier* (SCR). The SCR gets the signal from the trigger coil and switches the circuit to cause the capacitor to discharge into the spark coil primary. A high voltage induced in the spark coil is directed to the spark plug. The SCR then switches the circuitry back, to allow the capacitor to charge, to get ready for the next discharge.

NEW TERMS

atoms: Small particles which make up matter.

breaker points: The switch used in the ignition primary system to control coil operation.

capacitive discharge ignition system: An ignition system that uses the energy stored in a capacitor to develop high voltage.

capacitor: An electrical device used to store or soak up a surge of electricity.

circuit: A complete path for electrical current flow.

coil: An electrical device used to step up voltage for ignition.

condenser: The capacitor used in the ignition primary to prevent contact breaker point arcing.

conductor: A material that allows electrical current flow.

current: The flow of electrons in an electrical circuit. Measured in amperes. Abbreviated *I.*

electricity: The flow of electrons from one atom to another.

ignition cables: High-voltage ignition wires used to carry secondary voltage.

ignition system: The electrical system that provides the high-voltage spark to ignite the air-fuel mixture in the cylinder.

induction: The transfer of energy from one object to another without the objects touching.

insulator: A material that prevents the flow of electricity.

magneto: Device used to develop the high voltage necessary for ignition.

spark plug: Ignition-system part used to create a spark in the combustion chamber.

voltage: The source of potential energy in an electrical system. Measured in volts and abbreviated *E.*

SELF CHECK

1. Write a definition for *electricity.*
2. Where are the breaker points on an engine?
3. Where does electricity flow when the breaker points are closed?
4. What happens to the flow of electricity when the breaker points open?
5. What happens in the secondary wire when the breaker points open?
6. Where does the spark plug fit?
7. What wire is connected to the spark plug?
8. How does electricity go through the spark plug?
9. How does a spark plug make a spark?
10. How is a CD ignition system different from one with breaker points?

DISCUSSION TOPICS AND ACTIVITIES

1. Use a small engine cutaway model to identify the parts of a magneto ignition system.
2. Turn an engine's crankshaft and watch the breaker points open and close. Can you describe the magneto operation?