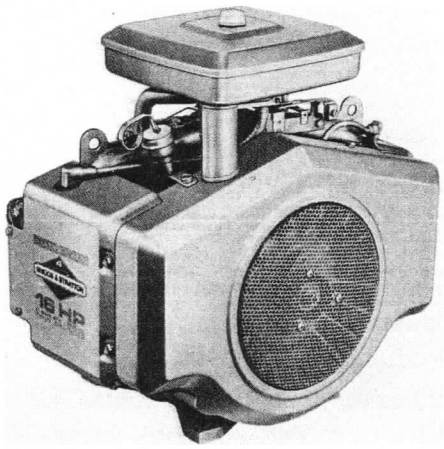

unit 11
cooling systems

During the engine's power stroke, a mixture of air and fuel is burned in the cylinder. This burning creates a lot of heat. Much of this heat is used to push down the piston. Some of the heat goes into the engine's parts. We need a way to take the heat away from these engine parts; otherwise the parts could be damaged. In this unit we will see how engines are cooled.

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

1. **Describe the purpose of the engine cooling system.**
2. **Describe the operation of the draft-type air-cooling system.**
3. **Explain the operation of the forced-air-circulation cooling system.**
4. **List the components used in a liquid-cooling system.**
5. **Trace the flow of coolant through a liquid-cooling system.**

DRAFT AIR COOLING

There are several ways in which engines are cooled. One way is called *liquid cooling*. A liquid such as water circulates around all the hot engine parts. The water takes away the heat. Most automobile and outboard engines are cooled this way.

Many small engines are air-cooled. Air goes around the engine parts and takes away the heat. Air may be forced around the engine parts by a natural draft or by forced circulation. Most motorcycles and mopeds use a draft cooling system.

The components that get the hottest, such as the cylinder and cylinder head, have fins, Figure 11-1, to direct the greatest amount of air into contact with the greatest amount of hot metal. When the engine is running, heat builds up in the cylinder head and cylinder. As the heat goes through the cylinder head and cylinder, it moves out into the cooling fins, as shown in Figure 11-2.

Heat must be removed from the cooling fins. This may be done with a natural draft. As a motorcycle, Figure 11-3, or moped moves along, it pushes through the air. This air flows over the cooling fins and carries away the heat. The faster

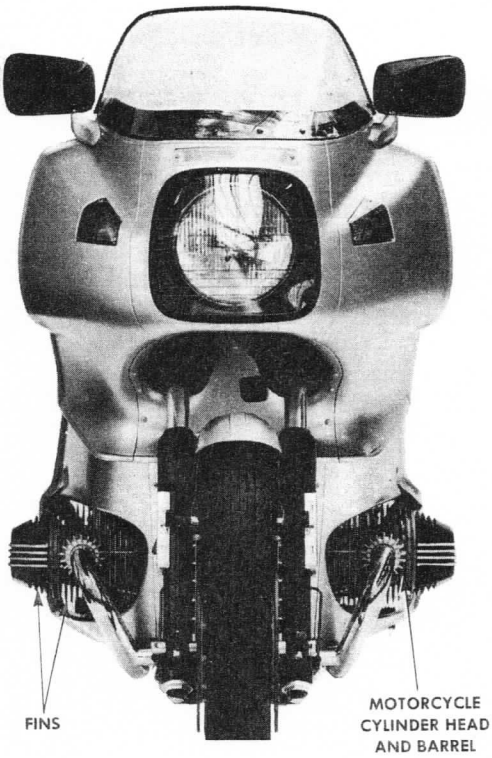

Figure 11-1. Air-cooled engines have cooling fins on cylinders and cylinder heads. (B.M.W. of North America Inc.)

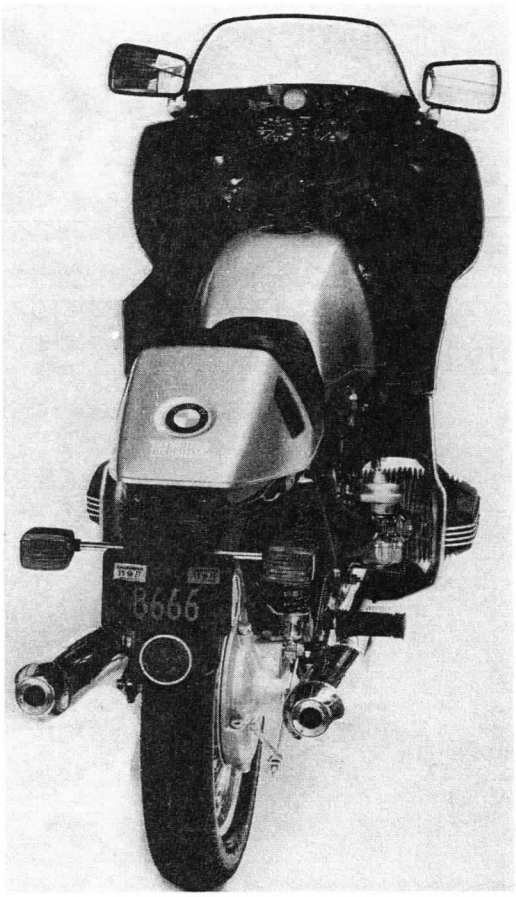

Figure 11-3. Air moves around the engine parts to cool them as this motorcycle goes down the road. (B.M.W. of North America Inc.)

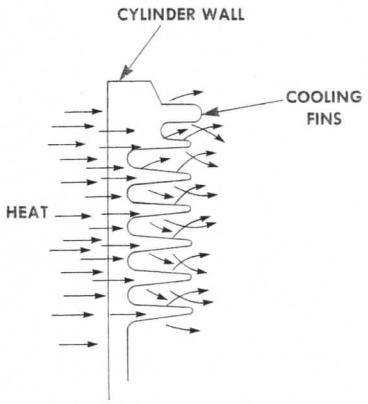

Figure 11-2. Heat goes through the engine parts and into the cooling fins.

the motorcycle goes, the more air flows over the engine. The only difficulty with this system is that when the motorcycle is stopped and the engine is running, there is no air flow over the engine. If the engine runs too long under these conditions, it will overheat.

FORCED-AIR COOLING

Many small engines used on lawn equipment and stationary equipment do not move or do not move fast enough for draft cooling. Air has to be forced around the parts with a pump. In this section will see how the forced-air cooling system works.

The main air-cooling parts are cooling fins, flywheel fins and a blower housing. The engine parts that get the hottest are the cylinder and cylinder head. Both of these parts have cooling

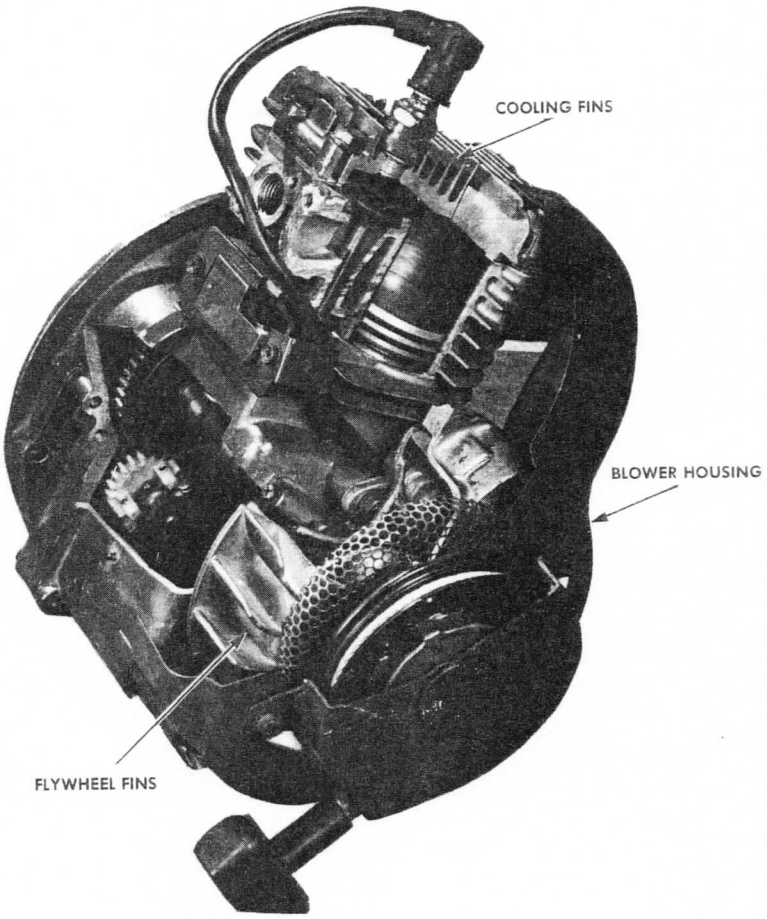

Figure 11-4. Forced-air cooling parts.

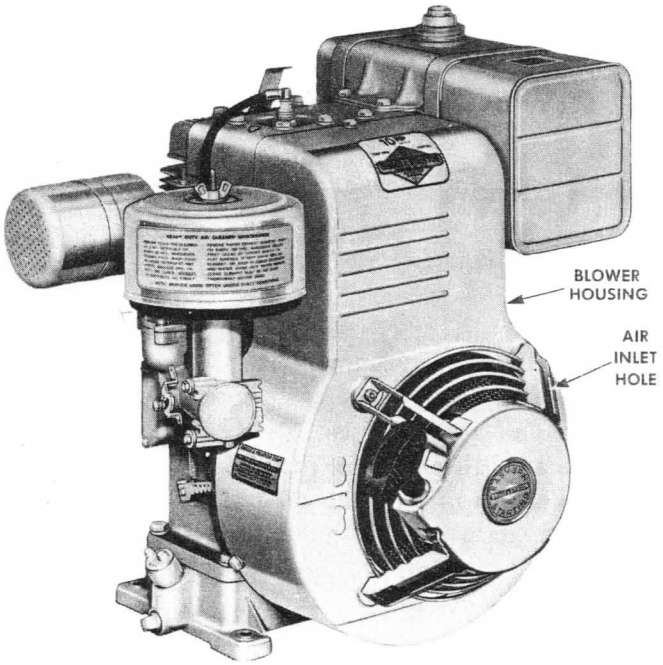

Figure 11-5. The blower housing covers the flywheel. (Briggs & Stratton Corp.)

fins, similar to those on a motorcycle or moped engine, to control heat and air flow.

The flywheel is used as a pump to move air around the engine parts. The flywheel has fins that help it pump the air. An engine with cooling fins and flywheel fins is shown in Figure 11-4.

The flywheel is covered over with a blower housing. The blower housing is used to direct the cooling air. There is an air inlet hole in the middle of the blower housing. Cooling air comes in this hole. A blower housing with an inlet hole is shown in Figure 11-5.

The flywheel turns when the engine is running. The fins on the flywheel make it work like a fan. Cool air is pulled in the inlet hole of the blower housing. The inlet hole has a screen covering it, Figure 11-6. The screen keeps grass and other foreign objects out of the housing.

The shape of the blower housing controls where the air goes. As shown in Figure 11-7, air goes up to the top of the blower housing. It then goes through each of the cooling fins. The cool air takes heat away from the fins, and the engine parts are cooled down, Figure 11-8.

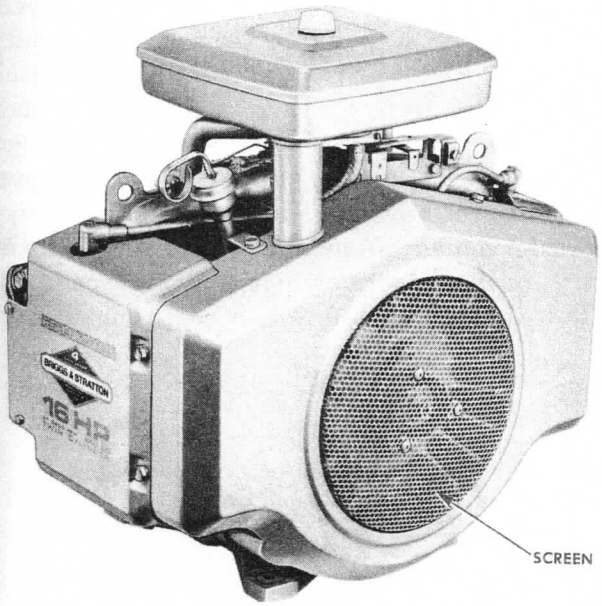

Figure 11-6. A screen is used to keep grass and leaves from going into the blower housing. (Briggs & Stratton Corp.)

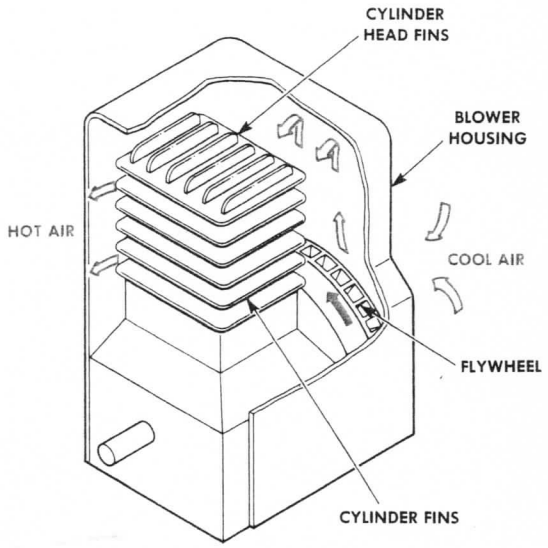

Figure 11-7 Cool air is pumped by the flywhee around the hot engine parts to cool them.

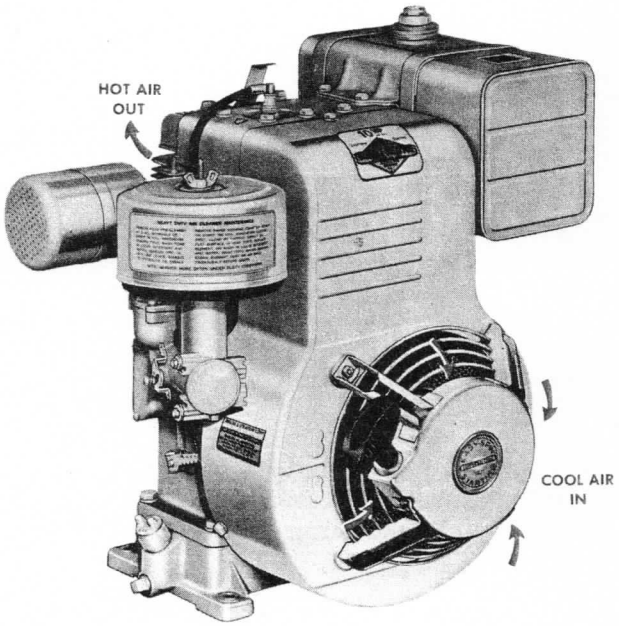

Figure 11-8. Where air goes in and comes out of an engine. (Briggs & Stratton Corp.)

LIQUID COOLING

Most outboard engines and a few motorcycle engines have a liquid cooling system. The liquid cooling system circulates liquid around hot

engine parts to carry off the heat. Coolant passages called *water jackets* surround each cylinder in the block and the cylinder head very close to the valve area. Heat from the burning air-fuel mixture passes through the metal of the cylinder head and cylinder wall and enters the water jackets. The heat then goes into the liquid coolant circulating through the water jackets.

An advantage of the liquid cooling system is that it can take care of more heat than can air-cooling. A liquid carriers heat more efficiently than a gas (air) does. A multi-cylinder liquid-cooled engine is also less expensive to make, since the cylinders may be cast together in a block instead of made separately. An additional advantage is that liquid-cooling passages reduce engine noise so that engine operation is much quieter.

OUTBOARD COOLING SYSTEMS

Outboard engines use liquid cooling because often they are large, multi-cylinder engines which would be difficult to cool by air. Since they are always operated in water, they have a ready source of coolant. Cooling water is pulled into the lower unit of an outboard near the propeller. The water is directed up into the power unit, where it circulates through passages in the cylinder and cylinder head. The water removes the heat. The heated water is directed back down to the lower unit where it goes out of the engine. The water circulation through an outboard is shown in Figure 11-9. Water is pulled into the outboard and circulated through the engine by a water pump. The pump, usually located in the lower unit, is driven by the drive shaft that drives the propeller. The pump consists of a synthetic rubber impeller, which is keyed to the driveshaft, and a pump housing, which is offset from center with respect to the driveshaft. As the impeller spins, a low-pressure area is created in its center. Water is drawn into the center of the impeller and is thrown off the impeller blades by centrifugal force. This causes water to be drawn in and pushed out of the pump.

Many outboards use a pump that has a variable volume. It pumps less water at high speed. This is necessary because the pump turns so fast at high

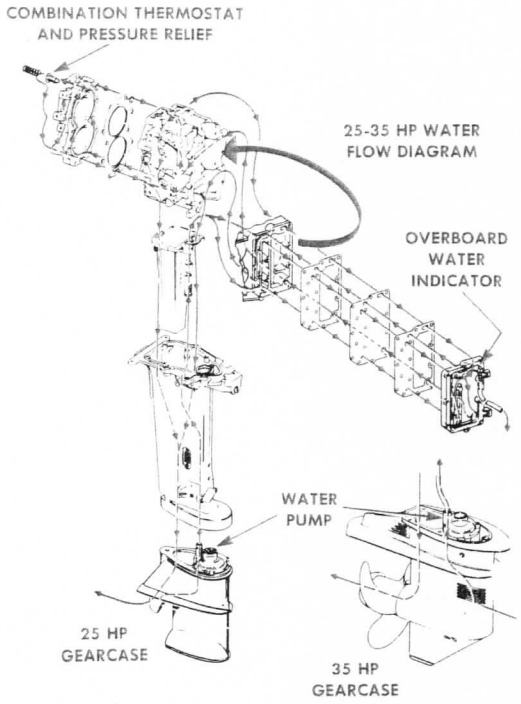

Figure 11-9. Coolant flow through an outboard engine. (Evinrude Motors)

speed that water would move too fast through the engine. Also, engine power is needed to turn the pump. If the pump does not have to work as hard at high speed, less engine power is wasted. This is achieved by making the pump impeller blades flexible. At low speeds the blades contact the housing, creating a good seal between the blades. A high volume of water is pulled in. At high speed, water resistance prevents the blades from touching the housing. The pump is less effective and the volume of water decreases. The shapes of the impeller blades at high and low speed are shown in Figure 11-10. An outboard engine must

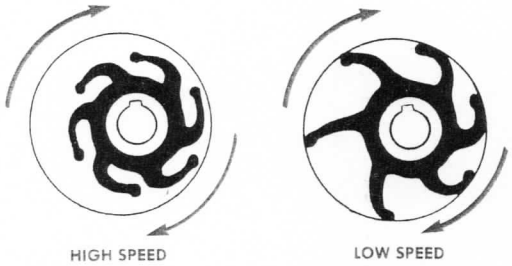

Figure 11-10. Shape of impeller blades at high and low speed. (Evinrude Motors)

always be operated in water so that there is a coolant flow. In the shop, outboards are operated in a water tank like the one shown in Figure 11-11.

Efficient temperature control is achieved in a liquid-cooling system by regulating the flow of coolant through the system with a thermostat, Figure 11-12. The thermostat is a temperature-controlled valve which controls the flow of water into the radiator from the engine.

A thermostat prevents overcooling. An engine operating at too low a temperature becomes less efficient. During the power stroke, heat from the burning mixture is pushed down the piston. If too much of this heat is lost to the cooling system,

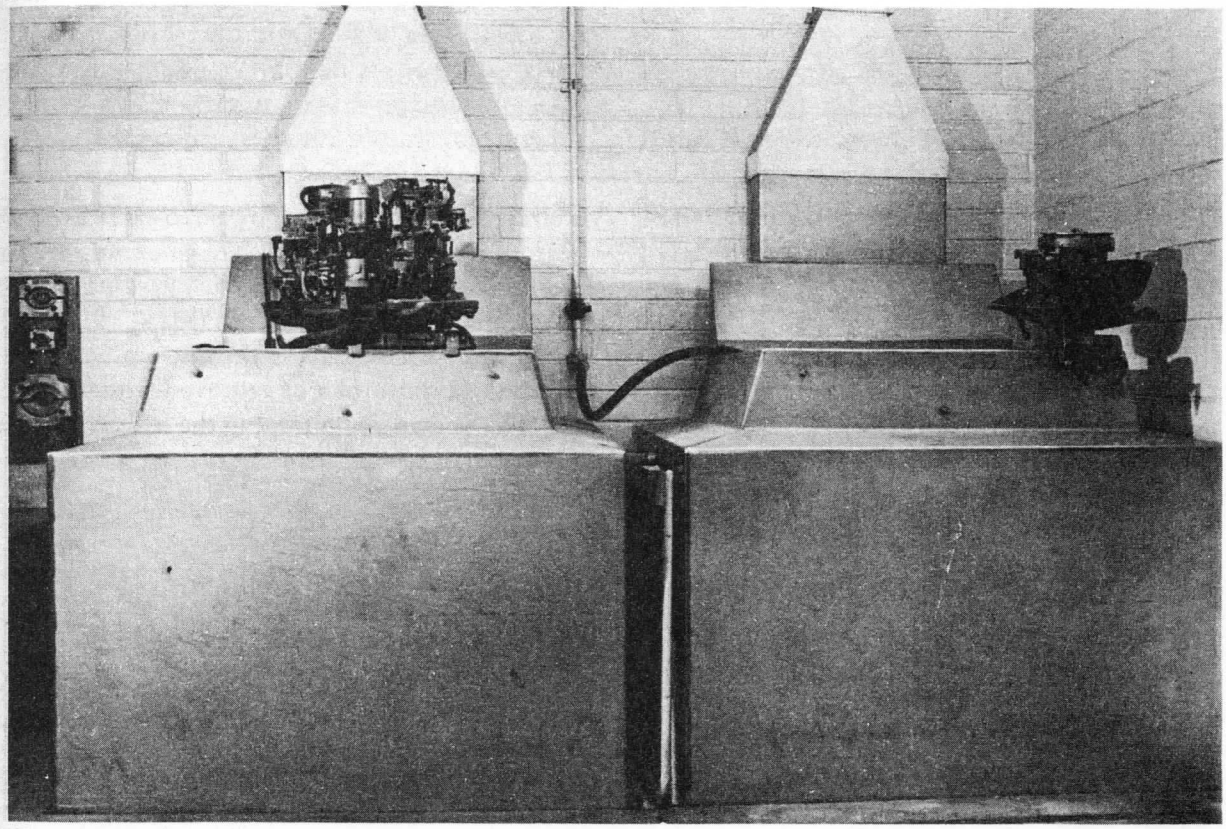

Figure 11-11. Outboards must be operated in a water tank in the shop for cooling.

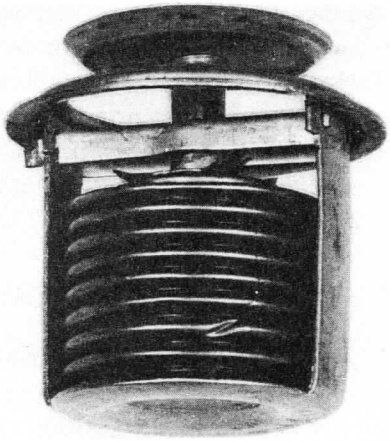

Figure 11-12. A thermostat regulates the flow of coolant.

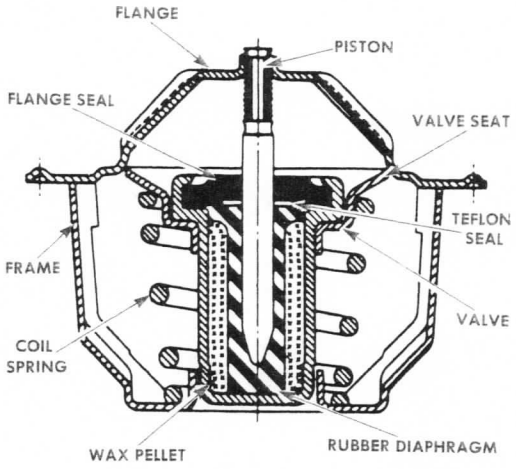

Figure 11-13. Sectional view of a thermostat. (Chevrolet Div. — General Motors Corp.)

power and efficiency also are lost. If the cylinder area is too cool, fuel will not burn completely. Some of the fuel may run down the cylinder walls past the rings, washing off lubricating oil. Enough gasoline may enter the oil pan to dilute the oil. During the exhaust stroke, unburned gasoline that did not wash down the cylinder is pushed out, adding to exhaust emissions. Whenever the fuel is not burned completely, power is lost and fuel economy suffers.

In a pellet thermostat, Figure 11-13, a wax pellet or power element in the thermostat expands when heated and shrinks when cooled. The pellet is connected through a piston to a valve. The heated pellet pushes against a rubber diaphragm which forces the valve to open. As the pellet shrinks on cooling, it allows a spring to close the valve and stop circulation of coolant through the power head.

As the engine becomes warm, the pellet gets big and the thermostat valve opens, permitting the coolant to flow through the radiator. This opening and closing of the thermostat valve permits enough coolant to enter the power head to keep the engine within operating-temperature limits. The thermostat is mounted in the coolant passage leading to the power head.

MOTORCYCLE COOLING SYSTEMS

As mentioned previously, most motorcycles have air-cooled engines. A few large touring motorcycles use a liquid-cooling system. A liquid is circulated through the engine to carry away the heat. A coolant pump circulates the coolant and a thermostat regulates the flow. These parts work like those described for outboards.

The heat removed from the hot engine parts by the coolant must then be removed from the coolant. This is done by pumping the hot coolant out

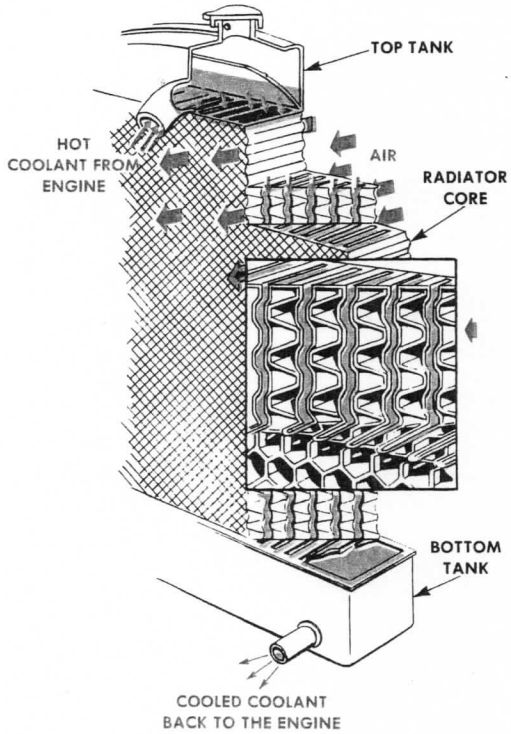

Figure 11-14. Flow of air and coolant through a radiator. (E. I. DU Pont DE Nemours & Co.)

of the engine and into a heat exhanger, commonly referred to as a *radiator*. The radiator removes heat from the coolant.

The radiator, mounted in front of the engine, is made up of a top tank, a bottom tank and a center core or heat exchanger. Hot coolant is pumped out of the engine through a large hose connected to the top tank. It enters the radiator core through several small distribution tubes. These tubes are made from a metal that is a good heat conductor, usually copper or aluminum. The heat passes out of the liquid and into the wall of the tubes, which are fitted with copper or aluminum fins. Air circulated through the core by the motorcycle moving through the air takes the heat from the fins. The cooled liquid runs into the bottom tank of the radiator. A large hose allows the coolant to be drawn from the bottom tank back into the engine to pick up more heat, Figure 11-14.

NEW TERMS

air cooling: Cooling engine parts by circulating air around them.

air pump: Pump used with an air-cooling system to force air around hot parts.

coolant: Liquid used in liquid-cooling system to carry away heat; usually a mixture of ethylene glycol and water.

coolant pump: Pump used to circulate coolant around hot engine parts.

cooling fins: Metal fins used on air-cooled engine parts to move heat away from the parts.

cooling system: An engine system used to keep the engine's temperature within limits.

radiator: A large heat exchanger located in front of the engine.

thermostat: A device in the cooling system used to control the flow of coolant.

water jackets: Passages in the cylinder block and head for coolant flow.

SELF CHECK

1. Why do engine parts get hot?
2. What can happen if engine parts get too hot?
3. What are the three ways in which engines are cooled?
4. How is an air draft used to cool an engine?
5. List the main forced-air cooling parts.
6. What are cooling fins used for?
7. What does the flywheel do in air cooling?
8. How does liquid cooling work?
9. Explain the purpose and operation of the coolant pump.
10. Describe the purpose of the radiator.

DISCUSSION TOPICS AND ACTIVITIES

1. Use a cutaway model of an engine to trace the flow of cooling air through the cooling system.
2. Put a thermostat in a pan of hot water and observe opening of the valve.