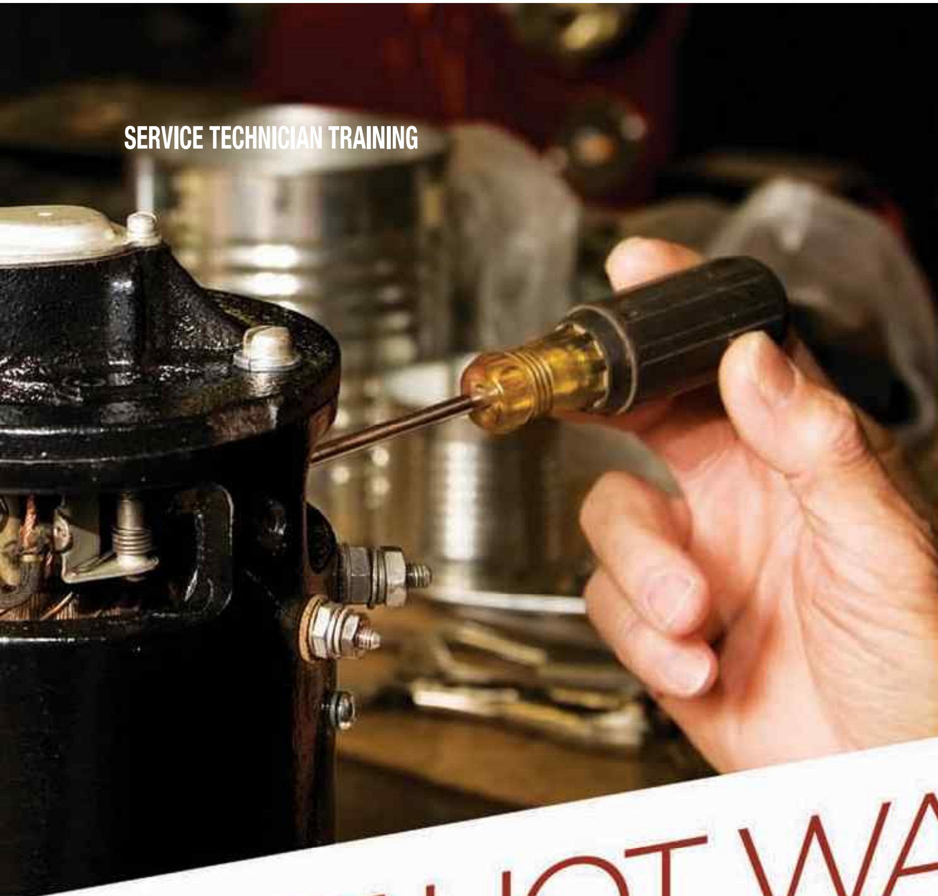

THE HOT WATER MACHINE

by Gary Weidner

Up to this point, we've covered only cold water pressure washers. In this chapter, we will begin to get involved with hot water machines. The first thing to do is determine what defines a "hot water machine" for our purposes.

Definition

We will cover pressure washers that add both heat and pressure to the water supplied to them, the output being hot water under pressure. Typical output water temperatures range from 150–200F.

We will not be considering non-heated units that are intended to be supplied with hot water and simply step up the pressure (same as a cold water washer). Also not part of our hot water machine discussions are "steam cleaners," machines that deliver steam (typically at 300F or above) instead of hot water. Steam cleaners merit a separate discussion of their own.

As far as I am aware, every hot water pressure washer contains a cold water machine, the output of which is passed through some sort of water heater under high pressure and then discharged to the spray gun. The machine's controls (discussed in later chapters) generally interface with both the water system and the heating unit.

It's logical to ask, "Why not heat the water first, at low pressure, and then pressurize it?" There is a problem with heating the water first: components like pumps and unloaders have problems handling water at the higher temperatures. It isn't just a question of whether the components can stand the heat; pumps and unloaders usually contain

areas where the pressure drops. In the reduced-pressure areas, the water boils at lower temperatures than the familiar 212F. Boiling (vaporizing) water inside a pump or unloader is likely to cause damage.

Methods of Heating

A machine heats water by consuming fuel or electricity using one of three devices: an oil burner, a gas burner, or an electric heater. There are other ways to heat water, but so far none have proved practical for pressure washers. (Apologies to environmentalists—solar heating cannot produce heat at the relatively huge rate that is required for this type of equipment.)

Oil Burner Concepts

Most portable hot water pressure washers are oil-fired, because oil heat is the most practical for portability. Fuel flexibility is also an attraction, since most of these machines can be fueled with No. 2 heating oil, diesel fuel, or kerosene. (The manufacturer probably optimized the burner system for one of them, but users commonly switch fuels.) Additionally, on a diesel engine-driven machine, the engine and heating system can share a common fuel tank.

In the oil-fired pressure washer, we have a crude water tube boiler, with many feet of pipe or tubing wrapped to form a heat exchanger. The pipe or tubing may be wrapped in such a way as to form the combustion chamber as well as the final heat exchanger. Some designs use combustion heat to preheat the incoming water or the incoming combustion air. The oil burner itself is the same in principle as home heating oil burners. In fact, most American made equipment uses home oil burners directly transplanted to the pressure washers.

Just like a gasoline engine, air, fuel, and spark are what we need for this thing to work. Forced air is supplied by a blower. Fuel is delivered to an atomizing nozzle under pressure by a fuel pump. The ignition spark is provided by a high-voltage transformer (like the ignition coil does for a gasoline engine), or by a solid-state, high-voltage igniter or a magneto. Once we have these three ingredients, they must be delivered to the right location in the right amounts, just like in an engine.

Gas Burner Concepts

Most stationary hot water pressure washers are natural gas-fired, because it's usually cheapest and easiest for the customer to have the fuel piped from the gas utility right into the machine. Some stationary units are propane (LP gas)-fired. A minority of portable hot water machines are gas-fired, and they rely on LP gas as a fuel. However, as we will see in later chapters, the pressure washer's voracious appetite for heat input means that rather large LP gas tanks have to be carried around with the portable machine.

Gas-fired units usually use a pipe or tubing "coil" to form a combustion chamber/heat exchanger much the same as for the oil-fired units. A difference is that the forced air supplied for combustion in oil-fired units allows them to be oriented with the coil axis horizontal or vertical. Gas burners on pressure washers, on the other hand, are almost all "naturally aspirated"—they have no blower and depend entirely on convection to move the hot gasses through the coil area. Consequently, a machine of this type can only have its coil oriented vertically, somewhat like the arrangement in a gas-fired home water heater.

Electric Heat Concepts

Units using electricity have no flame or burner, just electric heating elements. These machines are best suited for applications where a combustion flame is not allowed (e.g. hazardous atmospheres) or where cleanliness is very important (e.g. a factory where operations are too clean to tolerate a burner). Like the stationary gas-fired machines, the "fuel" (electricity) is

For Easy Fasteners or Tight Spaces

If you are a mechanic, you know what a palm ratchet is. If an air ratchet isn't at hand, it speeds up tightening a lot of easy nuts or bolts, and in a tight spot it could be one of your few choices.

You can make your own pocket-ratchet by using an abrasive chop saw to cut down the handle of a regular 3/8-drive ratchet (photo above). Remember to round off the cut end on a grinder.

For those who like to be more sophisticated, the "Palmster" #BSP-52 from J.H. Williams Tool Group (photos below) is the way to go. The Palmster folds into a very small size for pocket stowing or palm use, yet it opens to provide a handle for leverage. It has a fine-tooth ratchet so that you don't have to swing it very far to get the "next click."

Key Concepts

Oil, gas, or electricity are used to heat water.
- Each has advantages for particular situations
- Oil is favored for portability
- Gas is favored for stationary setups
- Electric heat is favored for unusual atmospheres or for cleanliness

It takes a huge amount of heat to raise the temperature of flowing water.

"piped" (wired) directly from the electric utility right into the machine.

In some designs, the heating elements heat the high pressure water directly by being immersed in it. Other designs use indirect heating: the elements heat a tank of water, which in turn transfers heat to a coil or heat exchanger containing the high pressure water.

Each design approach has its advantages and drawbacks. Direct immersion provides faster warm-up and continuous high water temperature, but it requires huge amounts of electric power.

The indirect method allows use of somewhat smaller heating elements because of the considerable amount of heat stored in the tank of hot water. When the wash gun is spraying, reserve heat is drawn from the tank of hot water, slowly lowering its temperature even though the elements are heating.

Whenever the operator shuts off the wash gun, the heating elements have a chance to "catch up." This is much like the situation where a modest-sized air compressor with a large receiver tank provides large bursts of compressed air, catching up in between.

Lots of Heat

As already mentioned, it takes enormous amounts of heat to significantly raise the temperature of water flowing at a rate of several gallons per minute. Even a modest size pressure washer may commonly have a burner rated at 300,000 Btu/hr input. The heat from that burner is enough to heat three or four homes in the upper Midwest of the U.S.

In the case of electric heating, the power draw is very large indeed. Ignoring efficiency factors for the present to make a crude comparison with the burner above, we find 300,000 Btu/hr of heat provided by electric elements requires about 88 kW (88,000 watts). If we were to obtain 88 kW from a 240-volt single-phase power line, it would require a current of 367 amps! To avoid that impractical situation, most electric heated washers operate on three-phase power lines, often at 460 volts.

The chapters to follow will go into further detail on hot water machines. *CT*