# THE WATER HEATER WORKBOOK

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## A HANDS-ON GUIDE TO WATER HEATERS

by
LARRY AND SUZANNE WEINGARTEN

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Introduction by
JOHN JAVNA

MONTEREY, CALIFORNIA

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## INTRODUCTION

In 1989, when I was writing 50 Simple Things You Can Do To Save The Earth, I called Larry Weingarten for advice on how people could save energy and resources with their water heaters. It was amazing to discover how much Larry knew about the subject...and how articulate he was in explaining it to me.

Unfortunately, I could only fit a few of his tips into my book. But now there's good news: Larry has written his own book.

As far as I'm concerned, what Larry Weingarten doesn't know about water heaters isn't worth knowing. So if you're ready to pay attention to that neglected appliance, you've come to the right place.

John Javna
The EarthWorks Group
February 25, 1992

A book that furnishes no quotations is no book;
it is a plaything.
—Thomas Peacock (1785-1866)

"What Is the use of a book," thought Alice, "without
pictures or conversations?"
—Lewis Carroll (1832-1898)

## ACKNOWLEDGMENTS

Many thanks to the individuals and organizations who helped us with this book, particularly The American Council for an Energy Efficient Economy (ACEEE) for allowing us to use their information on life-cycle costing. Pacific Gas and Electric company (PG&E) for letting us use their solar system diagrams, and The Earthworks Group, whose book 50 Simple Things You Can Do To Save The Earth (because of the inquiries it generated) was the catalyst for our Workbook.

Very special thanks go to two masters of understatement: John Middleton for his wonderfully expressive illustrations, and Al Headon of Ontario Hydro for sharing with us his truly comprehensive knowledge of water heaters.

Why do writers write? Because it. isn't there.
—Thomas Burger (dates unknown)

Unless we change direction,we are likely to end up where we are headed.
— Chinese Proverb

## OPENING QUESTIONS

### Why write a book about water heaters?

We put together THE WATER HEATER WORKBOOK to help reduce the many forms of waste involved in heating water — the waste of energy poorly used and the waste of money needlessly spent. For the sake of convenience and increased sales, the United States has steadily become a “throw-away” society. For several decades, planned obsolescence has insidiously and increasingly been integrated into our lives. We now have strong evidence that this way of life is doing tremendous damage to the planet.

### What are the figures?

During this last year (2012) more than seven million water heaters (about 85% of the water heaters shipped in the U.S.) were sold as replacements. That was 889 heaters sold every hour, and, of course, the numbers increase each year. The raw material, energy, and time that it takes to make, transport, install and recycle or dump all those heaters must be substantial by anyone’s measure. What a pleasure it has been to learn there are relatively simple things which can be done to maintain water heaters, to more than double their useful life, and to vastly reduce the number of replacements needed.

> The world is a fine place and worth fighting for.
> — Ernest Hemingway (1898-1961)

**How do you benefit?**

You can conserve energy, resources and your money by following the recommendations on water heater maintenance you'll discover in the pages ahead. Make your heater more efficient, safer, and less likely to cause trouble. Money spent on maintenance will offer a greater rate of return than most any other secure investment. You really can't lose.

Our recommendations favor uncomplicated solutions and equipment. Even where complex equipment is more efficient, purchase price and repair costs can eat up savings. We prefer proven equipment that has been designed with an eye toward upkeep by the non-specialist.

**Why haven't you heard about water heater maintenance before?**

The information we present here is not, for the most part, anything new. People have known about corrosion, sediment, anodes and a whole host of other water heater basics for decades. Yet today this information is not common knowledge even in the plumbing trade, nor is it readily available to those who seek it. This book is an attempt to change the situation.

We hope you find the WORKBOOK both enlightening and useful. We've tried to be thorough in our presentation, but new ideas are constantly being brought to market, and we make no pretense of being all inclu-

> The time has come when scientific truths must cease to be the property of the few — when it must be woven into the common life of the world.
> — Louis Agassiz (1807-1873)

sive. If you have ideas or information for future editions, please let us know.

**Is this a do-it-yourself book?**

Although many of the procedures we discuss are of the do-it-yourself variety, some are not. They require professional plumbing or electrical skills. If you don't possess these skills, it is essential you get qualified help. Your advantage will lie in knowing exactly what you want to have done.

We cannot be responsible for any damage caused by the use or misuse of information in this book.

**Please note:** All temperatures in this book are given in degrees Fahrenheit.

If all printers were determined not to print
anything till they were sure it would offend
nobody, there would be very little printed.
— Benjamin Franklin (1706-1790)

## WHAT'S COST EFFECTIVE?

While the following information will show you how to make most any glass-lined tank last a very long time, is that the best thing to do? With insulation, heat traps, and so on, older heater efficiency can be improved substantially. There are, however, tanks with newer combustion and/or heat recovery technologies which are simply more efficient than one can hope to make an older heater. These new efficient units are usually priced accordingly.

You could do a life-cycle cost analysis at this point. This is a way of figuring your total cost, including purchase price and energy costs over the life of the equipment, which is very useful when comparing different pieces of new equipment. Unfortunately, the number of dollars saved by various energy-saving measures and dollars saved by increasing equipment life can only be guessed at.

You might, then, consider the “least first cost” approach, which has proven effective in the energy conservation field. Here's an example: In the right circumstance, you can install a good low-flow showerhead and cut your hot water needs in half, for $10, or you can spend $2,000 on a solar system to give you the same effect. Clearly, in this somewhat slanted example, the showerhead is the better buy. Turning down the water temperature would be an even better buy, as it costs nothing.

The big and obvious advantage to maintaining existing equipment is that you avoid having to buy new equipment. By doubling or tripling the useful life

Use it up, wear it out, make it do, or do without.
— New England Proverb

of a heater, you cut your yearly equipment cost to one half or one third. This saving will go a long way to balance projected savings from operating an efficient new heater. Thus we generally favor keeping older equipment when it can be maintained. Our approach throughout is to suggest doing first those inexpensive things that will reduce operating costs. Once they have been done, the water heating bill may be small enough that buying the most efficient equipment cannot be justified by economics alone.

If your heater shows signs of extensive damage and a new heater is in order, then life-cycle costing can be done. On the next page begins a section on the subject borrowed from Consumer Guide To Home Energy Savings by ACEEE (The American Council for an Energy Efficient Economy).

**A True Story:** For five years, all they had gotten from their $7000 solar system was luke-warm water, and they were ready to scrap it. We found that their tempering valve had stuck open, constantly mixing cold water in with the hot. It took five minutes to fix. MORAL: Qualified help is cost effective.

To do more for the world than the world does for you — that is success.
— Henry Ford (1863-1947)

# Life-cycle Cost Analysis

**(This section courtesy of ACEEE.)**

Life-cycle cost analysis is a way of looking at the total cost of an appliance, light bulb, or other piece of equipment, rather than just the purchase cost. The life-cycle cost includes operating costs, such as fuel use, as well as purchase cost. Let's take a look at a few examples:

Mr. and Mrs. Jones are trying to decide between two refrigerators. The two models are the same size and have similar features, but Refrigerator A costs $600 while Refrigerator B costs $700. The EnergyGuide labels show that Refrigerator A costs $120 per year to operate, while Refrigerator B costs $90 per year to operate. A simple way to determine the better buy is to ask: "Is it worth paying $100 extra initially to save $30 per year in operating costs?" Sometimes the best answer will be clear. In the case of the Joneses, earning $30 per year on an investment of $100 is equivalent to about a 30% return-on-investment ($30/$100), which is a much better return than they could get from keeping their money in the bank. The Joneses decide to buy the more efficient Refrigerator B.

Sometimes the choice is not so clear. In these cases, you might want to calculate life-cycle costs for the different options. This takes longer, but it can help you determine the best buy.

## COMPUTING LIFE-CYCLE COSTS

To compute life-cycle cost for electric appliances, you need to know:

**1.** The purchase cost (obtained from the appliance dealer)
**2.** The cost of energy (obtained from your utility bills)
**3.** The yearly energy cost to operate the product (obtained from the EnergyGuide labels)

There are three kinds of lies: lies, damned lies, and statistics.
— Benjamin Disraeli (1804-1881)

**4.** The estimated lifetime of the appliance in years (see Table A.2 below)
**5.** A discount factor, a number that adjusts for inflation and for the fact that a dollar spent today does not have the same value as a dollar spent in the future, since today’s dollar could be invested and earn interest over time (see Table A.2 below for average figures)

This information can be plugged into the following formula:
Life-cycle Cost= Purchase Price +
(Annual Energy Cost x Estimated Lifetime x Discount Rate)

**TABLE A.2**
**CHARACTERISTICS OF APPLIANCES**
**FOR LIFE-CYCLE COST COMPARISONS**

| | Avg. lifetime appliance (years) | Discount factor[1] |
|---|---|---|
| Water heater (elec.) | 13 | .083 |
| Water heater (gas) | 13 | .083 |
| Refrigerator/freezer | 20 | .076 |
| Freezer | 20 | .076 |
| Air conditioner (central) | 12 | .084 |
| Air conditioner (room) | 15 | .081 |
| Range/oven | 18 | .078 |
| Clothes washer | 13 | .083 |
| Clothes dryer | 18 | .078 |
| Dishwasher | 12 | .084 |

1. Based on a real discount rate of 5% and an energy price escalation rate of 2%/year above inflation.

A witty statesman said, you might prove anything
by figures.
— Thomas Carlyle (1795-1881)

Let's consider another example. The Kellys decide to do a life-cycle cost analysis to compare Refrigerator A and Refrigerator B. The Kellys look on their electricity bill and find that they are paying 10 cents per kilowatt-hour (kWh). They look at the EnergyGuide labels on Refrigerators A and B. The yearly cost table at the bottom of the label shows that at an electricity cost of 10 cents per kWh, Refrigerator A has an annual energy cost of $100, while Refrigerator B has an annual energy cost of $120. The appliance dealer tells them that Refrigerator A costs $600 and Refrigerator B $520. Next, the Kellys look at Table A.2 above and find the lifetime and discount rate to use: 20 years and 0.76, respectively. A discount factor of 0.76 means that, on average, a dollar saved on lower energy costs during the refrigerator's lifetime is only worth 76 cents today, after inflation is taken into account.

| | **Purchase price** | **Yearly energy cost** | **Life-time** | **Estimated discount factor** | **Life-cycle cost** |
|---|---|---|---|---|---|
| Refrigerator A | $600 + | ($100 x | 20 x | .76) = | $2,120 |
| Refrigerator B | $520 +( | $120 x | 20 x | .76) = | $2,344 |

With this information, the Kellys can now calculate the life-cycle costs of Refrigerators A and B:

If Mr. and Mrs. Kelly decide to buy the more energy-efficient refrigerator (Model A), this decision will save them $224 ($2,344-$2,120) over the refrigerator's lifetime. The life-cycle cost comparison, rather than the purchase price, clearly shows which model is a better buy.

A worksheet is provided below to help you calculate the life-cycle cost of appliances you are considering.

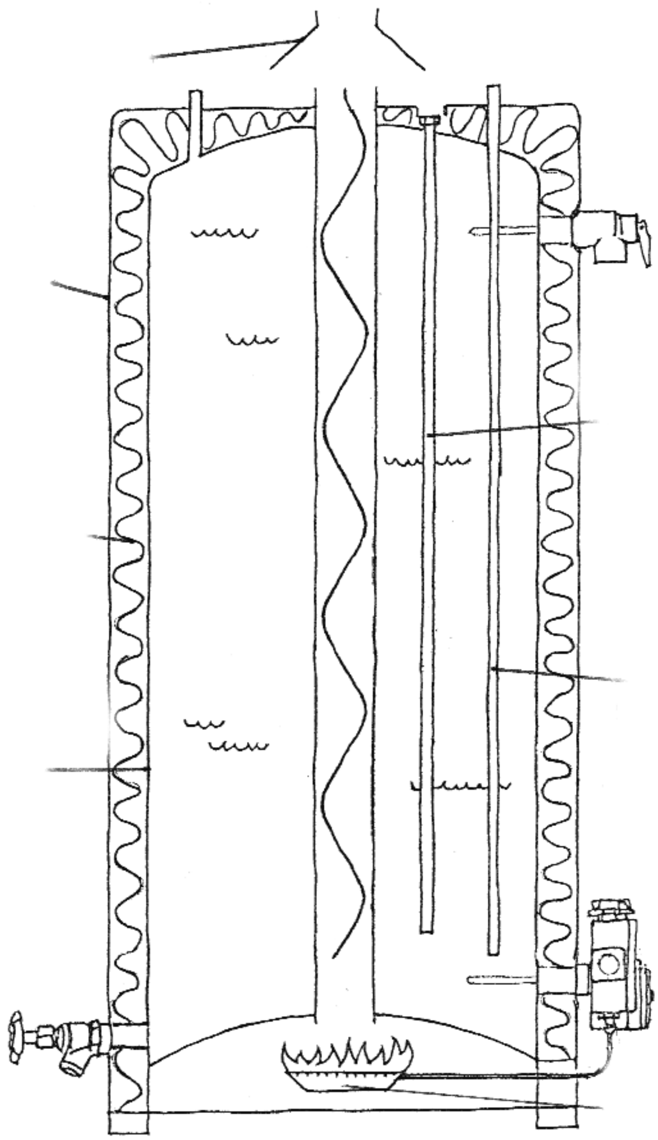
Opportunity has the uncanny habit of favoring those
who have paid the price of years of preparation.
— Anonymous

## Worksheet for Computing Life-cycle Costs

Electricity Price_______cents/kWh Gas_______cents/therm
Obtain from your utility bills or call your utility

| | Purchase price | Yearly energy cost | Life-time | Estimated discount factor | Life-cycle cost |
|---|---|---|---|---|---|
| Appliance A | ____ + | (____X | ____X | ____) | =____ |
| | from appliance store | from bottom of Energy Guide label | from Table A-2 | from Table A-2 | |
| Appliance B | ____ + | (____X | ____X | ____) | =____ |
| Appliance C | ____ + | (____X | ____X | ____) | =____ |
| Appliance D | ____ + | (____X | ____X | ____) | =____ |
| Appliance E | ____ + | (____X | ____X | ____) | =____ |
| Appliance F | ____ + | (____X | ____X | ____) | =____ |
| Appliance G | ____ + | (____X | ____X | ____) | =____ |
| Appliance H | ____ + | (____X | ____X | ____) | =____ |
| Appliance I | ____ + | (____X | ____X | ____) | =____ |
| Appliance J | ____ + | (____X | ____X | ____) | =____ |

When plans are laid in advance, it is surprising
how often the circumstances fit in with them.
— Sir William Osier (1849-1919)



**Diag. 1 GAS WATER HEATER**

**Chapter 1**

## ANATOMY OF A WATER HEATER

### GENERAL DESCRIPTION

Most tank-type water heaters sold in the United States have the same basic construction: They are steel tanks lined on the inside with a glass-like coating (similar to ceramic glazes) and insulated outside with fiberglass or rigid foam. The insulation is covered with a sheet-metal jacket. Heat is usually supplied by burning gas or using electric heating elements; both types are thermostatically controlled. Inside, screwed in from the top, you will find at least one sacrificial anode rod, used to prevent tank rusting, and a dip tube, which delivers cold water to the tank bottom (Diagrams 1 and 2).

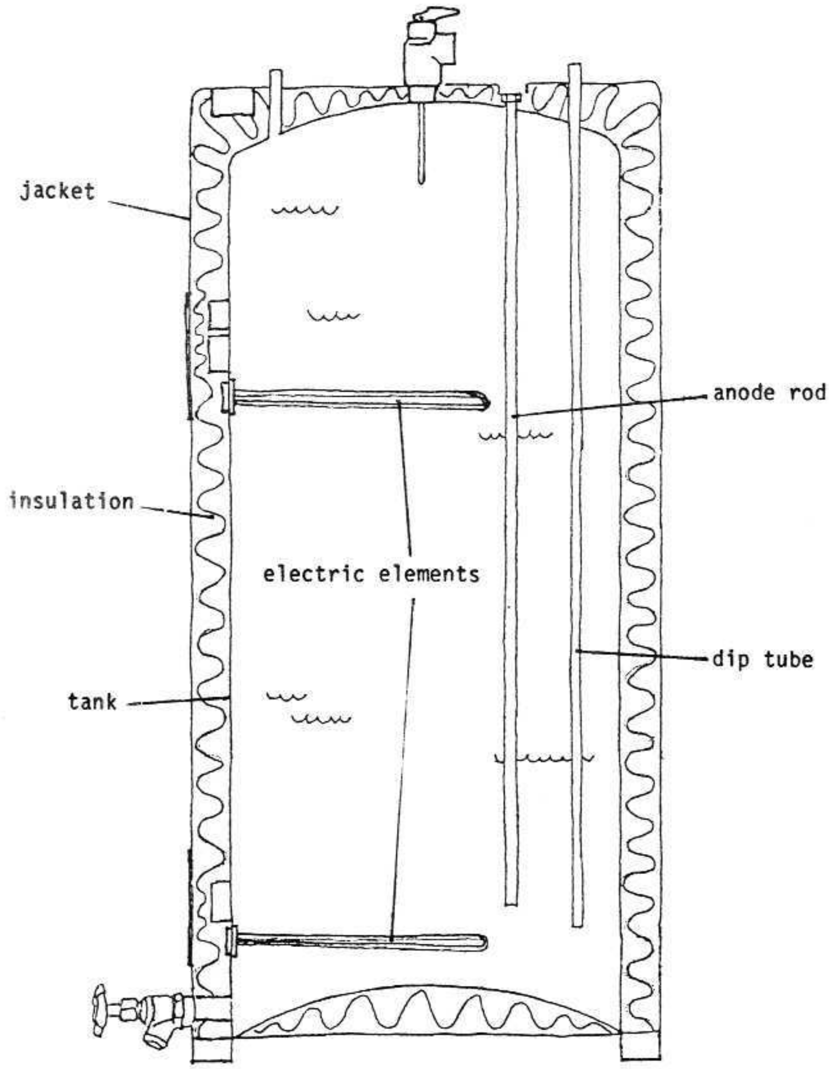
Other kinds of tanks are available, but less common. Some steel tanks are lined with cement or high-temperature plastics. Tanks may also be made of a more corrosion-resistant metal such as copper, stainless steel or monel. Tanks made entirely of plastics have also appeared on the market.

While gas and electricity are most common, other energy sources may be used for heat. Oil-, coal- and wood-fired water heaters exist. Solar energy can be used to preheat, and some tanks use electricity to drive a heat pump.

### GLASS LINING

Your water heater's main protection from rusting is its glass lining. Because of the processes involved in manufacturing, a steel tank's interior is not entirely covered with glass. There are bare areas vulnerable to rusting at

The beginning of wisdom is to call things
by their right name.
— Chinese Proverb




**Diag. 2 ELECTRIC WATER HEATER**

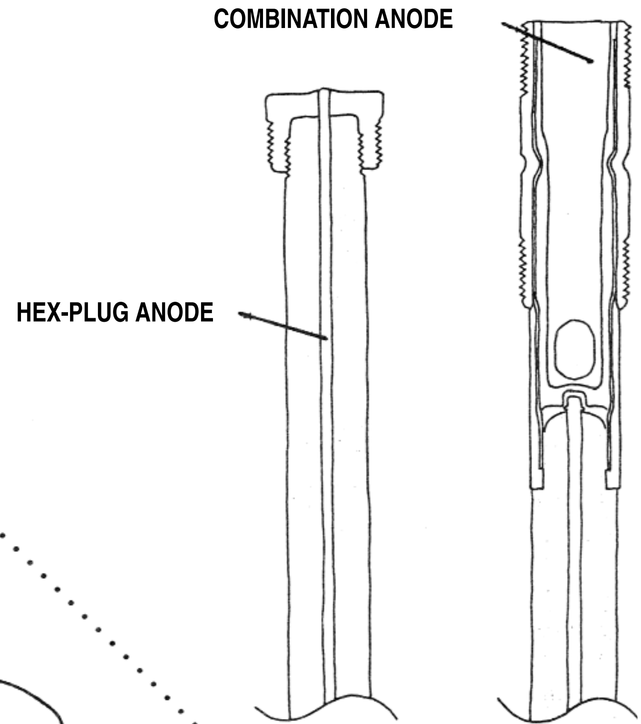
welds, seams, fitting penetrations and at pinholes and cracks in the lining itself. The glass lining can be damaged by rough handling, and the first time a tank is pressurized with water, the lining may crack as the unit flexes slightly. When sediment builds up on the bottom of gas-fired heaters, heat transfer is slowed and overheating occurs. This excess heat slowly dissolves the glass and exposes the tank's steel.

**ANODES** Working in partnership with your tank's glass lining is its sacrificial anode rod. By means of an electrochemical reaction (akin to what happens in a battery), the anode itself corrodes away instead of the steel tank. Rusting of your tank is virtually stopped as long as a working anode is in place.

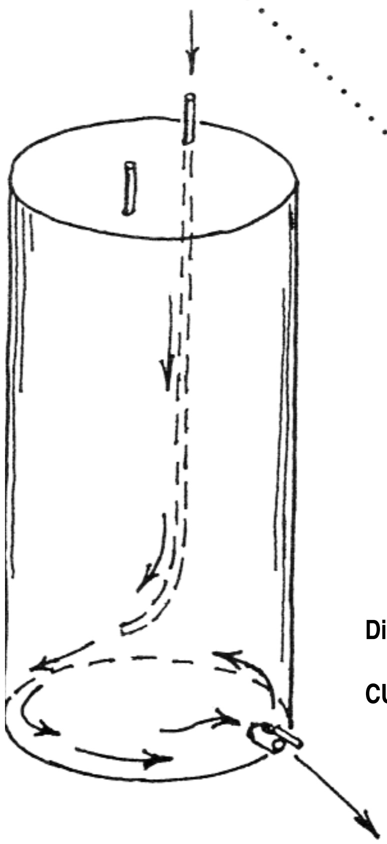
An anode is made from an alloy of magnesium, aluminum or zinc that is formed around a steel core wire. Magnesium rods are used most often. Tanks in hard water areas may have aluminum rods, and where hot-water odor is a problem, the zinc alloy is useful.

You will find anodes installed in two ways. Usually, the anode is attached to a ¾-inch threaded hex plug, which is screwed into the tank top. In some heaters, the anode is combined with the hot outlet pipe nipple, also screwed in at the top; we call this a combination anode. Every glass-lined tank has at least one anode. Some residential tanks with longer warranties may come equipped with a second one. Usually, in such a case, one anode will be of the hex-plug type and the other will be a combination type (Diagram 3). On large residential heaters, two hex-type anodes may be used.

The foul sluggard's comfort: 'It will last my time.'
—Thomas Carlyle (1795-1881)




Diag. 3



Diag. 4

CURVED DIP TUBE

Though all glass-lined tanks have anode rods, locating them can be a chore. See Chapter 3 for a discussion on finding and inspecting anodes.

**DIP TUBES** Another component in residential heaters is the dip tube. Usually made of plastic, it is suspended from a steel ring in a port at the top of the heater. It delivers water from the cold inlet at the top down to the tank bottom to prevent mixing of the hot and cold waters. Since hot water is less dense, it floats on cold water. It naturally rises to the top of the heater and is the first water used when the tap is turned on. With no dip tube, you would get a very short shower. Because dip tubes can fall in, crack off or split, you should check your dip tube if insufficient hot water is a problem.

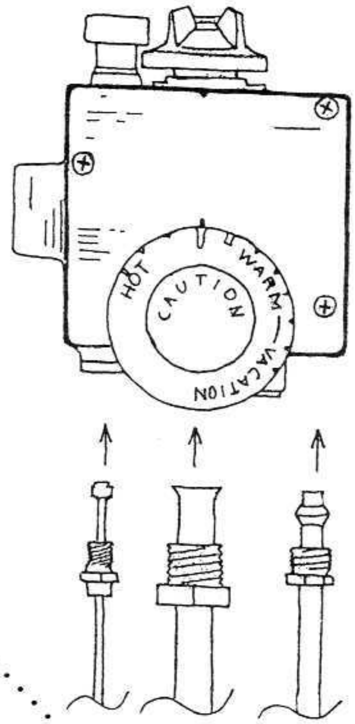
Some new heaters are being supplied with dip tubes which are curved at the lower end. They swirl water around the tank and stir up any sediment. The idea is that sediment in suspension will follow the water flow out the tap instead of settling on the bottom and causing problems. Curved dip tubes can also be added to existing tanks to help flush sediment out the drain valve (Diagram 4).

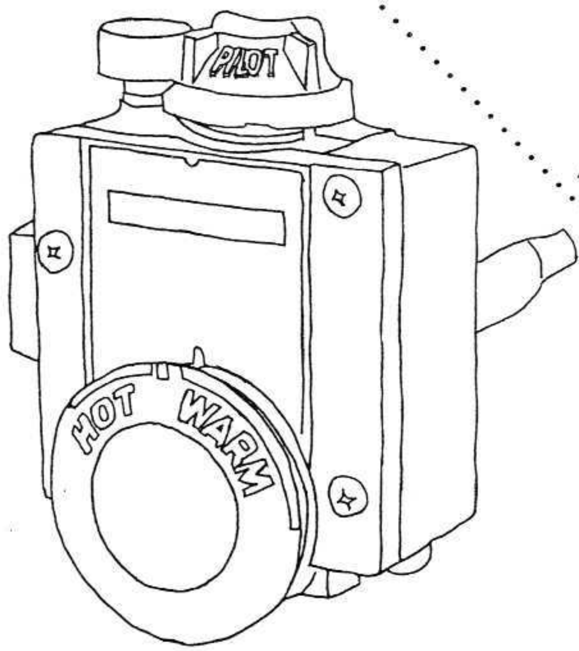
Tanks that do not have dip tubes introduce cold water through a port on the side of the tank, close to the bottom. This arrangement is often used in commercial heaters, mobile home heaters and in many Canadian heaters.

**GAS CONTROLS** Residential gas water heaters are controlled by a thermostat with a direct immersion temperature probe (Diagram 5). The thermostat is screwed into a port near the bottom of

Only the educated are free.
— Epictetus (1st century A.D.)

Diag. 6 THERMOSTAT HOOK-UP




Diag. 5 THERMOSTAT

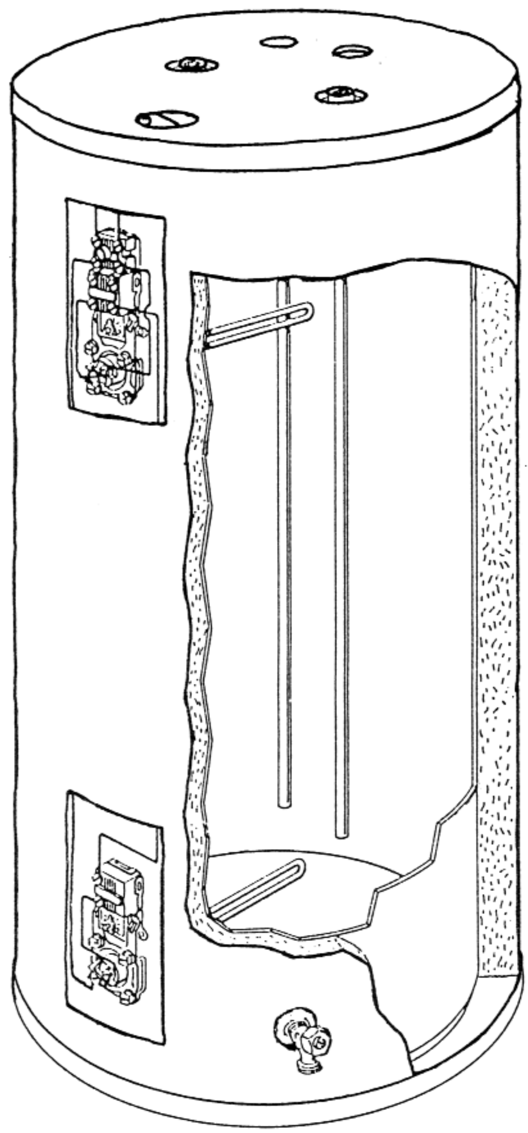
the tank, where the coolest water will be. Usually you will find a dial on its front, which controls the temperature, and a knob on top, which can be set to ON, OFF or PILOT. (See Sediment Control, Chapter 3, for discussion on setting the temperature.) The top knob may contain a recessed screw which can be used to adjust the size of the flame on the main burner. Another control feature is a high-limit safety switch, sometimes referred to as the ECO (energy cut-off). Should the water temperature ever reach 190° (210° on older heaters), the ECO will open and shut down the heater by disabling the control; nearly all heaters will then need a replacement control.

Three tubes extend down from the control (Diagram 6): The largest is the gas supply to the main burner, a smaller one feeds the pilot light, and the smallest is a thermocouple, which powers the control as long as the pilot is operating. Gas controls have some serviceable parts: the thermocouple may need replacement if the pilot will not stay lit; the "magnet," which is inside the control and regulates gas flow may be replaceable on older heaters; the burner assembly is removable for cleaning; and there may be a main burner adjustment. Opening up the body of the control is not recommended.

**ELECTRIC CONTROLS** Most electric water heaters have two immersion-type heating elements running horizontally inside the tank, one in the upper half and one near the bottom. These can be either high- or low-watt density elements. The latter, while larger and somewhat more expensive, tend to produce less sediment.

Heaters are usually wired so that the lower element

If you think education is expensive, try ignorance.
— Derek Bok (1930- )



Diag. 7 ELECTRIC THERMOSTATS

does the bulk of the heating. The upper one comes on only when a large amount of water has been drawn and the tank has cooled. They normally don’t operate simultaneously.

Usually, each element is separately controlled by an adjustable thermostat mounted on the side of the tank, directly above the element (diagram 7). Some new heaters do not have an adjustable upper thermostat. Instead, it comes pre-set at 120° and has a high-limit switch that will shut off power to the heater if water temperature exceeds 190°. (It can be reset by pushing its red button.) If your heater has only one element, it will be low in the tank and have a thermostat and high limit similar to that of the upper element in a two-element tank.

Electric thermostats usually perform well for years; however, overheating, moisture or loose wire connections can cause damage.

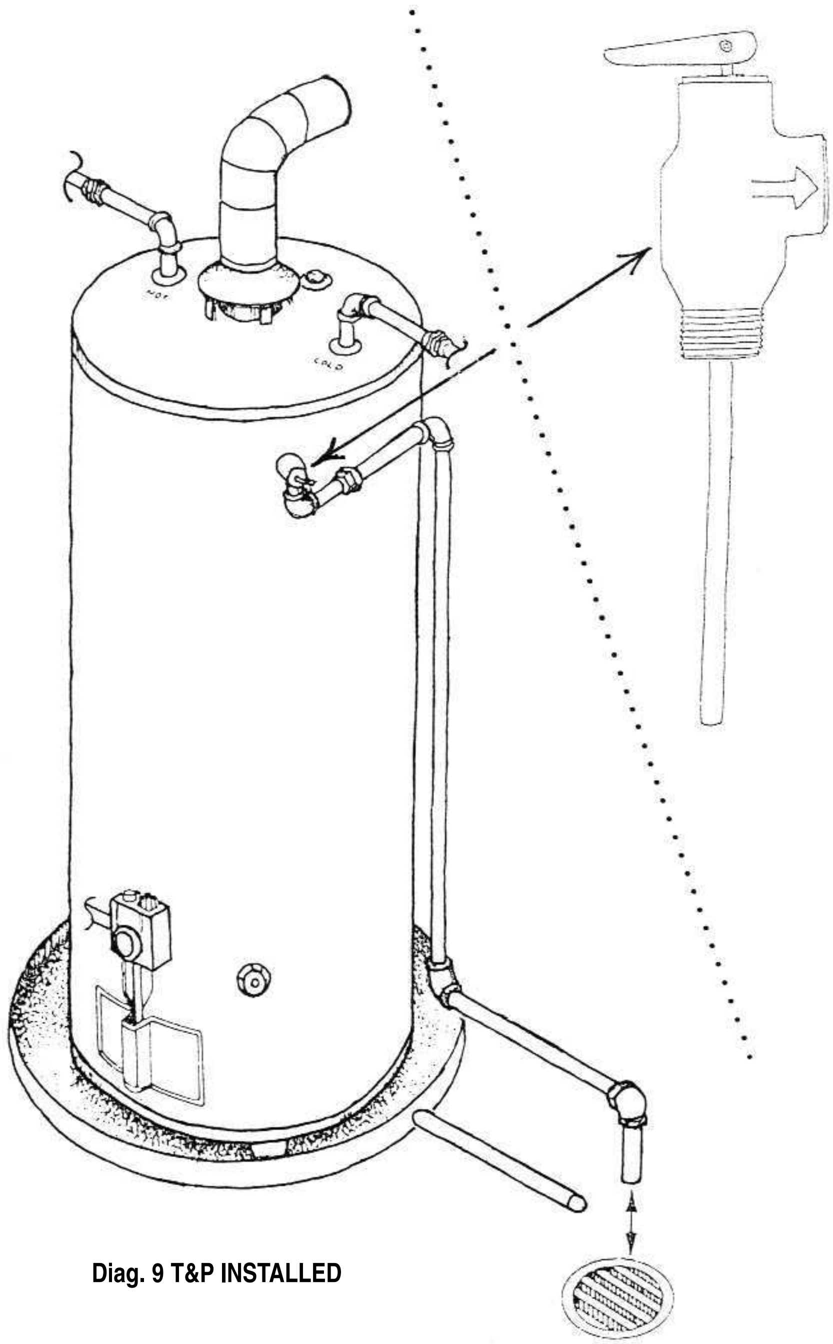
## TEMPERATURE AND PRESSURE RELIEF VALVES

Sometimes referred to as the T&P or pop-off, the temperature and pressure relief valve is a safety device that all modern water heaters must have (Diagrams 8 & 9). Should the other safety features fail, the heat-sensitive part of this valve will open at 210° and expel hot water, allowing cold water in to prevent boiling and possible explosion. In addition, if for any reason the water pressure exceeds 150 pounds per square inch (psi), the valve will open to relieve that pressure.

The rated Btu (British thermal unit, a measure of

> Truth has a way of shifting under pressure.
> — Curtis Bok (1897-1962)

Diag. 8 T&P



Diag. 9 T&P INSTALLED

heat) capacity of the T&P must be higher than that of the water heater it serves. Also, the T&P valve should have a discharge line leading down and away from the tank to reduce the possibility of scalding or flooding (see Chapter 6).

**DRAIN VALVES** Whatever the heat source, your tank will have a drain valve. Many water heaters come equipped with a cone-shaped plastic valve. These can cause trouble, but, fortunately, they are replaceable. Some manufacturers use a more conventional faucet-like plastic drain valve with a knob. A brass hose bibb would be more durable, however, and a brass ball valve would be best of all, as it permits effective tank flushing (Diagrams 10 to 13).

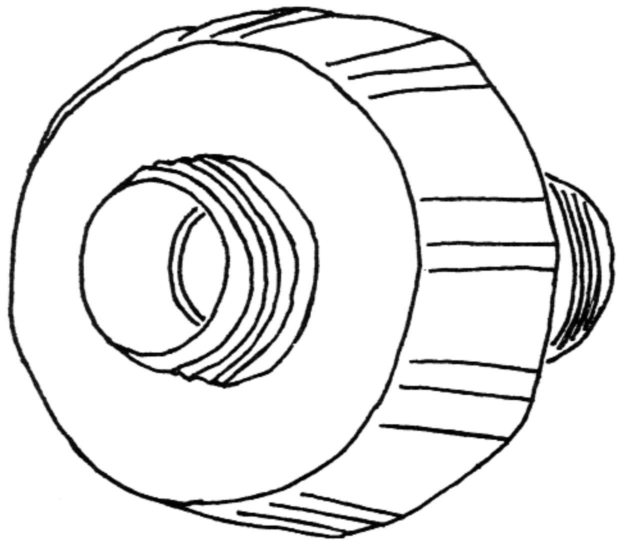
Now you have a good picture of how a water heater is put together and what its main components are. In Chapter 2, we'll talk about a water heater's weak spots to get an understanding of why tanks fail.

---

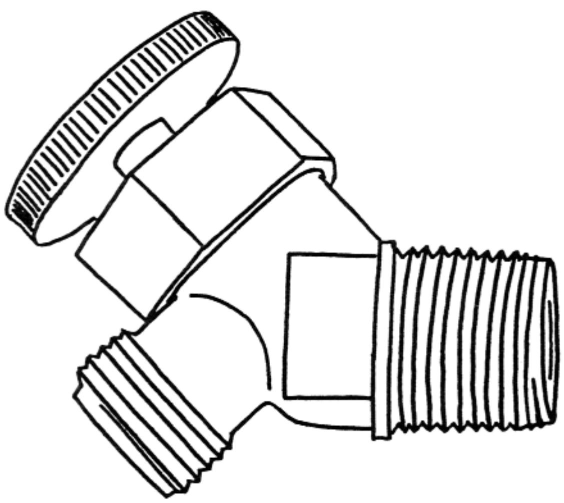
**A True Story:** Because the owner was not getting sufficient hot water, he purchased a bigger water heater, moving a wall to make room for it. Called to hook up the new heater, we took a look at his old one. His cold water dip tube had broken off, so cold water then entered at the top, where it diluted the hot. He could have solved his problem with an inexpensive replacement part. MORAL: Information saves you money and headaches.

---

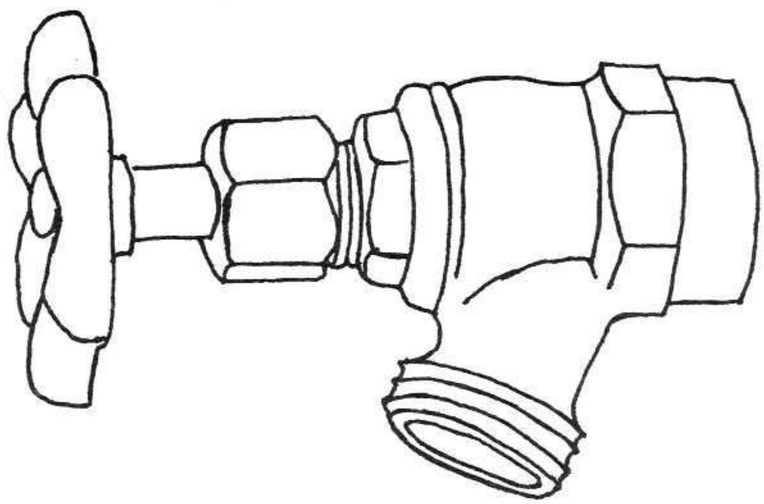
If has long been an axiom of mine that the little things are infinitely the most important.
— Sir Arthur Conan Doyle (1859-1930)



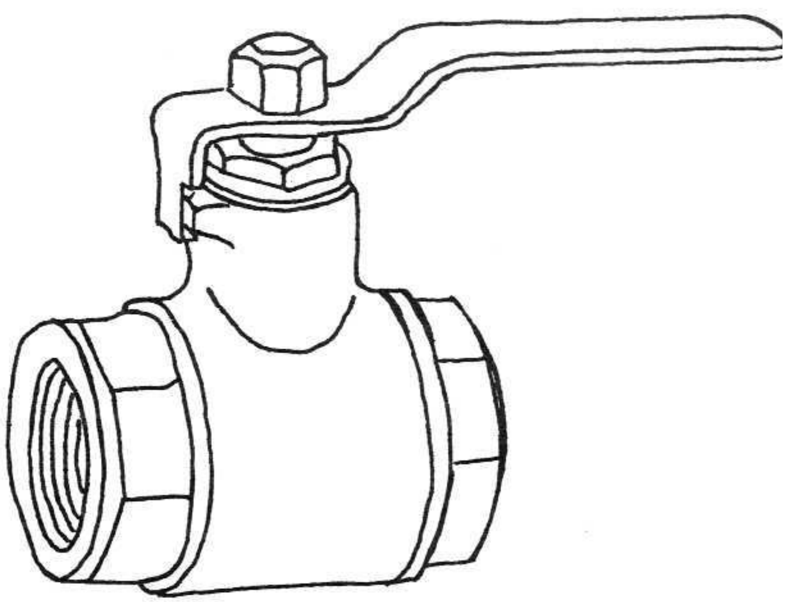
Diag. 10 CONE-SHAPED DRAIN



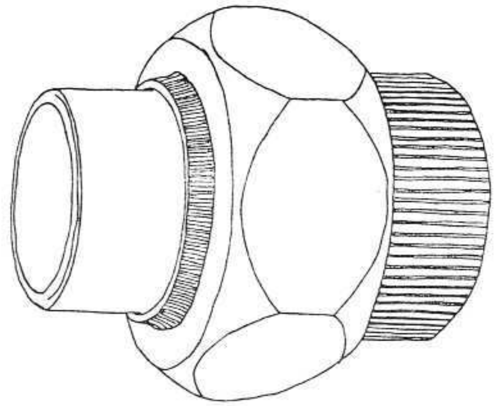
Diag. 11 PLASTIC BIBB



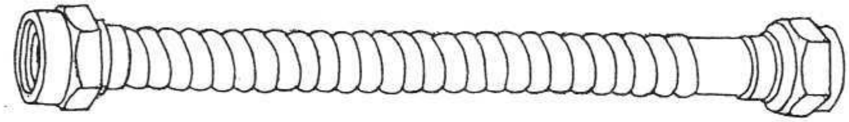
Diag. 12 BRASS BIBB



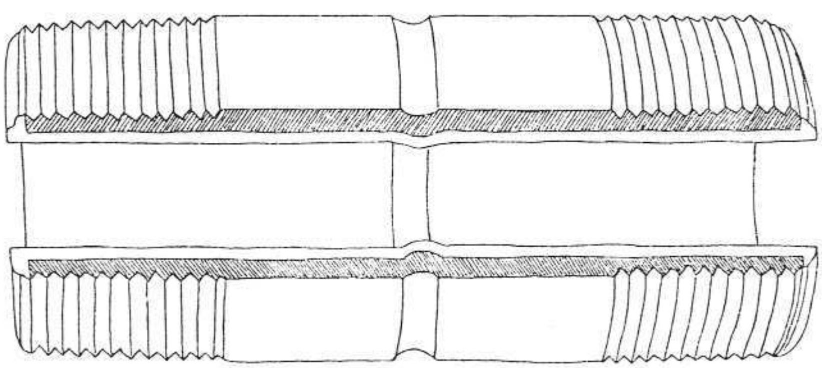
Diag. 13 BRASS BALL VALVE



Diag. 14 DIELECTRIC UNION



Diag. 15 FLEX-LINE DIELECTRIC



Diag. 16 PLASTIC-LINED NIPPLE

**Chapter 2**

## WHY TANKS FAIL

Simply put, rusting is what makes steel tanks leak and require replacement. There are a number of factors that contribute to the rusting of water heaters. Proper installation, maintenance and adjustment will nearly eliminate these factors.

**DEPLETED ANODES** The inside of your tank is protected only as long as the anode rod has sufficient sacrificial metal remaining on its steel core wire. Inspect the rod periodically and replace it when needed (see Chapter 3). Without a functioning anode in your tank, any other measures are just wasted energy.

**ELECTROLYSIS** Just as magnesium anodes corrode (purposely) in the presence of steel, steel will rust (to the detriment of your tank) when it’s near to copper or brass. The more of these metals there is, the more the steel tank will rust. Water heater connections such as hot, cold and recirculating loop lines are often made of copper and brass. When they are joined directly to the tank, excessive rusting occurs at the connections, restricting water flow and weakening the steel. Dielectric unions and plastic-lined steel nipples have been developed to reduce this electrolytic corrosion (Diagrams 14 to 16).

**SEDIMENT BUILD-UP** Heat forces minerals out of solution, forming solids that settle on the bottom of your tank. This sediment is mostly calcium carbonate. The harder the water, the more sediment. When sediment accumulates in a gas heater, it forms a barrier between the water and the

It Is better to wear out than to rust out.
— Richard Cumberland (1631-1718)

flame, slowing heat transfer. The subsequent overheating of the tank bottom can cause two problems. First, the glass lining starts to dissolve at temperatures above 160°. Over time, the steel tank bottom is gradually exposed to water and potential rusting. Second, severe overheating can weaken the metal bottom to the point of deforming under normal pressure. (Temperatures exceeding 1,000° have been measured at the bottom of a severely scaled tank!)

Sediment causes additional problems. In both gas and electric heaters, a dense sediment layer can insulate the tank bottom from the protection of the anode rod. The sediment can also play host to bacteria. Most of these are not harmful to our health, but they do make the environment in the sediment more corrosive. Thus the steel is under harsher attack than with heat and sediment alone.

**HIGH TEMPERATURE & PRESSURE** Elevated temperatures cause a more rapid accumulation of sediment and they speed up chemical reactions. For every temperature rise of 20°, reaction speed is about doubled. Since the rusting reaction between steel and oxygen is accelerated by heat, avoid high temperatures.

Excessive water pressure (over 80 psi) can also damage a tank. Higher pressures make a tank flex slightly, causing the glass lining to crack and flake. High pressure may come from the water supply or from the slight expansion of water caused by heating. A pressure gauge that reads 0-200 psi can be attached at the drain valve and will help identify pressure problems.

**SOFTENED WATER** Softening water works indirectly to reduce the service life of

In a major matter, no details are small.
— Jean Francois Paul de Gondi (1613-1679)


**CORROSIVE CHEMICALS AND GAS HEATERS DON'T MIX**

your water heater unless you perform regular maintenance. Softening is done by exchanging salt for hardness in the water. This salt is more corrosive to the anode rod than the calcium carbonate it replaces. Since softened water doubles or triples the speed of an anode's consumption (greatly shortening its useful life), frequent inspection is essential with softened (or phosphate-treated) water. We suggest checking the anode every one to two years.

**EXTERNAL ENVIRONMENT** Don't overlook your tank's surroundings. If the air burned in a gas heater is damp or carries salt, chlorine or other corrosive chemicals, it will attack the tank from inside the flue and combustion chamber (see illustration, p. 31). It may even void the warranty.

Keep your heater dry. Many tanks have failed because a plumbing fitting leaked and rusted through the tank externally. Troublemakers include the drain valve, heating elements and hot and cold connections. Even a loose packing nut on an overhead shutoff valve may leak and ruin a tank. Tanks can fail for any one or combination of these reasons, but there are various things you can do to prevent failure. Chapter 3 describes how.

A True Story: The heater had a hole rusted right through it—from the top! A leaky gate valve on the plumbing overhead had dripped for months and eaten away the top of the tank. If the owner had thought to look, he could have prevented the tank's early demise. MORAL: Like all steel things, water heaters will turn into rust when no one is looking.

We cannot command nature except by obeying her.
— Francis Bacon (1561-1626)

# Chapter 3

## MAINTENANCE: GIVE YOUR OLD HEATER NEW LIFE

Before anode inspection or any plumbing work on your heater, do the following:

* Turn off power, if electric, and confirm that power is off by using a volt-ohm meter to check at upper thermostat; turn control to pilot, if gas.
* Turn off water supply to tank — usually a gate valve on the incoming cold line.
* Open a hot tap inside the house to take pressure off system.
* Drain 1-2 gallons from heater’s drain to prevent spillage when you disconnect plumbing on top.

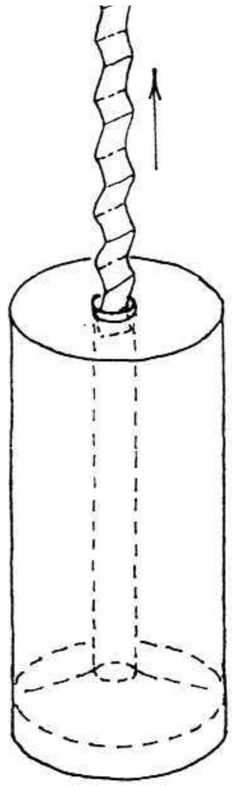
**Note:** If people in your dwelling must use water while you are working on the water heater, have them use cold water only, or you may get soaked with water coming back out the hot line. (If the people are out of your control, you may want to plug or cap the hot line coming out of the wall.)

## DETERMINE CURRENT STATUS

### Check Tank’s Age

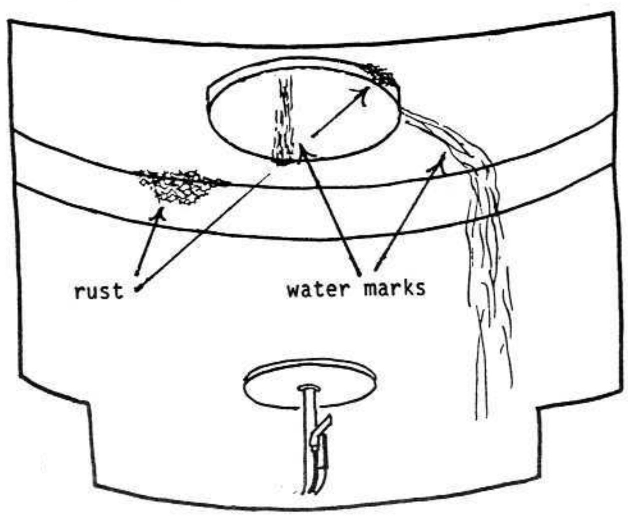
It’s useful to determine the age of your tank before working on it. A heater’s age can guide you to appropriate inspection and maintenance. For example, if a heater is only a few years old, it’s likely the

> Everything that enlarges the sphere of human powers, that shows man he can do what he thought he could not do, is valuable.
> — Samuel Johnson (1709-1784)



**Diag. 17**

**FLUE BAFFLE**




**Diag. 18**

**COMBUSTION CHAMBER**

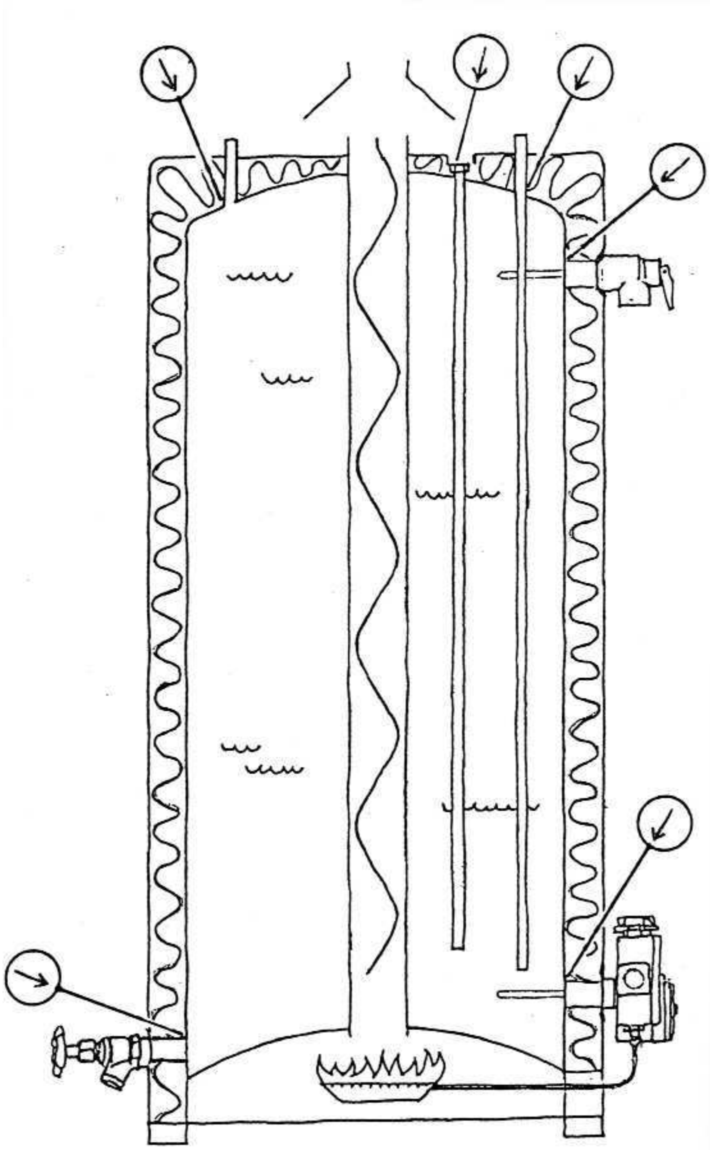
anode rod will still have life in it. However, a heater more than six years old (or one which is using softened water and is over two years old) will probably need a new anode. Older heaters are also more likely to have troubles with a damaged dip tube and more likely to possess recalcitrant drains.

To determine a heater’s age, look at the serial number printed or stamped onto the name plate. If it starts 0108... or A08..., that means it was made in January of 2008. 0210... or B10... means February 2010. If it starts 0604..., that means it was built in the fourth week of 2006. If the serial number simply does not make sense with these guidelines, look for “warranty” on the name tag; the A08S or other code may be found there. If none of this leads you to a date, proceed with servicing the unit. It probably needs it.

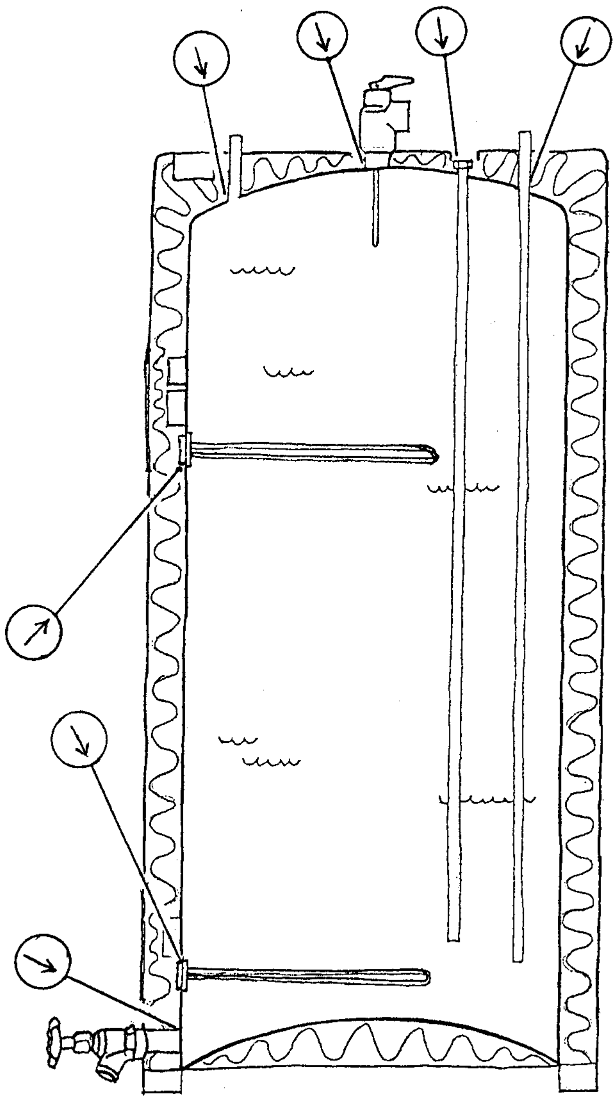
**Examine Combustion Chamber** Inspection of a gas heater’s combustion chamber and flue will show you if your tank is in good enough condition to warrant working on it. First, turn the control to pilot. Then remove both combustion chamber hatch covers on older heaters, or remove the outer hatch on heaters made since 2003 and look through the window of the inner hatch. Also remove the vent pipe with draft diverter on top of the heater. Pull out the baffle (Diagram 17). Now inspect both the combustion chamber and internal flue with a flashlight. If you find no signs of heavy rusting or water marks, the tank is a good candidate for maintenance (Diagram 18).

**Inspect Fittings** Next, look at the area around each of the tank penetrations (Diagrams 19 & 20): hot line, cold line, anode rod,

Let us dare to read, think, speak and write.
— John Adams (1735-1826)



**Diag. 19 CHECKPOINTS: GAS**



Diag. 20 CHECKPOINTS: ELECTRIC

T&P valve, drain valve, and thermostat. To check the hard-to-reach fittings (for example, the thermostat), push a cotton swab around the joint and then check it for moisture. If these areas are dry and fairly free from rust, good. If not, either disconnect, clean, and wrap the old fitting with Teflon® tape, or install a new fitting (see Plumbing Maintenance, this chapter). If your heater is electric, take the hatch covers off and inspect upper and lower element sites. Heating elements may need new gaskets.

**Evaluate Anode** The best clue you have about the interior condition of a tank is its anode rod. (Remember, the anode rod is the key to a heater’s longevity.) If you find a good amount of sacrificial metal left, there should be no major damage inside the tank. One exception to this rule is that some anodes will passivate; that is, they form a hard, adherent, calcium carbonate coating which prevents further corrosion of the sacrificial metal. This results in a rod which looks fine, but is not fully protecting the tank. You can test for passivation by bending the rod. If scale flakes off the bend, the rod has passivated.

An anode usually corrodes in a predictable manner. It begins as a solid metal rod with a steel support wire embedded in its core. When the anode corrodes to the point where six inches of this core wire is exposed (usually at the top or bottom), it should be replaced. The wire is sometimes covered with a coat of soft calcium carbonate, which will easily come off. Don’t mistake this build-up for the corroding sacrificial metal.

Other criteria for anode replacement are passivation

0 excellent! I love long life better than figs.
— William Shakespeare (1564-1616)

(described above), a diameter reduced down to about half of the original 3/4- to 7/8-inch size, heavy pitting, or splitting down its length (Diagram 21). As the anode deteriorates further, more core wire will be exposed until the sacrificial metal is completely gone. The core wire itself will then start rusting away. Finally, all that is left is the hex plug (or the hot outlet nipple, if you have a combination anode).

If the anode has a substantial amount of bare wire, you can assume damage has occurred in the tank. If, however, you found no external evidence of trouble during your inspection, maintenance is still worth pursuing.

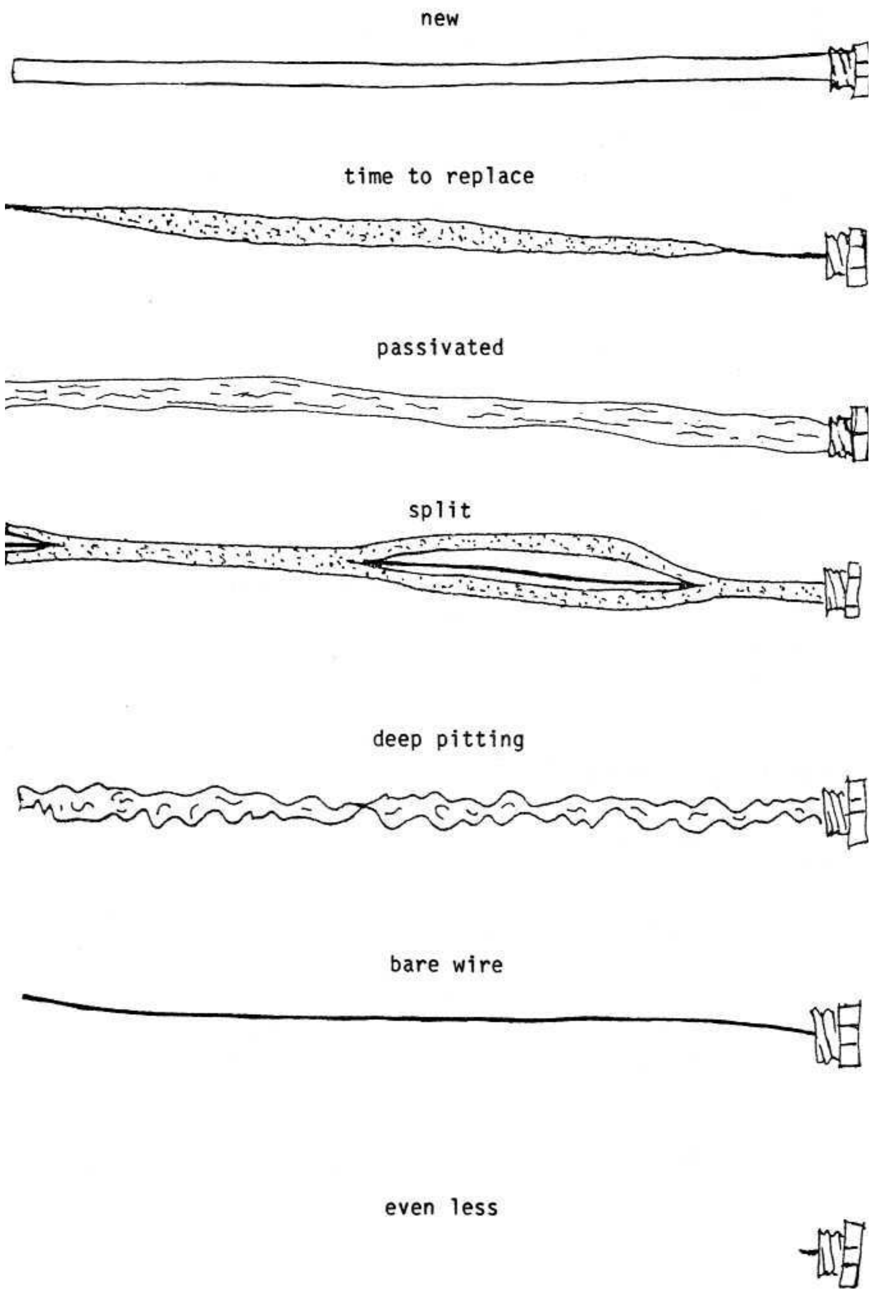
## MAINTENANCE TASKS

If you have determined that your water heater is reasonably healthy and warrants maintenance, you can make it safer, more efficient, and much longer lived by performing the maintenance described below.

**Anode Inspection** Anodes normally should be checked every three to four years. If you have very hard, acidic or softened water, check your anode every one to two years. Learning the history of water heater replacement in your neighborhood may be useful, but the condition of your current anode and its age will be the most important factors in helping you determine when it should be checked. (See previous section for description of anode conditions.)

Before you can install a new anode, the old one must be located and removed. This is not always an easy

No time like the present.
— Mary De La Riviere Manley (1663-1724)




**Diag. 21 ANODE DETERIORATION**

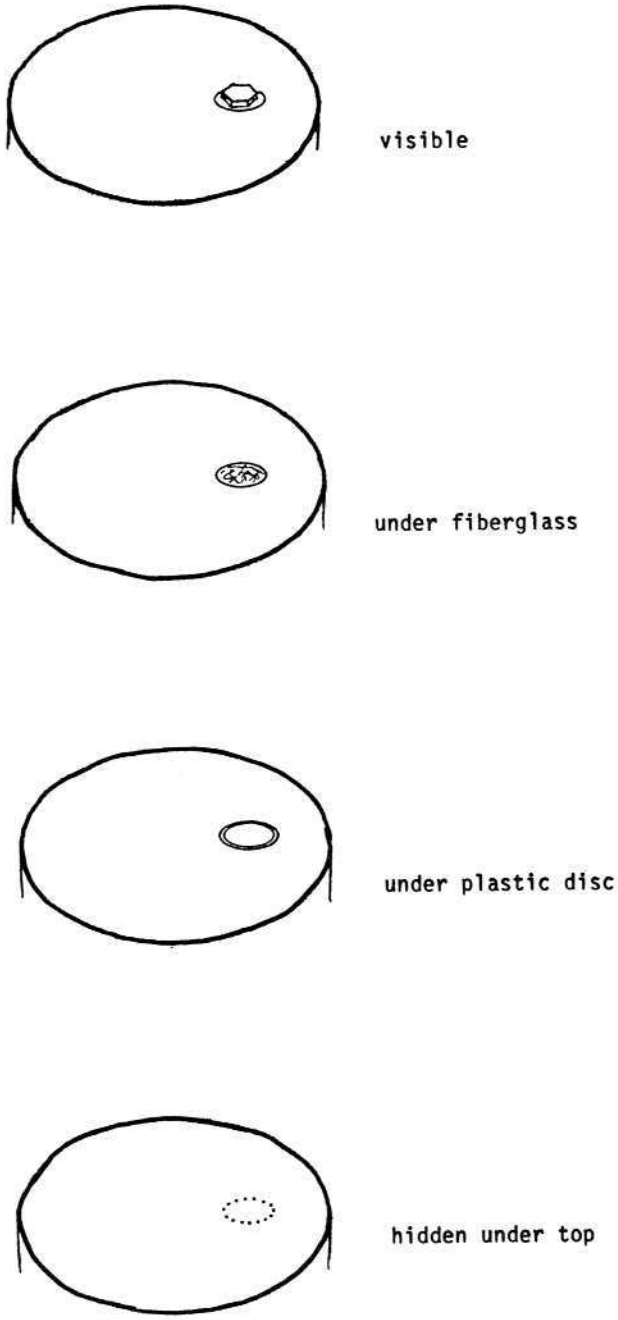
task. (If you’re lucky the water heater instructions or online spec sheets will give you anode location.) Some manufacturers provide tanks with anodes of the combination type. You may be able to test for this by disconnecting the plumbing from the hot outlet nipple and poking a stiff wire down it, into the water heater. If it stops firmly only a little way in (three to six inches), then you have found the anode, which can be unscrewed with a pipe wrench. If your wire meets no resistance, the anode is elsewhere. If the tank has a ball heat-trap nipple, it may be necessary to remove the nipple to see if there is an anode attached.

Many hex-type anodes are apparent on the top of the heater. The hex head itself may be visible, it may be buried under a mound of fiberglass, or it may be under a plastic disc.

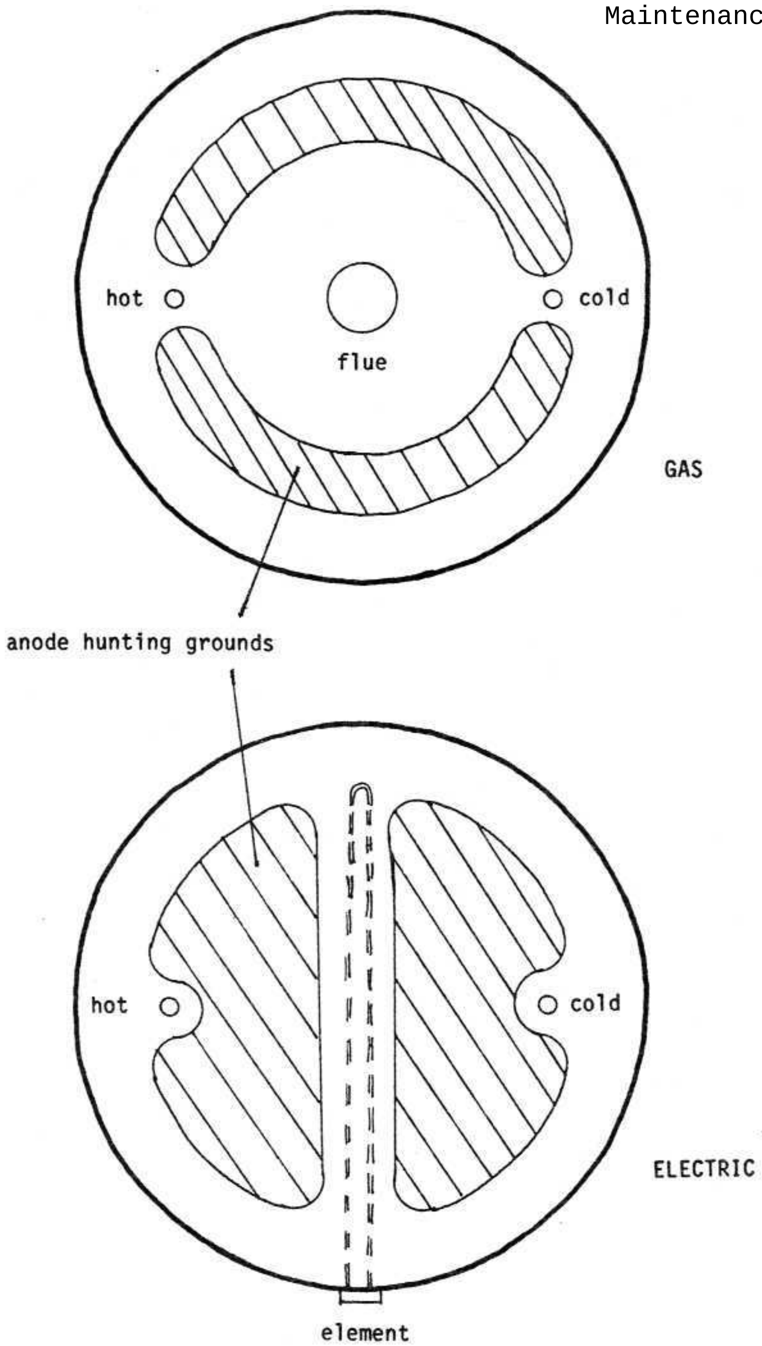
Sometimes, however, it will be hidden under the sheet-metal top (Diagram 22). If it’s hidden, there are two ways to find it. One is to undo the screws which hold the top in place, mark the top and side with a crayon for correct replacement, then lift the top and locate the anode. (Unfortunately, sheet-metal tops are commonly foamed-in-place on newer tanks, and taking them up is neither easy nor recommended.)

The other method leaves the top in place. Drill a 1/4-inch hole in the sheet-metal top. (Only the top, not the tank, please!) Using a long, thin screwdriver, poke down and around to locate the hex head. Keep in mind that in a gas heater, the anode will usually be as far from the flue as the hot and cold lines are. With electric heaters the anode will be offset from the center so that it will not run into the heating elements. It may require several holes

'Tis a good reader that makes a good book.
— Ralph Waldo Emerson (1803-1882)




**Diag. 22 FINDING THE ANODE**




**Diag. 23 ANODE LOCATIONS**

to locate the anode (Diagram 23).

Once the anode has been found, use offset tin snips or a hole saw to create permanent access. Trim away foam if needed. The sharp sheet-metal edge should be bent down with light taps from a hammer or taped over to protect fingers. Unscrewing the hex head anode will require a 1-1/16-inch socket, 3/4-inch drive preferred, a breaker bar and some brute force. You may need someone to steady the tank while the anode is broken loose.

**Overhead Clearance** Too often there seems to be insufficient overhead clearance to easily remove the old anode or insert a new one. If you cannot extract the existing anode without severely bending it, inspect it as far as you can to see how much metal remains. If there is sufficient metal, if it has not passivated, and if no core wire is exposed in what you can see, you might wish to reinstall and continue to use your present anode. Corrosion is usually more extensive at its upper end, which is more vulnerable because it's near the tank fittings and in hotter water. So even though you can't see the entire rod, no visible bare wire at the top would suggest the anode has life in it still.

If a new anode is called for, bend the old rod to remove it. Then bend the new anode directly in the middle, insert it half way, straighten it against the opening, and install it the rest of the way. To test your "straightened" anode for straightness, lift the rod out of the tank one to two feet and tilt it (in the tank) so its tip is touching the inner wall

> You have to take life as it happens, but you should try to make it happen the way you want to take it.
> — Anonymous

of the tank, and then rotate it. If the anode top wobbles, the rod is bent. Try to straighten it to minimize the wobble. Otherwise, it will strike the side wall, flue or element and refuse to screw in.

If clearance over the heater is less than two feet, two options exist. One is to drain the tank, disconnect plumbing and energy supply to facilitate tipping, and lean the tank over enough to install the anode. The other way is to get a link-type anode, which has short sections of sacrificial metal joined together (like link sausage) in such a way as to allow flexing and easier installation in tight places. While link anodes cost more, they are a handy option. If your need is for aluminum or zinc anodes, they are softer than magnesium and much easier to bend. One other option: If you have a gas heater with overhead vent, you may be able to slip the anode up the vent, then down into the heater, without needing to bend it.

**Anode Selection and Replacement** There are a variety of anodes available, and the following information will help you to select the appropriate one for your heater.

Of the three alloys used in anodes, the most commonly used is magnesium, then aluminum and lastly aluminum/zinc. If you have water that is not exceptionally hard, magnesium is the metal of choice. If you have very hard (or softened) water, aluminum may be used. Aluminum may also be considered when you find the old anode corroded down to the wire or completely gone. In an already damaged tank, when magnesium

The more alternatives, the more difficult the choice.
— Abbe D'Allainval (1700-1753)

is used to replace a severely corroded anode, it may overreact and produce so much hydrogen gas that it causes spurting at the faucets. However, an automatic float vent can be installed in the hot outlet to correct this problem.

Be aware there is debate concerning the effects of aluminum in the diet and its possible contribution to Alzheimer’s disease. Since there will be anode corrosion by-products in the hot water, if you do install an aluminum anode, it is safer not to cook with or drink the hot water.

Another possibility, although more expensive than the others, is an impressed-current anode, also known as a powered anode. It is an electric device that plugs into the wall and feeds a very small amount of electricity into the heater to replace the sacrificial anode reaction. It is especially good in softened water, where there are odor issues, or where sacrificial anodes are being rapidly consumed, and it is a permanent replacement.

To determine what kind of anode your heater currently has, bend it. If it bends easily, it’s aluminum; if resistant, it’s magnesium. Heaters seldom, if ever, come provided with zinc rods as original equipment. Zinc alloy anodes are used to replace other rods only when a sulphur odor is present in the hot water. The rod has a lower driving current, so it produces less of the hydrogen that contributes to the odor. (Note: zinc rods are about 90% aluminum.)

Anode length is another consideration. Normal anode

> Never believe anything until it has been officially denied.
> — Claud Cockburn (1904-1981)

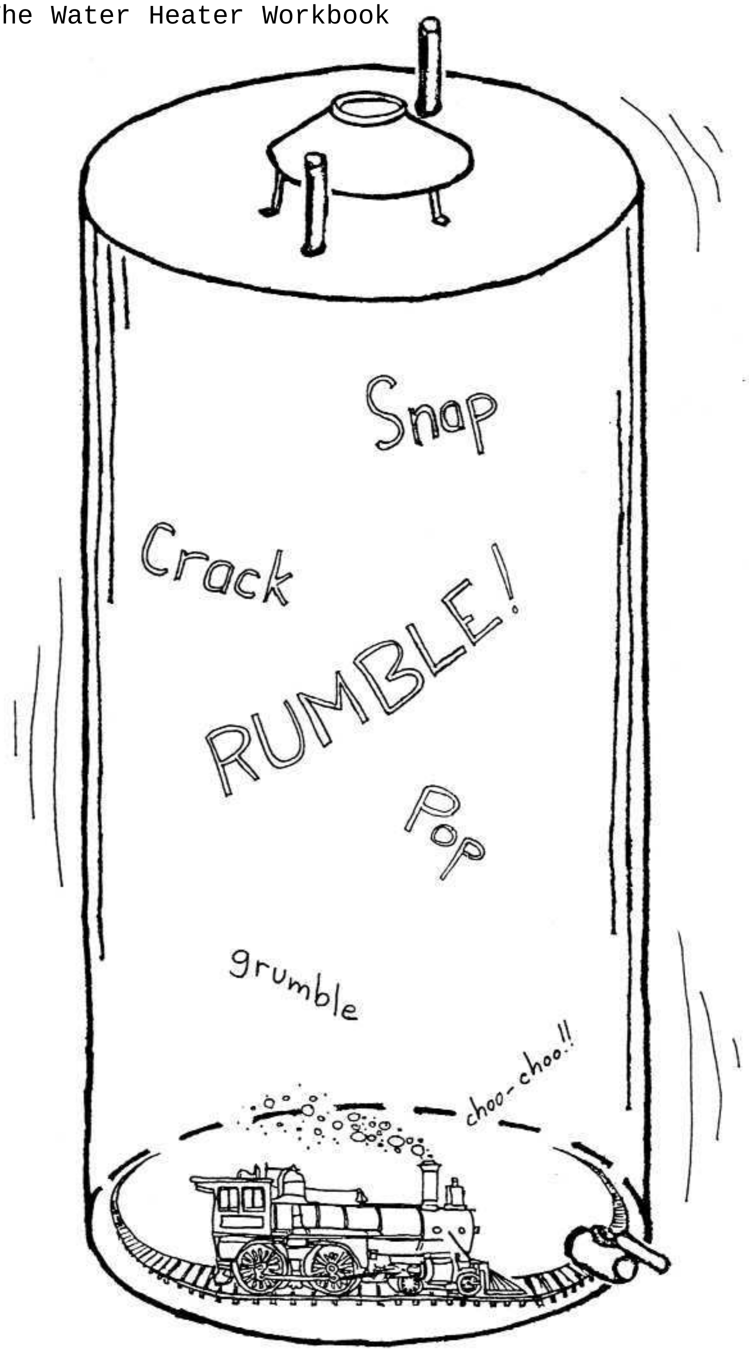
length for average residential heaters is 44 inches. An anode should reach to within a couple of inches of a tank’s bottom. If only a short anode is used, the protective current supplied by the anode will probably not reach the bottom well enough to protect it adequately. While you can easily cut an anode if it is too long, stretching one is another matter!

**Adding a Second Anode** In maintaining your water heater you may wish to add a second anode, which will provide even better long-term protection. This should be done particularly in areas with naturally soft water, or if the heater cannot be checked regularly. You can add a second anode to tanks equipped with a hex-head anode by replacing the hot water nipple with a combination anode. Depending on the thickness of insulation on top of the heater, the nipple on the anode will need to be from two to six inches long. Don’t do this if you are using an aluminum/zinc anode for odor, or the smell may become worse.

**Sediment Removal** Sediment accumulation on tank bottoms causes a number of problems (see Chapter 2, Sediment Build-up). Much of the time sediment does its damage stealthily, like a thief in the night, and only when your tank leaks are you made aware of the problem. However, three things can happen which are noticeable clues your tank has a sediment problem: lower element burnout in electric heaters, noise in gas heaters, and odor in either.

Lower element burnout occurs when sediment piles up high enough to bury it, causing overheating. You’ll

Property has its duties as well as its rights.
— Thomas Drummond (1797-1840)




Diag. 24 "A FREIGHT TRAIN IN MY TANK"

be made aware of element failure because suddenly your hot water will run out long before it used to.

In the second case, you might wonder if you're imagining things. In gas heaters a popping, crackling, or rumbling noise can be heard when water trapped in the sediment superheats and turns to steam. This boiling creates a noisy vibration, and people's reactions range from annoyance to fright. Some colorful descriptions of the noise include "burglars breaking in," "a bowling alley," and "a freight train in my tank" (Diagram 24).

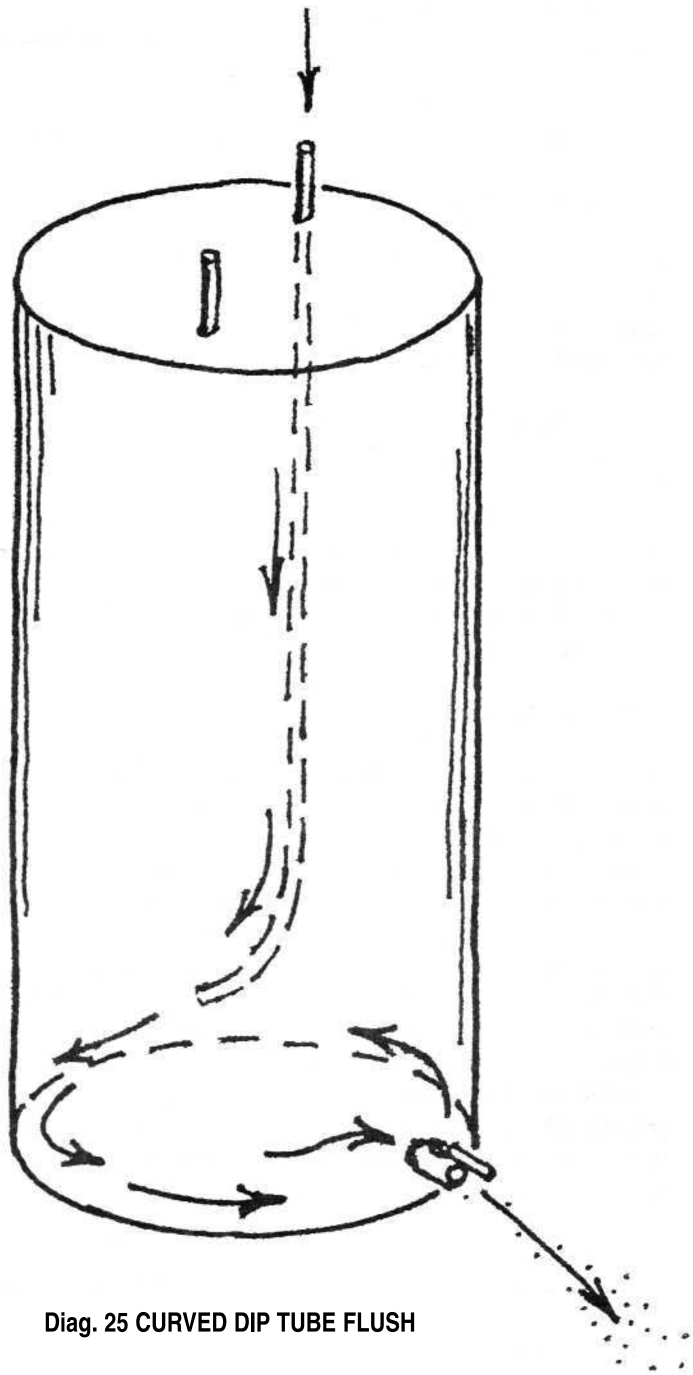
In the third instance, it is your nose which detects the problem. Sediment is a breeding ground for bacteria, which can produce an unpleasant sulphur or rotten-egg odor. (See Trouble-shooting — Odor, Chapter 7, for odor treatment instructions.)

Here are a few ways you can get the sediment out of water heaters. First, you can use the sweeping action of water from a curved dip tube (cold water inlet) to rinse it out. A second way is to use a Muck-Vac™ , which is a tool we developed to vacuum out the deposits. A third method is to dissolve the sediment. Fourth, in electric heaters you can use a shop vac to pull sediment out of the lower element opening. There is at least one other way to get rid of sediment: We have been told you can disconnect and drain your heater, turn it upside down, and shake it vigorously as you squirt a hose up inside to help wash out the sediment. ( We are unable to recommend this latter method with much enthusiasm.)

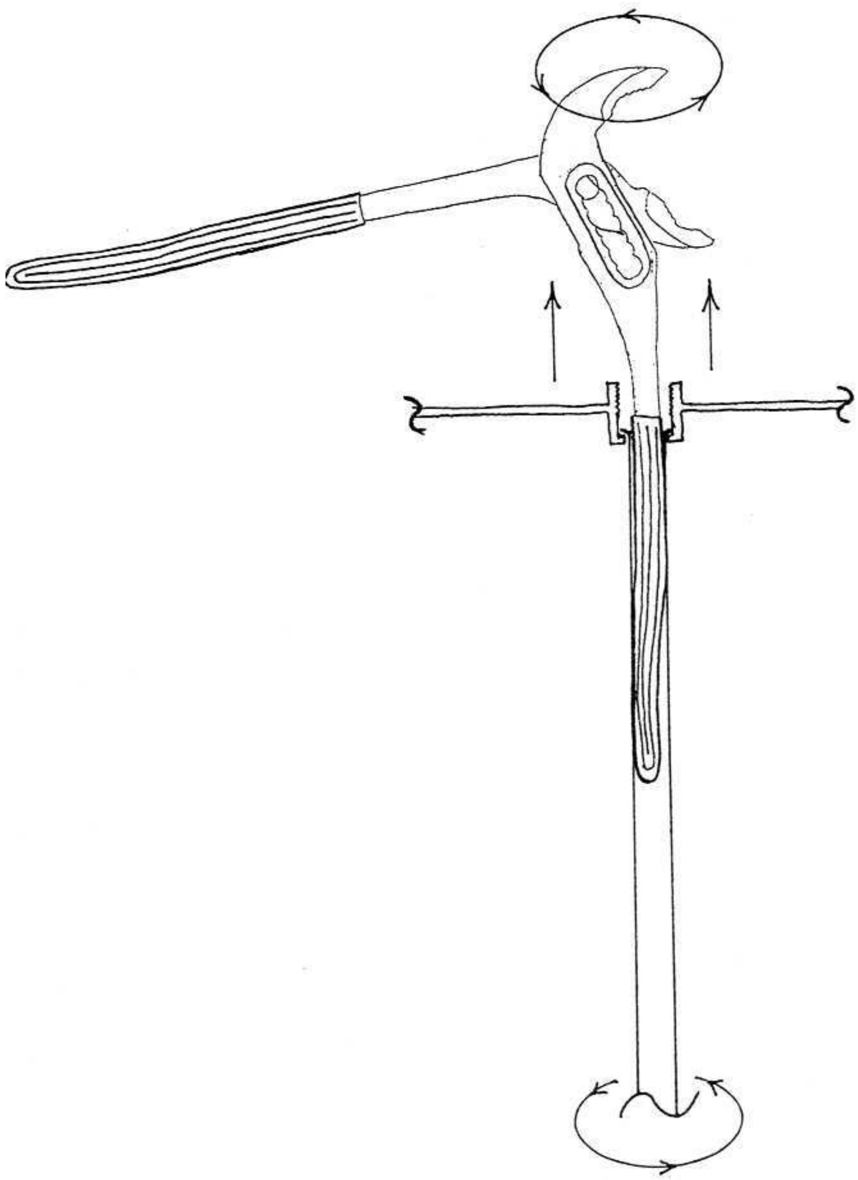
## The Curved Dip Tube Flush

Usually the dip tube is a straight

He that will not apply new remedies must expect new evils; for time is the greatest innovator.
— Francis Bacon (1561-1626)



Diag. 25 CURVED DIP TUBE FLUSH



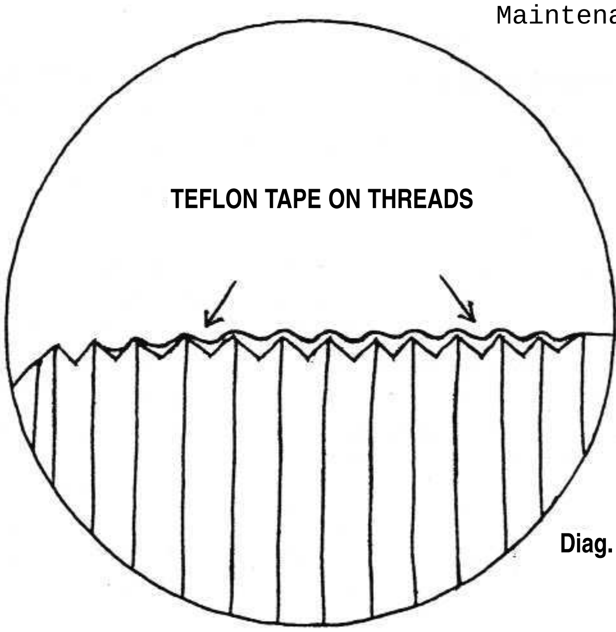
**Diag. 26 REMOVING DIP TUBE**

plastic pipe extending most of the way to the bottom. The area directly under the tube is often clean and free of sediment because it is being swept whenever the heater is used, but sediment builds up on the rest of the tank's bottom. Draining the heater in the conventional manner does little good because only the sediment near the drain valve is flushed out. Since the bottom of the tank is usually domed, sediment settles toward the outside edge, which is lower, and forms a ring around the inside of the tank. The usual straight dip tube provides no motivation for any sediment which is not already near the drain to move over and be rinsed out.

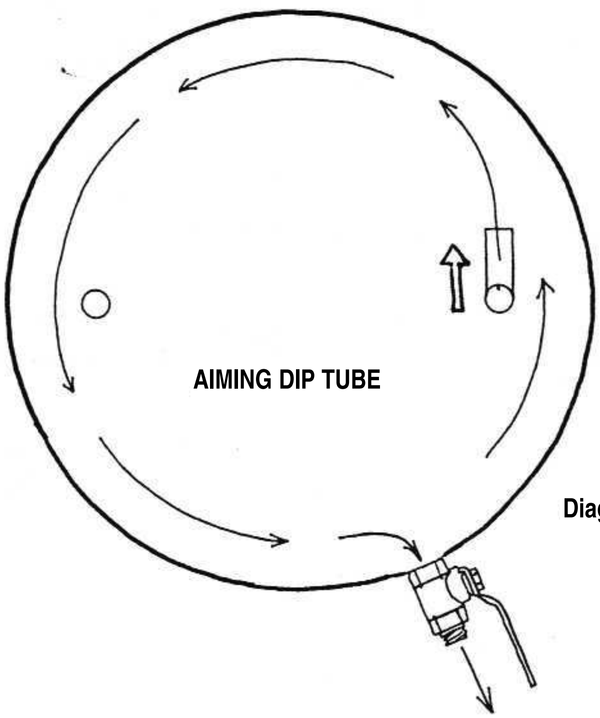
Effective rinsing is accomplished by installing a curved dip tube (or one which causes the incoming water to sweep the bottom) and by fitting the tank with a good drain valve. Entering through a curved dip tube, incoming water is made to swirl around the tank, picking up sediment and carrying it out through the opened drain valve (Diagram 25). Rinsing is accomplished by letting water run out full force, under pressure, for three to five minutes. This works well where the water pressure and flow are not restricted.

To install a new dip tube, you must first unscrew the existing cold water nipple. Insert a dowel or straight vinyl-coated plier handle into the dip tube and pull up while moving in a circular motion. This will walk the dip tube up high enough to grasp and pull out (Diagram 26). If rust has built up in the port above the dip tube and is preventing its removal, this must be scraped away first. Next, mark the inside of the new dip tube's nipple so you can determine the direction of its curve during installation. After a generous wrapping with Teflon tape

A wise man proportions his belief to the evidence.
— David Hume (1711-1776)




Diag. 27




Diag. 28

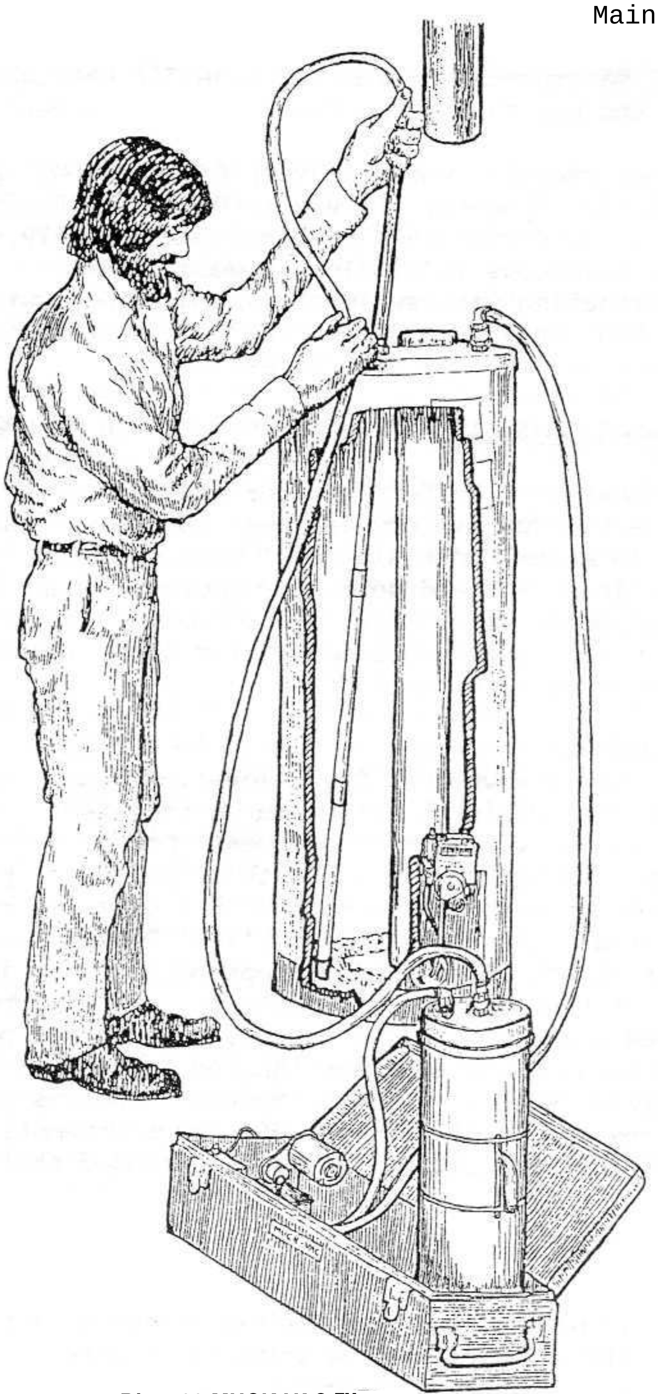
(six to eight turns, or enough to round the threads — Diagram 27), the nipple is screwed in so that the curved end of the dip tube is pointed straight back, to make water travel the long way around to the drain valve (Diagram 28).

To permit the most effective flushing, it is recommended that a 3/4-inch ball valve be installed, with a nipple if needed, to serve as the drain valve. Ball valves are superior because of their large opening, easy use, and quick, positive shut-off. You need to add an adapter which goes from 3/4-inch pipe thread to hose thread. You would then have a valve which is simple to use and unlikely to clog, one which will speed rinsing. Second best would be to install a 3/4-inch brass hose bibb. This hose bibb is more durable than plastic, but doesn't have all the advantages of a ball valve.

The dip tube flush is best used for deposits that are not too heavy. However, even if another method is needed to remove heavy deposits initially, the curved dip tube and drain valve should be put in at that time so future maintenance can be done. Normally, the tank should be flushed every six months, but in very hard water areas this needs to be scheduled more often.

**Muck-Vac Method** A second way to clean out sediment is with the Muck-Vac tool. Its long wand is inserted through ports in the top of the tank and extended to the tank's bottom, where it vacuums up sediment and water. The sediment is trapped inside a filter, and the water is returned to the tank. This method is useful for heavy accumu-

Man is a tool-using animal.... Without tools he
Is nothing, with tools he is all.
— Thomas Carlyle (1795-1881)




**Diag. 29 MUCK-VAC ™**

lations. Muck-Vac is a tool intended for use by people experienced in plumbing (Diagram 29).

**Dissolving Sediment** You can also remove sediment by chemical means. There's a citric acid-based descaler on the market called Mag-Erad®. Its use is somewhat involved, but it can do a good job, especially when used in conjunction with a curved dip tube. You can get detailed instructions from its distributor, A.0. Smith (which is also a water heater manufacturer). Note: while the Mag-Erad instructions advise operating the gas heater's burner while the tank is not full of water, this procedure contradicts usual manufacturers' instructions for tank operation and may damage the flue.

Another chemical which is very effective but potentially dangerous to use is sodium hydroxide (lye). This dissolves most sediment readily, but it is hazardous to handle, produces flammable gas when reacting with sediment, and must be neutralized and rinsed when done. We suggest this material be used only by the professional.

**Sediment Control** Sediment build-up can be slowed in both gas and electric heaters. Softening water can be used to help reduce buildup as long as these considerations are kept in mind: Softening will shorten anode life by at least 50% and so require more frequent anode replacement; also, drinking or cooking with softened water is not recommended for those who should restrict salt in their diet.

> I have no business with factions or intrigue, but simply to promulgate the truth, and wait the tranquil progress of conviction.
> — William Godwin (1756-1836)

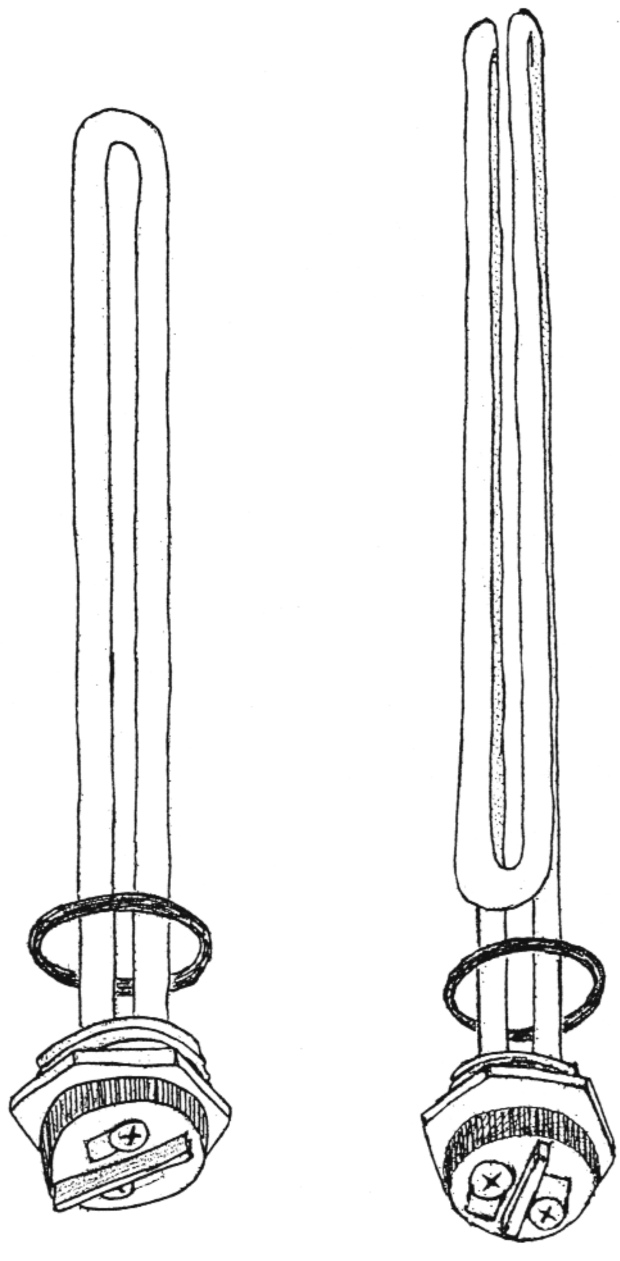
Another way to reduce sedimentation is to turn the temperature down to 130° or lower. Sediment buildup becomes rapid at temperatures over 140°. Lowering to 130° will aid in sediment control, but still be high enough to limit growth of potentially dangerous bacteria in the tank. (For example, the bacteria that causes Legionnaires’ disease can colonize in hot water systems kept between 86° and 115° if they are not regularly subjected to temperatures above 130°. The bacteria can infect people when large quantities are inhaled in tiny water droplets, such as showers produce. Chances of healthy people getting the disease are remote, but in medical facilities, it is recommended that the plumbing and fixtures be regularly purged with 170° water.)

You can check the delivered temperature of your hot water by running the tap until it’s hot, filling a cup and then reading the temperature with a candy or meat thermometer. It may be useful to mark the spot on your water heater’s thermostat, once 130° (or desired temperature) is reached.

Some gas heaters have a main burner adjustment in the center of the On-Off-Pilot knob which can be used to reduce the size of the flame. This reduces the heat transfer rate and sediment accumulation. However, if your heater periodically runs out of hot water (e.g., from multiple showers), it’s best to leave this adjustment alone because “derating” it will cause the heater to take a little more time to recover.

Sediment accumulation in electric heaters can be

> In nature, there are neither rewards nor punishments,
> only consequences.
> — Robert Ingersoll (1833-1899)



Diag. 30 HIGH- & LOW-WATT DENSITY ELEMENTS

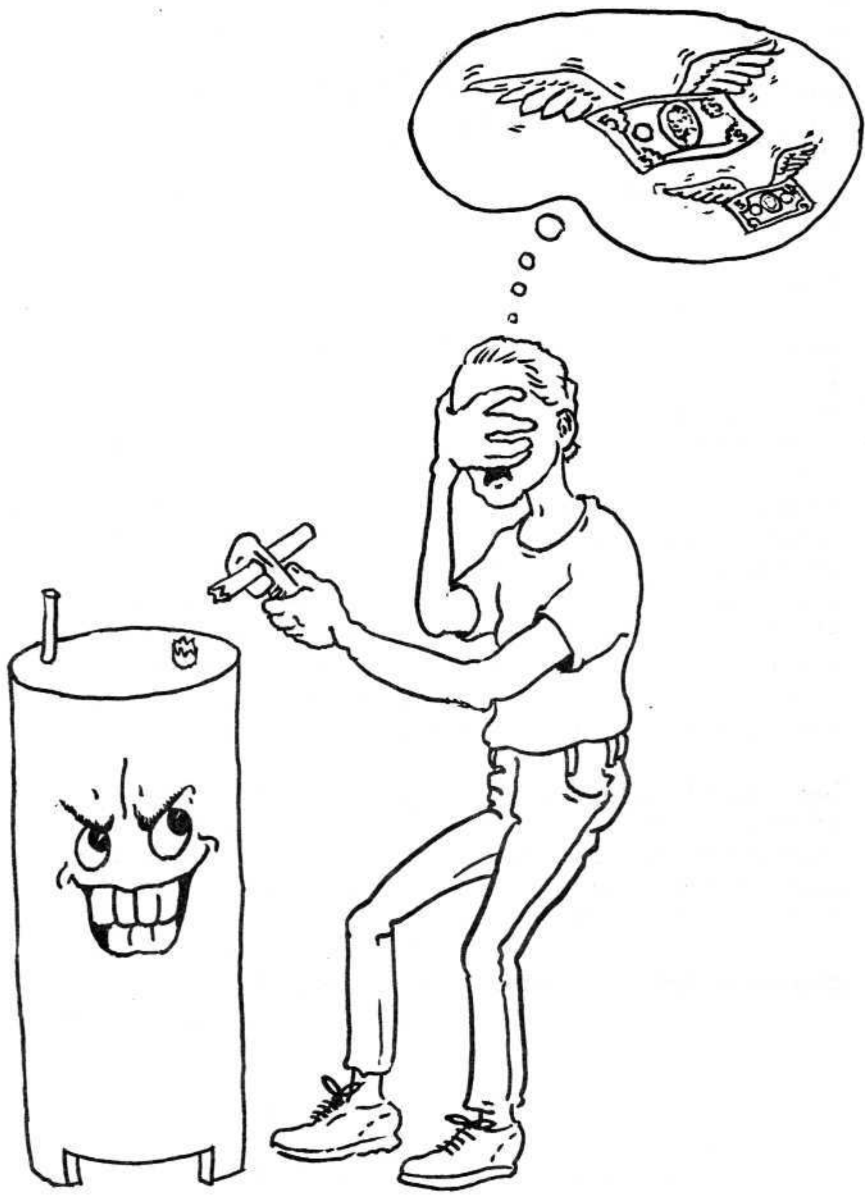
influenced by your choice of heating element. High- and low-watt density elements are both in direct contact with the water (Diagram 30). The low-watt density type has a greater surface area from which to give up heat, thus it doesn't need to get as hot and create as much scale. Use this type of element when a replacement is required, if sediment is a concern (see Heating Elements, this chapter).

One more thing which influences sediment is water pressure. If your house has water pressure much over 50 psi, install a pressure reducer to lessen the amount of sediment in your tank and reduce wear to your plumbing.

**Plumbing Maintenance** There are a number of threaded connections in and around water heaters, any of which can cause trouble. Examine for any signs of seepage the hot and cold lines, anode rod, T&P valve, drain valve and thermostat. Also, in electric heaters check heating element connections, and in gas heaters check thermostat connection. There are specific things to look for as you check the different fittings.

**Hot & Cold Nipples** Rusting is common inside steel plumbing and is hastened at points where different metals are joined together. Both copper and brass are "noble" to steel: that is, when either of these is in contact with steel, the steel rusts while the other metal remains virtually untouched. Because steel nipples commonly clog up with rust and restrict flow, brass nipples are sometimes used; but this just shifts the corrosion problem to the steel tank itself, where the nipple enters. Therefore, use steel nipples

So I will play the part of a whetstone which can
make steel sharp, though It has no power itself of cutting.
— Horace (65-8 B.C.)



A BROKEN NIPPLE IS NO CAUSE TO PANIC

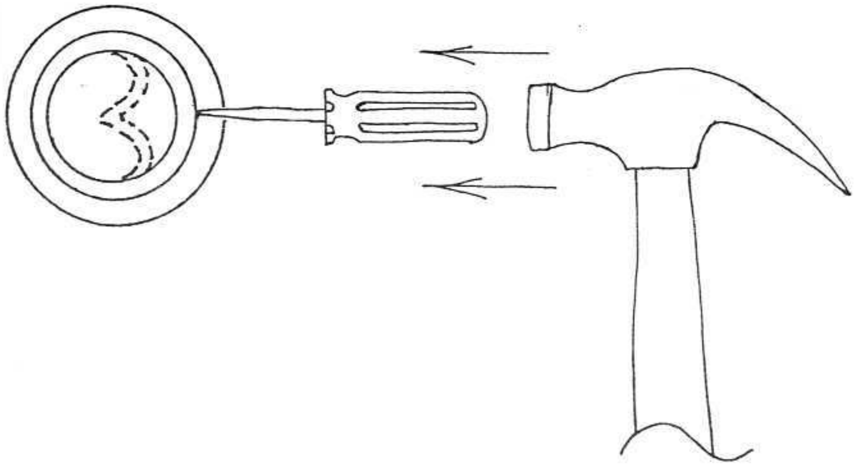
lined with plastic. These work well because the plastic interior does not corrode or clog, and the steel exterior gets along peacefully with the steel of your water heater.

Use plastic-lined nipples for the same advantages if your tank is installed with copper flex connectors or dielectric unions (which also act as barriers between dissimilar metals in an attempt to reduce corrosion).

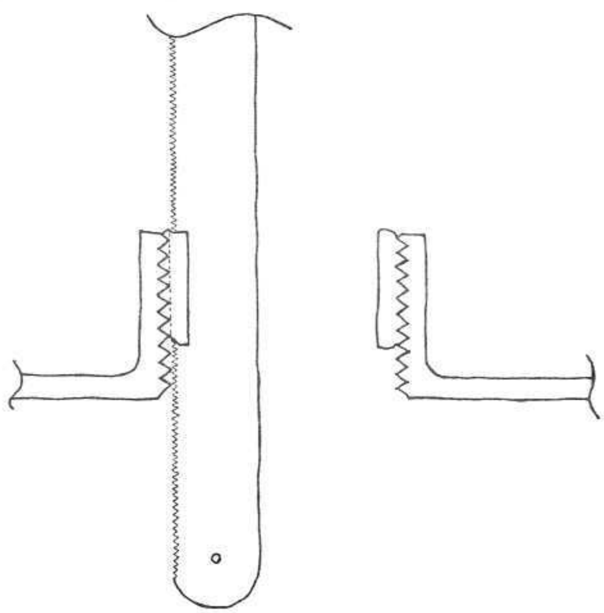
**Broken Nipples** Sometimes, in attempting to remove a rusted steel nipple,you might twist the pipe off, leaving a ring of steel in the water heater’s threaded port. Don’t panic (see illustration, facing page). It can be removed with a hammer and a flat screwdriver. The screw-driver must have good square edges, and it helps to bevel the edge a little, as well. This edge will catch the steel ring and pull it into the circle (Diagram 31) when tapped with the hammer. When the ring is bent inward sufficiently, the rust will be broken loose and you can use the screwdriver or pliers to unscrew it. If the ring is stubborn, a hacksaw blade can be used to cut a slot just to the threads, making it easier to pry out an end (Diagram 32). Wrap the replacement nipple well with Teflon tape to avoid this problem in the future. You might want to use a 3/4-inch pipe tap to clean up the threads before putting in the new nipple.

**Heating Elements** Heating elements usually bolt on or screw in. Both methods use a rubber or plastic gasket to make the joint water tight. If you remove the element for any reason, clean both the element and tank surfaces, and install a new gasket (if the old one is hardened) before replacing the element. Wrap threaded elements

O! this learning, what a thing It Is.
—- William Shakespeare (1564-1616)



Diag. 31 BENDING IN A BROKEN NIPPLE



Diag. 32 CUTTING THROUGH RING

two or three times with Teflon tape to ensure easy removal next time. (Reminder: Be sure you have turned off the power to the heater before working on it.)

The following conditions can cause element failure: buildup of scale on the element, immersion of the element in scale, and galvanic corrosion. Scale build-up on the element slows heat transfer and can cause overheating and deterioration. It’s rare, however, that enough scale accumulates on an element to cause failure. Scale usually flakes off elements and falls to the bottom. This scale can, in time, become deep enough to bury the lower element. When this occurs, the element will overheat and eventually must burn out. (See Sediment Removal, above, to avoid this problem.)

Most tanks come equipped with high-watt density elements, which are smaller and hotter than the low-watt density type. They also produce more sediment. Their greater thermal expansion leaves less scale on the element and sloughs off more scale onto the bottom. Conversely, low-watt density elements tend to accumulate more scale on the element itself and less falls to the tank bottom. In general, we suggest installing low-watt density elements to minimize sediment build-up in the tank. But this advice must be tempered with your local water conditions and experience.

Some sources suggest periodic cleaning of elements. If you have a problem with elements failing and the cause is build-up of scale on the element itself, it may be cleaned by soaking in vinegar and gently brushing to dislodge deposits.

> No generalization Is wholly true, not even this one.
> — Oliver Wendell Holmes (1841-1935)

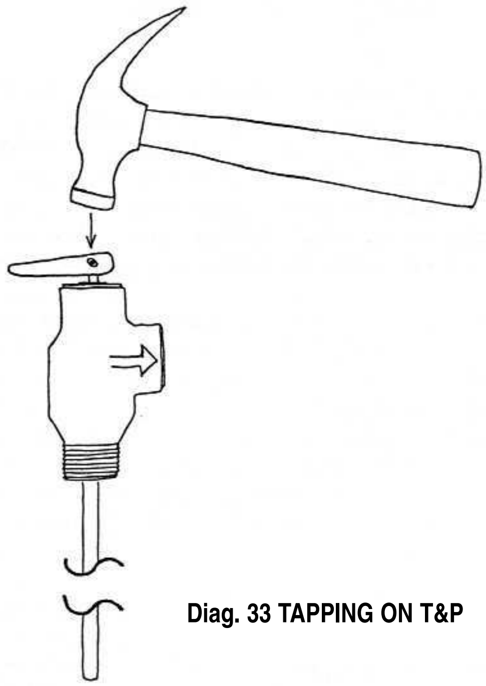
Galvanic corrosion can affect elements also. Electrolysis between a copper element sheath and its steel base can cause damage and weakening at that joint and ultimately ruin the element. A functioning anode will greatly slow the electrolytic action and protect the element as well as your tank. If you've replaced a burned-out element in an old tank, and the new element lasts only a short time, you might find the problem lies in the lack of anode and not with the replacement element.

**T&P RELIEF VALVES** This safety valve should be tested every six months to be sure it is operational. This is done by flipping the steel lever on the top of the T&P so that it lifts the brass stem it is fastened to. Check to make sure it allows plenty of water out. If it fails to open or if, after use, it leaks, try operating the lever several times. If that doesn't stop the leak, try tapping the stem lightly (Diagram 33). If it continues to leak, it will need to be replaced.

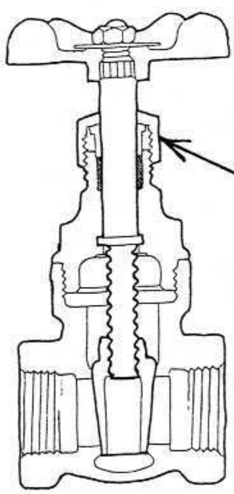
The pipe running from it must not be smaller than the T&P opening (normally 3/4-inch ) and must run to the floor, a sink or outside. The pipe should end between 6 inches and 2 inches above the floor. It must also be heat-resistant. (No garden hose, PVC pipe, etc.) It is best to install this drain line with some sort of union so when valve replacement is needed, the chore will be easier. Also, the line should drain downward so that water cannot be trapped in it (see the section on T&P valves in Chapter 6).

**Gate Valves** After years of operation (or non-operation), gate valves (i.e., main

It's not what we don't know that hurts. It's what we know that ain't so.
— Will Rogers (1879-1935)

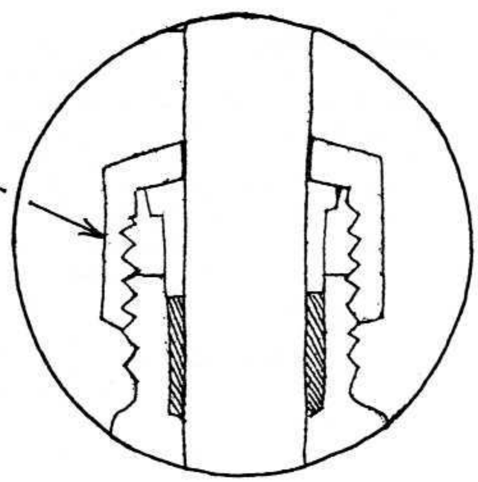


Diag. 33 TAPPING ON T&P



Diag. 34

GATE VALVE CUT-AWAY



Diag. 35

GATE VALVE PACKING NUT

shut off) can strip out when used, or the stem inside can snap off (Diagram 34). If this happens, the handle will turn and turn without coming to a stop. This lets you know the valve has gone on to the great forge in the sky. It’s handy to have a functioning shut-off so that when the water heater or any hot water plumbing leaks, you have a quick means of stopping the flow without shutting down the whole building. Some valves are soldered in place; some screw into place. If the brass valve is screwed to a steel pipe, that pipe nipple should be replaced with one that is plastic lined. Do not use a brass nipple between steel plumbing and the brass shut-off, as it will damage the steel fitting it is screwed into (see Hot & Cold Nipples, above).

Another thing to inspect on gate valves is the packing nut. This is the nut that is around the stem, just under the handle (Diagram 35). If water seeps from this joint, the nut may be tightened a quarter turn. If no further tightening is possible, back the nut all the way off, wrap the stem with Teflon tape and reattach the nut. The Teflon will act as the packing. Special graphite packing material is available also.

You can avoid most of these gate valve problems by using ball valves. They cost a little more, but they do perform better. Another advantage is that the position of a ball valve’s handle indicates whether it is open or closed.

**Drain Valves** Drain valves may drip, freeze up or get clogged with sediment. Although water heaters used to come supplied with brass drain valves, most today come equipped with plastic valves, which are not as durable and which are trou-

The reward of a thing well done, is to have done it.
— Ralph Waldo Emerson (1803-1882)

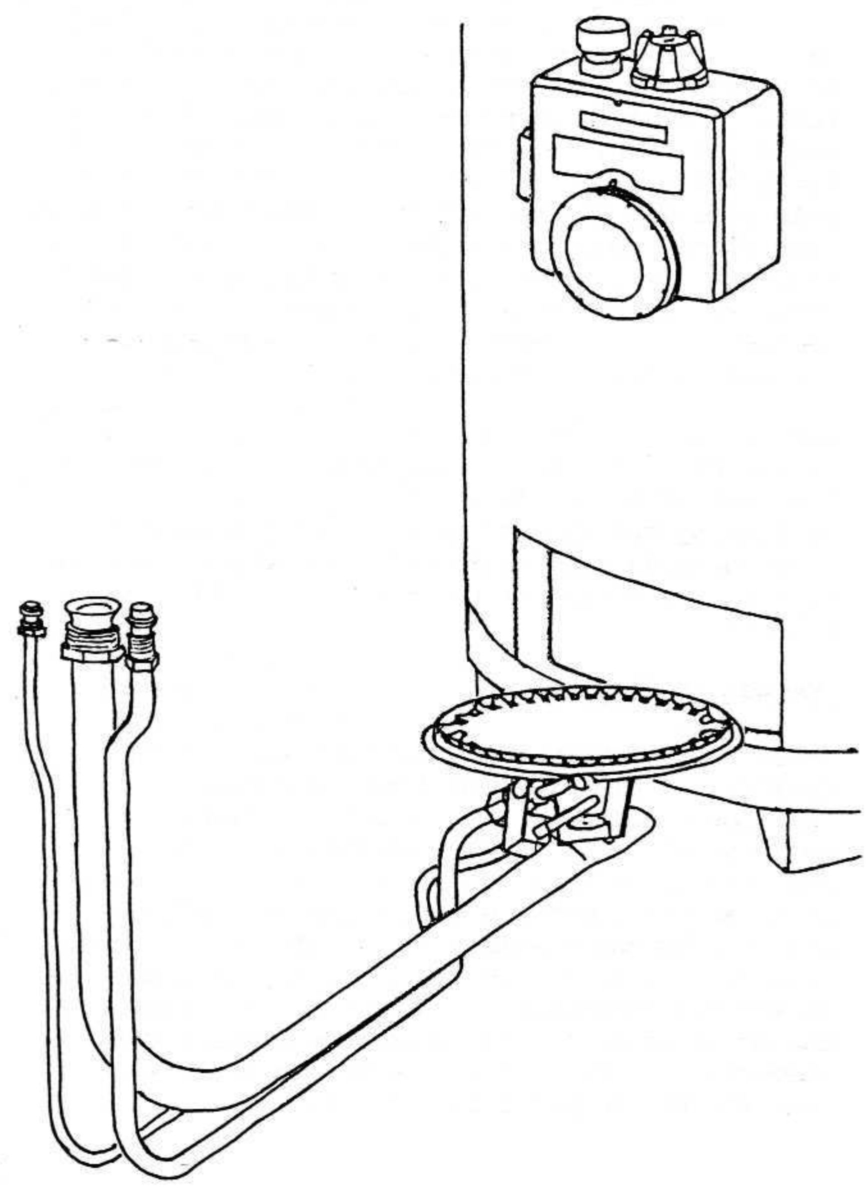
blesome to use.

It is easy to cross the threads when trying to attach a hose, and it is sometimes difficult to keep them from dripping after use. You would benefit by replacing the plastic with a 3/4-inch ball valve or hose bibb, as described in the section on sediment removal, above. You can remove the cone-shaped valve by unscrewing it counterclockwise four to six turns while pulling out. Then turn clockwise while continuing to pull. The valve will come out. Wrap teflon around the protruding nipple, and install a ball valve or hose bibb. With all other types of drains, the entire valve turns to unscrew itself from the tank. A water heater need not be emptied to replace its drain, but the pressure must be off. Relieve the pressure by closing the shut-off on the cold line and opening a hot tap until the water flow stops. Then close the tap to prevent air from entering. Keep others from using any water while you are working, or you might get an unexpected soaking. (Reminder; before you begin, turn the gas to pilot, or turn the power off.)

Some water will come out when installing a new drain, but usually not more than a cup or so. If your heater is set over 130°, avoid being scalded by running out enough water before you start so that incoming cold water has lowered the temperature at the bottom of the tank (approximately 10 gallons).

**Combustion Chamber Care** In maintaining a gas water heater, it is important to check the burner and combustion chamber. Scale from the flue and baffle can fall onto the burner and deform the flame. The best way to clean this is to shut off the gas, undo the three

It is one thing to show a man he is in error, and another to put him in possesslon of the truth.
— John Locke (1632-1704)



Diag. 36 GAS BURNER ASSEMBLY

nuts which attach the main burner, pilot and thermocouple to the gas control, and pull the burner assembly out of the heater (Diagram 36). Note how the burner hooks in place so you can reinstall it correctly. It can be brushed and the combustion chamber vacuumed clean. The burner assembly is then reinstalled and the pilot re-lit. Those with FVIR heaters should follow the manufacturers' instructions. Check all gas connections by soaking them with liquid glass cleaner. You will see bubbles or foam if there is any gas leak.

**Vent Inspection** Look at the vent pipe leading from the water heater. Is it intact without any holes rusted through it? Are all joints put together with two or more sheet-metal screws? Where the vent goes into the ceiling, does it go into double-walled or heat resistant pipe? Where it exits the roof, is there a roof jack with nothing combustible within one inch? Is there an unobstructed cap where it exits above the roof? Is that cap venting far enough away from any openable windows or air intakes? Does the vent slope so no condensation or water could sit in a low point? Building codes deal very specifically with venting. Read up on it or ask your building department or gas supplier about local codes if you have found anything questionable.

Watch out for backdrafting. Sometimes exhaust fumes are pulled back down the vent and spill out into the room. This can happen when vent fans, fireplaces or even upstairs windows draw air out of the house. You can test for it by holding a match near the draft diverter to see which way the flame or smoke goes while the water heater is firing. Turn on all vent fans and repeat the test. If there appears to be a

It is better to know some of the questions than all of the answers.
— James Thurber (1894-1961)

problem, contact local heating contractors for ideas.

**Keep Maintenance Records** A sticker right on the tank is a good place to record what you do and when you do it. Make a note to show when you check Or replace the sacrificial anode. Note also each time you flush out the sediment. You will probably find it useful to have a record of any replacement parts or modifications .

Now that you've made sure your heater will last many more years, look into Chapter 4 and learn how to make it perform more efficiently.

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**A True Story:** A man in San Francisco had read about sacrificial anodes in On The House, a newspaper column by Morris and James Carey. He called in to talk with the Carey brothers on their radio show and described what happened when he inquired at plumbing stores about a new anode for his five-year-old water heater. "I got very interesting answers: they didn't have 'em, they never heard of 'em, they didn't exist.... One guy said they didn't exist and I said, 'Well, the Carey brothers said they did in their column,' and he said they didn't know their (blip) from a hole in the roof! ...They were very eager to sell me a new heater." MORAL: Information on water heater maintenance is not easy to find, even in the plumbing industry. It pays to be persistent.

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Facts do not cease to exist because they are ignored.
— Aldous Huxley (1894-1963)

**Chapter 4**

# SAVING ENERGY

There are three basic ways for your water heater to use less energy: use the energy source more efficiently, prevent heat loss from the water heater and plumbing, and use less heated water.

## INCREASE EFFICIENCY

Utilizing the energy source more efficiently is largely in the hands of the manufacturers. Technology used in gas furnaces that extracts heat so well from the gas flame that a plastic flue doesn't melt has spread to condensing water heaters that are more than 90 percent efficient. Even regular gas water heaters have shown much improvement in the past few years in order to meet stricter federal regulations. Although independent gas water heaters have an energy factor (EF) ranging from 42% to 86%, they usually range from the mid-fifties to the low sixties. Electric heaters range from 81% to 97% EF, and heat pump technology utilizes electrical energy even better. (See Chapter 5 for pros and cons of different types of water heaters.)

### Remove Sediment

It's not very efficient to try to heat water through a layer of sediment. Removing heavy sediment will trim energy use about 5% in gas heaters. There will be no direct energy savings with electric heaters, though you will need fewer replacement elements. (Consult Chapter 3 for other benefits of sediment removal.)

## PREVENT HEAT LOSS

You can do several things to prevent heat loss from the water heater.

> The language of truth is unadorned and always simple.
> — Marcellinus Ammianus (4th century B.C.)

**Lower The Temperature** The most obvious way is to turn the temperature down. The smaller the temperature difference is between the water in your plumbing and the surrounding air, the better insulation will work to keep heat in. (See prior chapter on controlling sediment buildup for directions on how to check and adjust the temperature.)

In electric heaters, adding a timer to prevent operation during times of little or no demand (when you're sleeping or at work) will help reduce heat loss. Also, if your utility company offers time-of-day metering, you'll get a lower rate if you use your heater only during off-peak periods.

Another money saver would be a heat exchanger that reclaims waste heat from warm drain water to preheat the cold water.

**Add A Blanket** Adding a blanket is a good choice in many circumstances. A blanket is not recommended if the heater is indoors where its lost heat would be welcome (i.e., in a cool kitchen). If your heater is in an unconditioned space or you do not want any added heat, install a heavy blanket. With all marginally insulated heaters, we suggest using blankets rated R-11 or better. These cost more than the thinner ones but will do more to save energy, with essentially no more effort to install. Be sure to check all tank penetrations before wrapping the heater. If a fitting somewhere on the tank is seeping, a blanket will hide the fact while it slows the evaporation of the water and hastens rusting. So keep insulation away from hot and

After order and liberty, economy is one of the
highest essentials of a free government....
Economy is always a guarantee of peace.
— Calvin Coolldge (1872-1933)

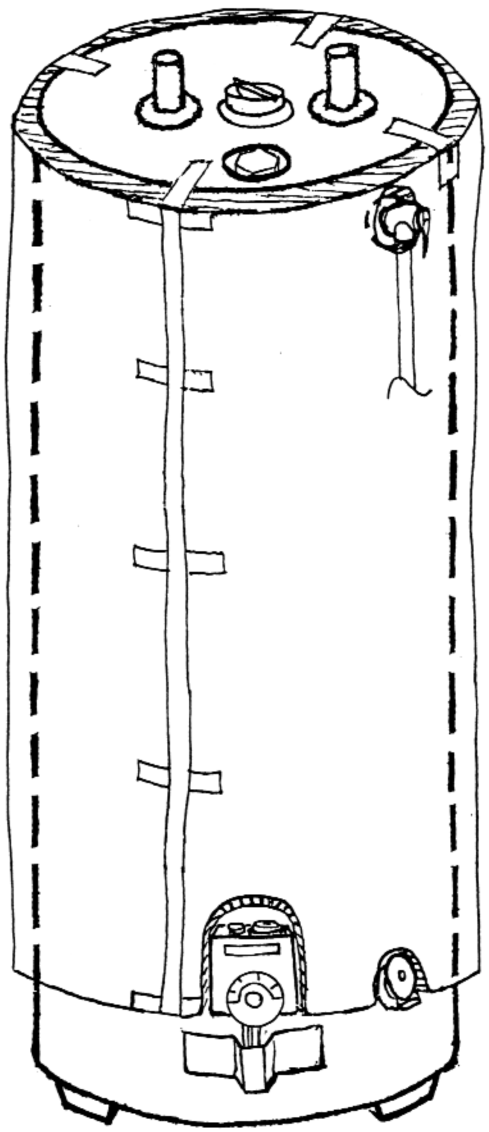
cold lines, anode, and T&P valve. Anodes and T&P valves are regular maintenance items and should not be covered.

Generally, water heater manufacturers would rather you not wrap their tanks, for when done incorrectly, problems can result. Also, useful labels get covered up. However, because of the substantial energy savings, we recommend that you insulate your present tank, if needed. When it finally gives up the ghost, though, purchase a tank which is already insulated to R-16 or better, so that it needn't be wrapped.

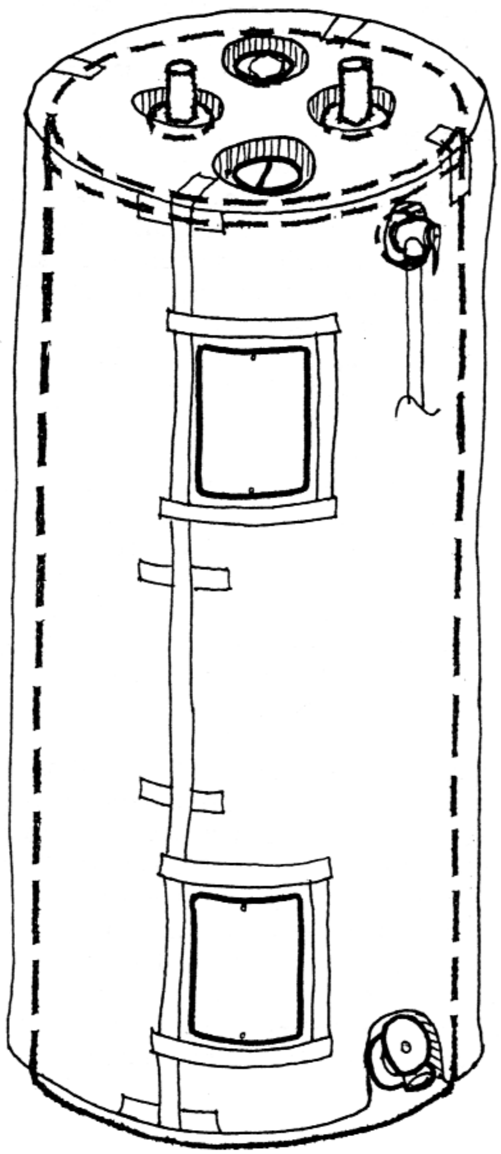
**On Gas Heaters** Purchase an insulating blanket which is sized correctly to fit your tank. Blankets are usually sized to fit heaters according to how many gallons a tank holds. Make sure the tank is not directly up against a wall or other equipment which would interfere with wrapping completely around it. Keep in mind that the blanket must not limit air flow to or from the heater, and that there is no advantage to insulating below where the water is stored. Envision a line running horizontally around the tank a few inches below the drain valve. This is where the bottom of the blanket should go. The junction at the top and sides of the tank should be the upper limit. Do not insulate the top (Diagram 37). Special vinyl tape should be supplied with the blanket to secure it. Strapping may also be included, along with instructions.

**On Electric Heaters** In addition to the sides, the top may also be covered on an electric heater. However, In order to prevent

> I suppose I must be a "progressive," which I take to be one who Insists on recognizing the facts, adjusting policies to facts and circumstances as they arise.
> — Woodrow Wilson (1856-1924)



Diag. 37 WRAPPING A GAS HEATER



Diag. 38 WRAPPING AN ELECTRIC HEATER

any chance of overheating electrical components and to allow necessary access, cut and tape the blanket edges to expose the upper and lower element hatches and the junction box which is usually on top of the heater (Diagram 38).

**Insulate Plumbing** Another way to help keep the heat in is to insulate the hot plumbing lines (and the cold line back 5 feet from the heater). There are good quality closed-cell foam insulations available which will make the job go quickly. As with blankets, use thicker rather than thinner insulation: 3/4-inch thick or better. Sizes vary depending on type of pipe: i.e., 3/4-inch copper pipe takes a different size than 3/4-inch galvanized pipe.

When insulating close to the water heater, do not cover unions or fittings at the ends of copper flex lines. If leakage should occur, covering it over will cause more damage to happen. Insulation should also avoid the draft diverter on gas heaters. This area can get quite hot; while the risk of igniting the insulation is small, you shouldn’t take that chance.

Some insulation comes partially or fully pre-slit down its length. Some has self-adhesive glue built in, or there are special hot melt or solvent glues available for making tight joints at fittings and seams. Another method is to tape these areas. We suggest using gas wrap tape instead of duct tape for this job. (Gas wrap tape looks like wide, heavy electrical tape and may be imprinted with the manufacturer’s name.) It is more durable than duct tape,

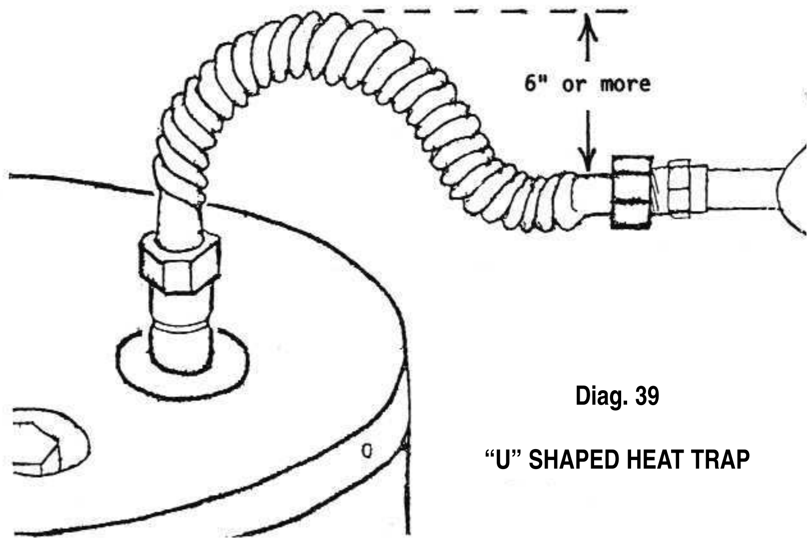
Nobody made a greater mistake than he who did nothing because he could only do a little.
— Edmund Burke (1729-1797)

particularly where there is exposure to sunlight. Use scissors or a razor knife to cut it. Another effective way to hold insulation in place is with plastic zip ties. Designed for electrical work, these durable ties are fast and easy to install.

**Install Heat Traps** Heat traps can also be used on the plumbing lines to help keep the heat where it belongs. They come in three forms. One type is a variety of ball check valve that blocks off both hot and cold lines at the top of the heater to prevent heat from floating up and out of the tank into the plumbing. Their only drawbacks occur at high flow rates, where some flow restriction and possible chattering of the ball may occur. Another is a diaphragm heat trap nipple that serves the same purpose. Either kind can potentially stick shut and halt flow from the tank. The third type of heat trap is made by bending long flex connectors into an inverted U shape (Diagram 39). Since heat rises, hot water is prevented from traveling any further than the top of the upside-down "U". In some circumstances heat traps can save as much as a blanket.

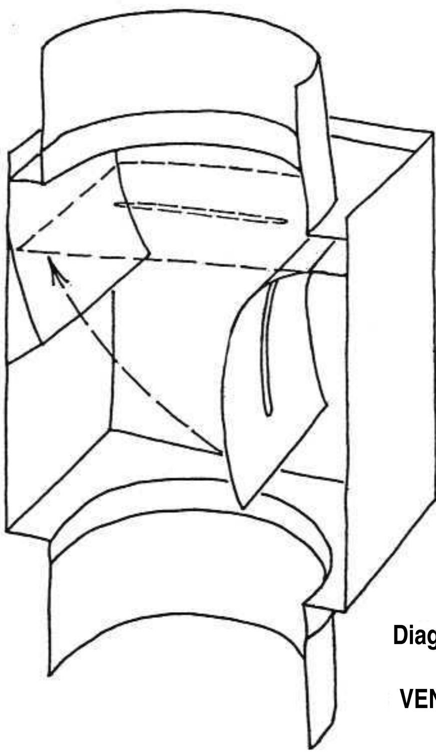
**Add A Vent Damper** Vent dampers are another way to cut heat loss from gas heaters. They work by means of a metal flap in the vent just above the heater; either heat from the burner or a motor is used to open and close this flap. The vent is 90% shut when the main burner is off. Claims and studies vary wildly as to the effectiveness of these units, but if the heater is indoors, you have the added benefit of less conditioned indoor air going up the vent (Diagram 40.)

Opinion has caused more trouble on this little
Earth than plagues or earthquakes.
— Voltaire (1694-1778)




Diag. 39

"U" SHAPED HEAT TRAP



Diag. 40

VENT DAMPER

**CONSERVE WATER** Perhaps the most effective thing you can do to save water-heating energy is to use less hot water. Start by installing low flow shower-heads and low flow aerators on faucets. (See www.consumerreports.org/cro/home-garden/bed-bath/showerheads/showerhead-buying-advice/showerhead-getting-started/showerhead-getting-started.htm). Also, in new construction or remodeling, use piping just large enough to handle the flow, but no bigger. Oversized plumbing leaves more water in the lines to cool and has a greater surface area to lose heat from (see illustration, next page). Consider running individual small-diameter lines directly to the point of use rather than a main line with branches. This will reduce the volume of water in the plumbing and speed up the arrival of hot water when the tap is used.

Recirculating loops, which provide instant hot water at the taps, can also eliminate water waste, but they do so by spending energy. If you have a recirculating loop, it will help to use a thermostat set at 105° to 110° and perhaps a time clock to regulate the pump.

If your home has one bath far from the water heater and it seems to take forever to get hot water to it, installing a small (4 to 10 gallon) 115 volt electric heater in the hot water supply line may solve the problem. You get hot water right away and hot water from the main tank reaches the smaller unit before it cools too much. Having the little heater simply plug in may save running a separate circuit. This saves water and the time waiting for hot water to get to the tap. It increases energy consumption, but less than a recirculating loop does.

> There can be no economy where there is no efficiency.
> — Benjamin Disraell (1804-1881)


**OVERSIZED PLUMBING: BIGGER IS NOT BETTER**

Utility publications can provide numerous ideas about water and energy saving measures: remember not to let water run while brushing teeth or shaving; when showering, stop the water flow while you are soaping up, shampooing, etc.; use cold water detergent and wash your colored clothes in cold water instead of hot. Ask your local utility people for their ideas on how to save energy.

Also available are new efficient methods of installing and controlling hot water recirculation loops. One such unit (made by ACT Distribution, Inc.) is described in the section on recirculating systems (see Chapter 6, p. 109).

And if you're replumbing, do an Internet search on Gary Klein and structured plumbing and learn another way to cut energy and water loss.

If you are not yet suffering from information overload, continue reading in Chapter 5 about the water heating choices available.

**A True Story:** He complained that his water heater didn't produce enough hot water. We could find no fault with the heater. Then we turned on the shower, and its forceful stream knocked the shampoo bottle off the shelf! Replacing the 7 gpm showerhead with a 2.5 gpm head solved the problem and gave him plenty of hot water. MORAL: The obvious is sometimes difficult to see.

> A wise man will make more opportunities than he finds.
> — Francis Bacon (1561-1626)

**Another True Story:** Most water heater owners don't know they need to check their T&P valve every six months or so to be sure it's still working, and these folks were no exception. One very cold night, when they were out of town/ the water in their pipes froze. When the water heater came on, there was no place for the expanding water to go because the cold water line was blocked with ice, and the T&P valve was stuck. Instead, the plastic drain valve blew out, and their house was flooded when the main line thawed. MORAL: Just as with anode replacement, the importance of T&P valve inspection is not stressed and ignoring either can lead to trouble.

The cruellest lies are often told in silence.
— Robert Louis Stevenson (1850-1894)

**Chapter 5**

## THINGS TO CONSIDER IN WATER HEATER SELECTION

There are a variety of ways to provide hot water for your household. Gas and electric tank-type and tankless heaters, solar heaters, heat pumps, woodstoves, combined space and water heaters, oil heaters and even tempering tanks may be used.

**GAS VS. ELECTRIC TANK HEATERS** The most common and least expensive heaters are gas and electric tank-type heaters. Generally, one is selected over the other on the basis of availability and cost of the two energy sources (and, of course, a thought to what type of heater is being replaced). In most areas, natural gas is less expensive than electricity, based on delivered Btu. Where natural gas is not available, bottled gas can usually be found and is competitive with electricity.

It’s worth your time to compare costs of the different energy sources. When comparing one gas or electric heater against another, it’s meaningful to look at the energy factor (EF). This will be on the energy-guide label. Don’t confuse this with the combustion or heating efficiency, which will be higher. EF measures overall tank efficiency and is the best measure of real-world performance. (See Chapter 4, p. 71, for specific EF figures for gas and electric water heaters.)

There are other considerations which may influence

> Experience teaches slowly,and at the cost of mistakes.
> — James Anthony Froude (1818-1894)

your decision. If you are considering electric, an independent 220 volt circuit will be needed. Also, since electric units heat water more slowly than gas, a larger tank is required, along with adequate space to house it. Cheek the "first hour rating" to see how many gallons a heater can produce in one hour and be sure that the models you look at all use the same temperature rise (90 is the norm) when figuring their capacity.

If you presently have electric and are considering switching to gas, can a gas line be installed without too much difficulty? What about venting? Is there an upper story in the way? If so, perhaps a direct-vent or power-vent heater can be installed which vents out a side wall.

**Gas: Direct Vent** The direct-vent heater is a special kind of tank-type gas heater. It’s an advantage in houses with tight construction or when converting from electric to gas. The air intake and exhaust vent are combined into a two-part pipe which can exit through a wall instead of the roof. This is convenient in situations where running a vent straight up would be difficult. Since this type of vent provides the heater with its own air supply and does not need indoor air to burn, tightly built homes need not worry about adequate air supply or backdrafting (when combustion fumes spill out into the area around the water heater). The combustion chamber is sealed, so gasoline or other flammable vapors are less likely to be ignited. Another benefit of direct-vent heaters is that already-heated or cooled indoor air is not constantly lost up the flue. In trade for these benefits, direct vent heaters have a bigger price tag than

Truth is the most valuable thing we have. Let us economize it.
— Mark Twain (1835-1910)

conventional gas heaters.

**Gas: Power Vent** This type of heater has some of the advantages of the direct vent. Long horizontal venting allows the heater to be located almost anywhere. It does use indoor air and requires a source of electricity, but these may be small drawbacks if locating the heater is a problem. Also, power vent kits are available that will adapt to any gas heater (see Appendix).

**TANKLESS HEATERS** You might wish to consider tankless heaters. They sound appealing: There is no storage tank to take up room or lose heat from, and they seem to offer unlimited hot water. However, they have drawbacks. They may not be able to handle more than one use at a time (no simultaneous showering and dishwashing). Also, the heater does not heat at all unless sufficient water flows through it. This causes the dreaded “cold water sandwich,” which is no fun when showering! With this type of heater, you can choose either a gas or an electric model. The latter usually costs more to run, but has no standing pilot light, which wastes energy and offsets much of the savings of a gas unit. Gas heaters can be equipped with pilots the user can turn on and off as needed to save standby losses, but that requires a trip to the unit each time hot water is wanted. Nonetheless, tankless heaters can make sense where demand is low, such as in offices where individual sinks need hot water, or in recreational vehicles, vacation cottages and small households.

Other things to consider are initial cost, longevity and serviceability. The installed cost of large tank

Man is a creature who lives not upon bread alone,
but principally by catchwords.
— Robert Louis Stevenson (1850-1894)

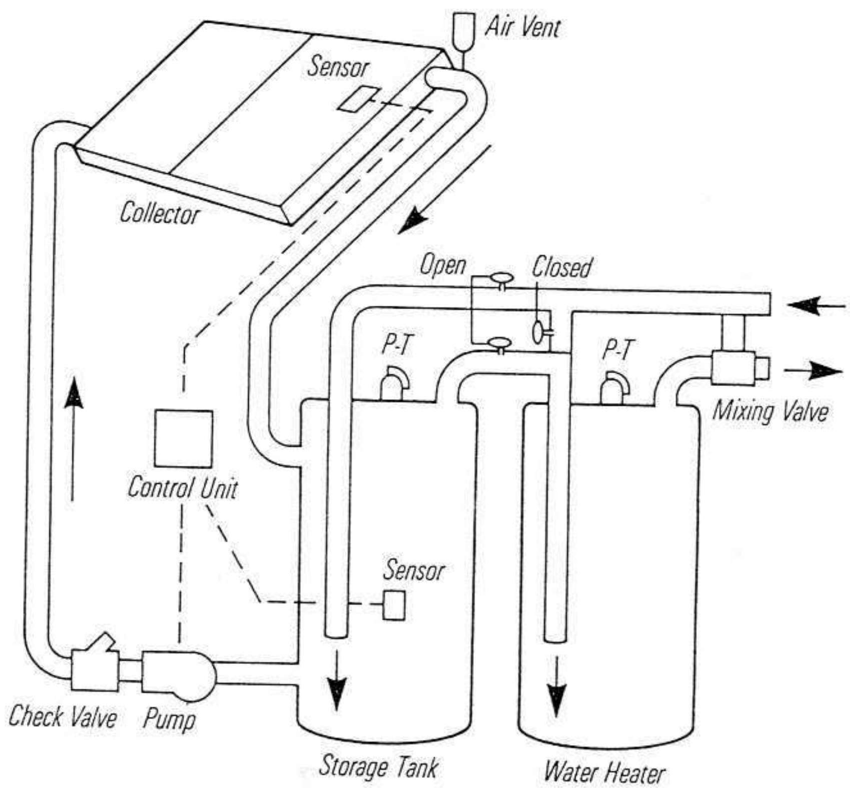
less heaters is several times that of tank-type units. Tankless heaters will equal or outlive unmaintained tank-type heaters. Qualified service personnel and repair parts may be harder to find for tankless than tank-type heaters.

While tankless units are the standard in Europe and Japan, user participation is required. One must adjust to tankless heaters. Americans are used to tank-type heaters, which normally function without a thought from their users. (For further reading on tankless heaters see a Consumer Reports article in October 2008, at http://www.consumerreports.org/cro/appliances/heating-cooling-and-air/water-heaters/tankless-water-heaters/overview/tankless-water-heaters-ov.htm; a Center for Energy and Environment Study on efficiency vs. cost, at http://www.state.mn.us/mn/externalDocs/Commerce/CARD_Natural_Gas_Tankless_Water_Heater_Study_100510053932_DomesticWaterHeatingReport.pdf, and ACEEE's Consumer Guide To Home Energy Savings, Ninth Edition, by Jennifer Thorne Amann, Alex Wilson, and Katie Ackerly, printed in 2007.)

**SOLAR HEATERS** Solar water heating has been around since the late 1800s. It did quite well until the advent of natural gas, which was so inexpensive that solar could not compete. Unsolved freezing and corrosion problems aided its demise then and again after its resurgence in the 1970s. Solar systems are designed to be either active or passive. Active systems require an active component, such as a pump or fan to help collect the heat; passive systems do not.

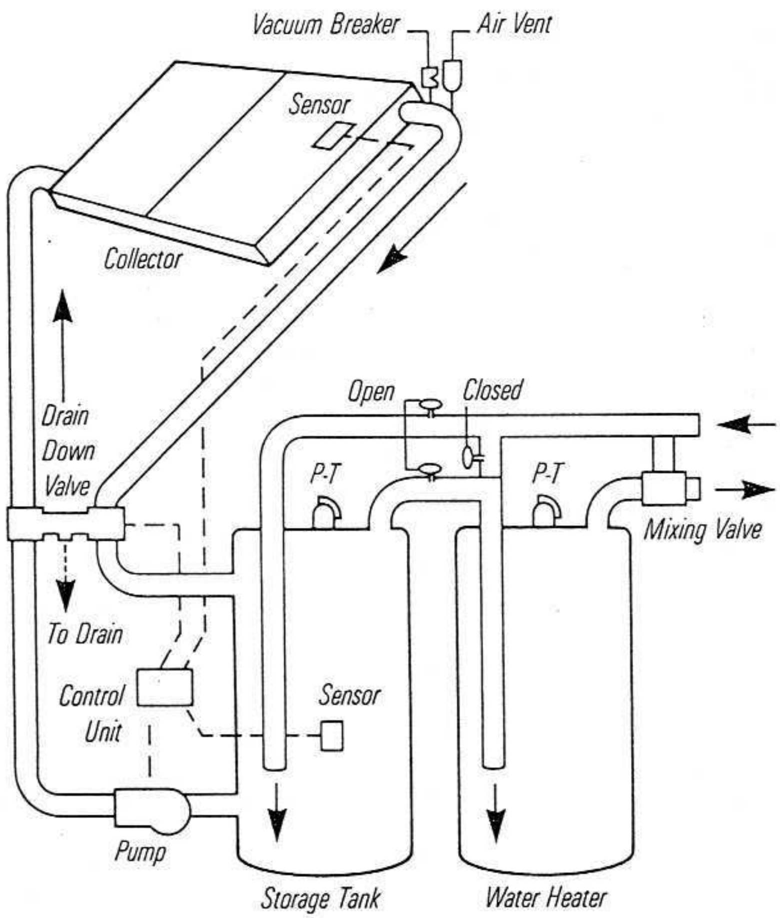
**Active** The basic types of active systems are named by the method they use to prevent damage to

I am, in plainer words, a bundle of prejudices —
made up of likings and dislikes.
— Charles Lamb (1775-1834)




Courtesy of PG&E

**Diag. 41 FREEZE-RECIRCULATE**




Courtesy of PG&E

**Diag. 42 DRAIN-DOWN**

the collectors in case of a freeze: freeze-recirculate, drain-down, drainback and systems using a freeze-resistant heat exchange fluid.

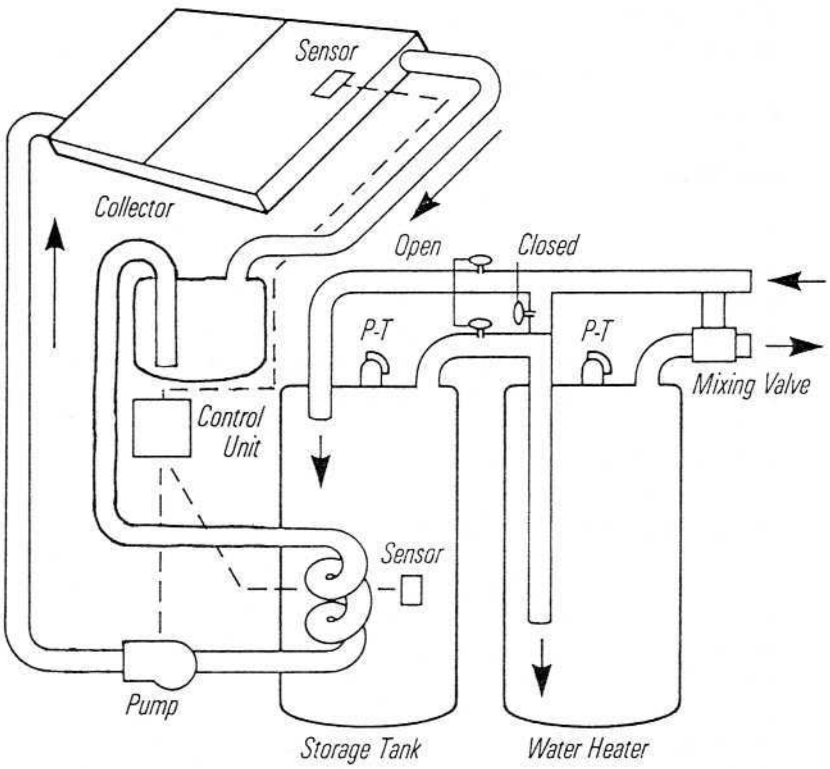
**Freeze-Recirculate** Freeze-recirculate systems protect the collectors by switching a pump on when the temperature nears freezing; the pump circulates water through the collector, sacrificing heat to prevent freezing (Diagram 41). This is an appropriate system for temperate climates, as long as the power doesn't go out.

**Drain-Down** Drain-down systems have valves that drain water out of the collector when it nears freezing (Diagram 42). These systems also drain automatically if the power goes out. A drawback is the amount of water wasted if the protection is called into use often. Also, equipment reliability has been a problem.

**Drain-Back** Drain-back systems use a small storage tank and heat exchanger to move heat to the potable water (Diagram 43). When the pump shuts off, water drains back from the collector to prevent freezing. In this system, the drained water is saved and re-used as the heat exchange fluid. If correctly installed, this system will work in any climate. As in any heat exchange system, however, there is some loss of efficiency (about 10%) at the heat exchanger.

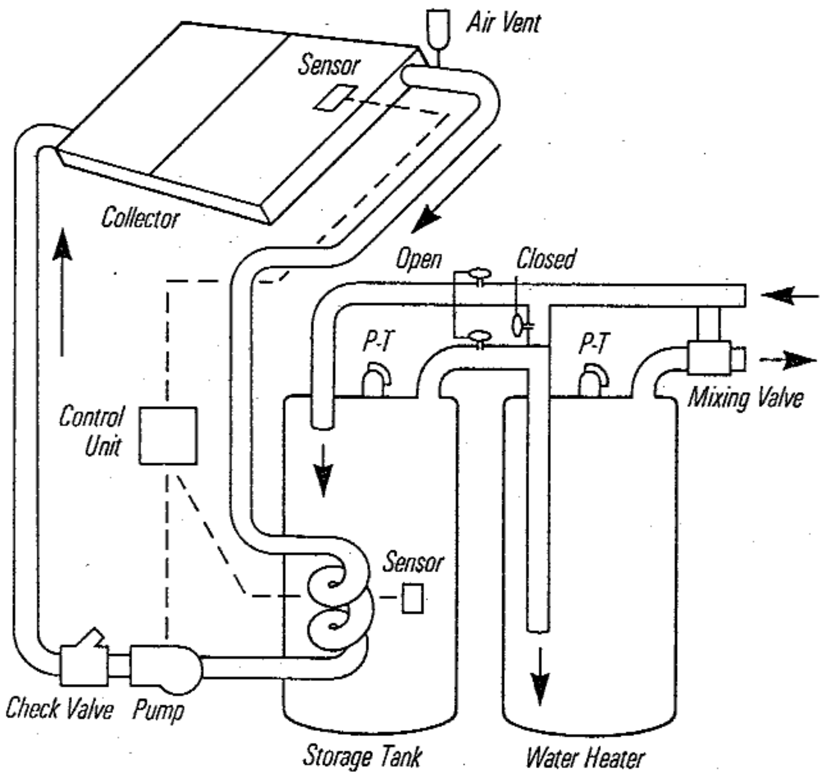
**Heat Exchanger** Systems using heat exchange fluid usually use a double-wall heat exchanger along with a glycol or oil-based fluid to collect heat (Diagram 44). In cold weather, the collector does not drain, but stays full of this fluid,

People who like this sort of thing will find this
the sort of thing they like.
— Abraham Lincoln (1809-1865)




Courtesy of PG&E

**Diag. 43 DRAIN-BACK**




Courtesy of PG&E

Diag. 44 HEAT EXCHANGER

which does not freeze. Corrosion prevention is a particular concern in the glycol systems. There are also systems that push air through special collectors to heat water with a heat exchange coil.

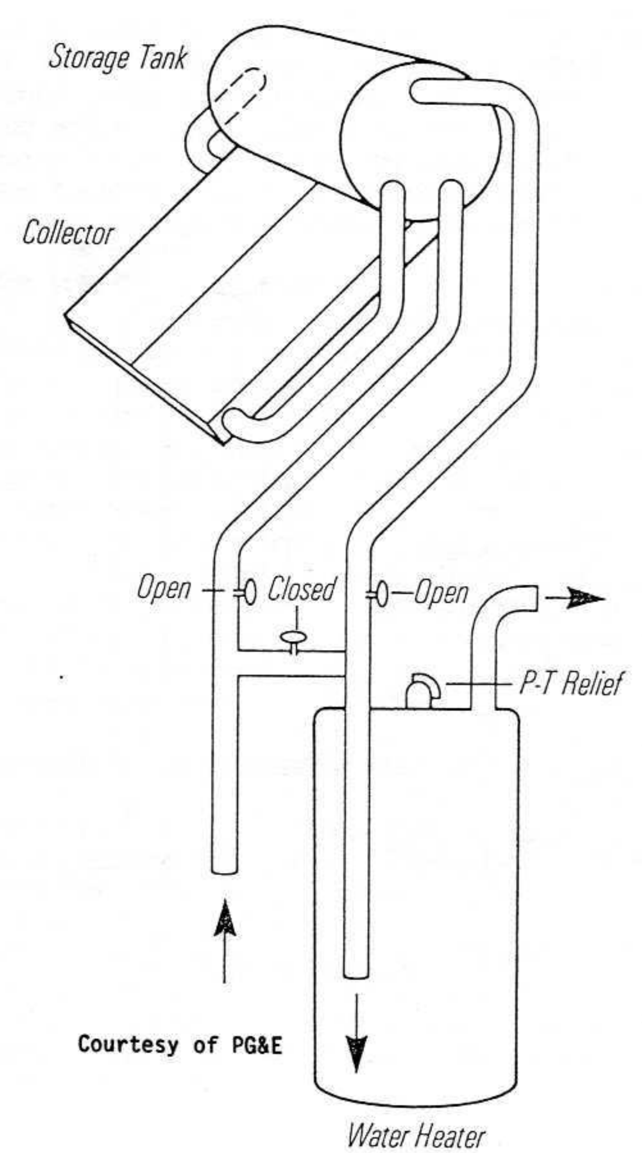
Each of these active systems relies on controls and sensors to regulate the pump or fan. As with any mechanical system, the more complex it is, the greater the need for regular maintenance. You can expect these systems to break down occasionally. Any solar should be installed so that it can be easily bypassed and a backup heater used.

**Passive** Passive systems are generally much simpler in both design and function than active systems. They do not require power. They have no pumps or controls.

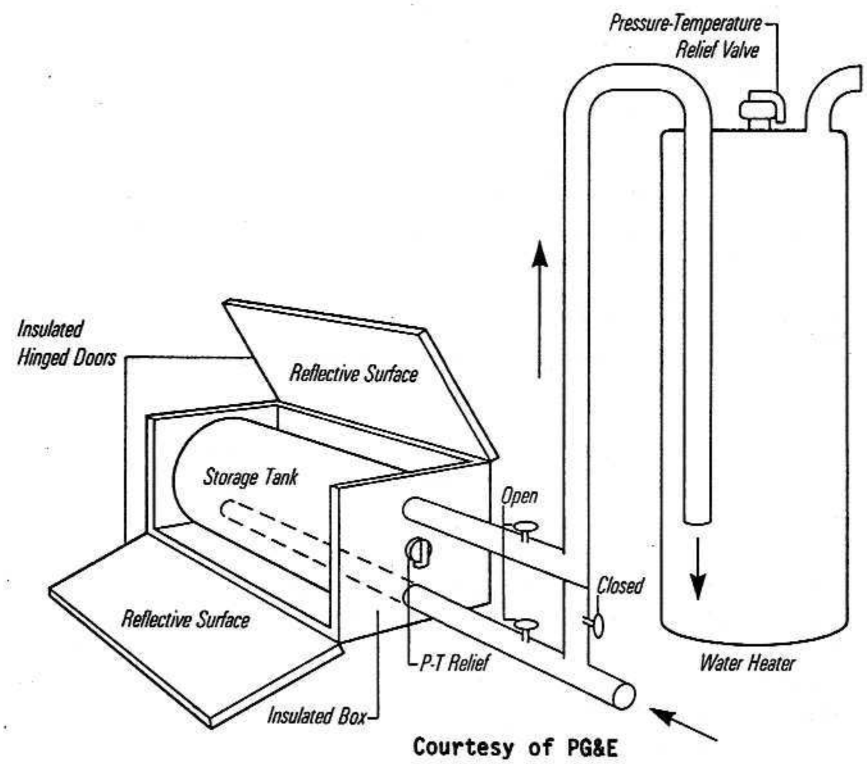
**Thermosyphon** Thermosyphon systems work on the principle that heat rises. The storage tank must be placed above the collector, usually on the roof (Diagram 45). These systems are used around the world in temperate climates and can be as efficient as active systems, with fewer moving parts to break down. Freeze protection is provided by freeze or bleed valves. When it gets cold, these valves open and drain out some cold water, allowing warmer water into the collector.

**Batch** Batch, breadbox and ICS (internal collector or storage) are all names for the oldest type of solar water heater. This type is generally a black tank placed behind glass in an insulated box. With no moving parts, such simplicity has great appeal. However, these heaters are not usually very efficient, as they lose a good deal of heat at night. If batch heaters were made with an insulated

Simplify, simplify.
— Henry David Thoreau (1817-1862)




**Diag. 45 THERMOSYPHON**




**Diag. 46 BATCH**

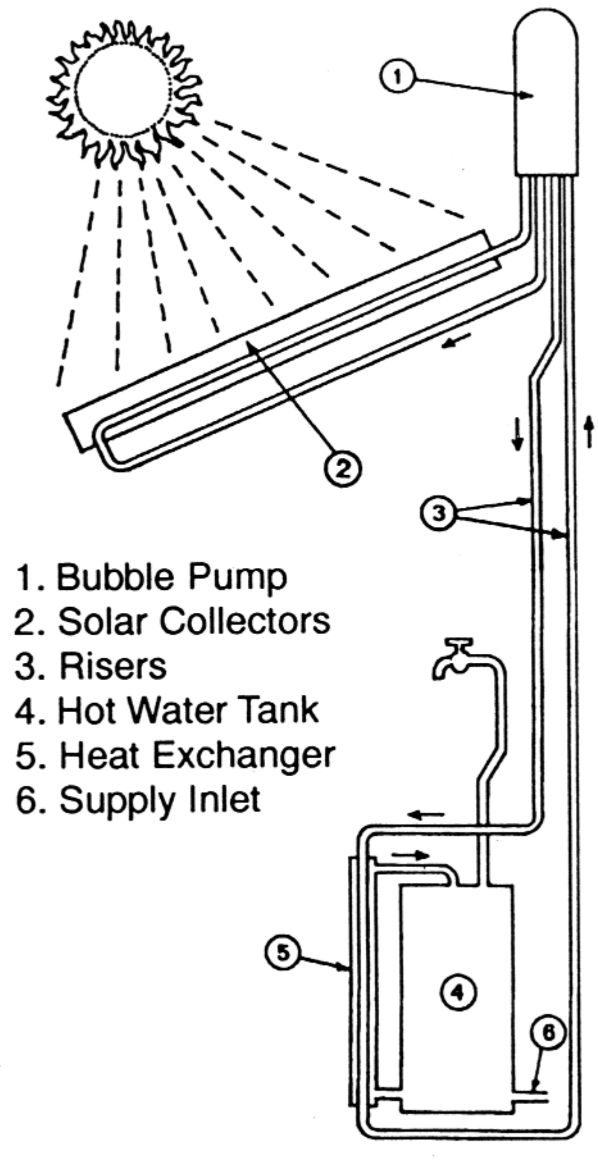
lid, they could work well, but the user would have to open and close it every sunny day (Diagram 46). A reliable, automatic insulating lid would make batch heaters more attractive.

**Geyser** A third type of passive solar is relatively new. It has promise for use in cold areas as well as temperate ones. Using the energy generated by a boiling water/glycol mix, the system pumps heat down from a collector into a ground-level storage tank. This system's percolating action works like a miniature geyser. Bubble Action Pumps Ltd. makes the pump that drives it (see Appendix, p. 145). With no moving parts, this technology has appeal (Diagram 47).

**HEAT PUMPS** Another type of heater is the heat pump. It works basically like any refrigeration system which collects and moves heat from one place to another. Most heat-pump water heaters remove heat from the air and put it into the water. Refrigeration repair people should be able to maintain these units, which are roughly twice as efficient as normal electric water heaters. If electricity is your only energy source and you have a warm place to install it, a heat pump is definitely worth considering. Of course, purchase price and maintenance costs must be figured into your decision. (See Appendix for sources of heat pump water heaters).

**COMBINED SPACE AND WATER HEATING** Combinations of space and water heaters are another choice, primarily for new construction or when remodeling is done. These units, as their name implies, use one heat source to heat both the living space and water. Their advantage is

> All this worldly wisdom was once the un-amiable
> heresy of some wise man.
> — Henry David Thoreau (1817-1862)



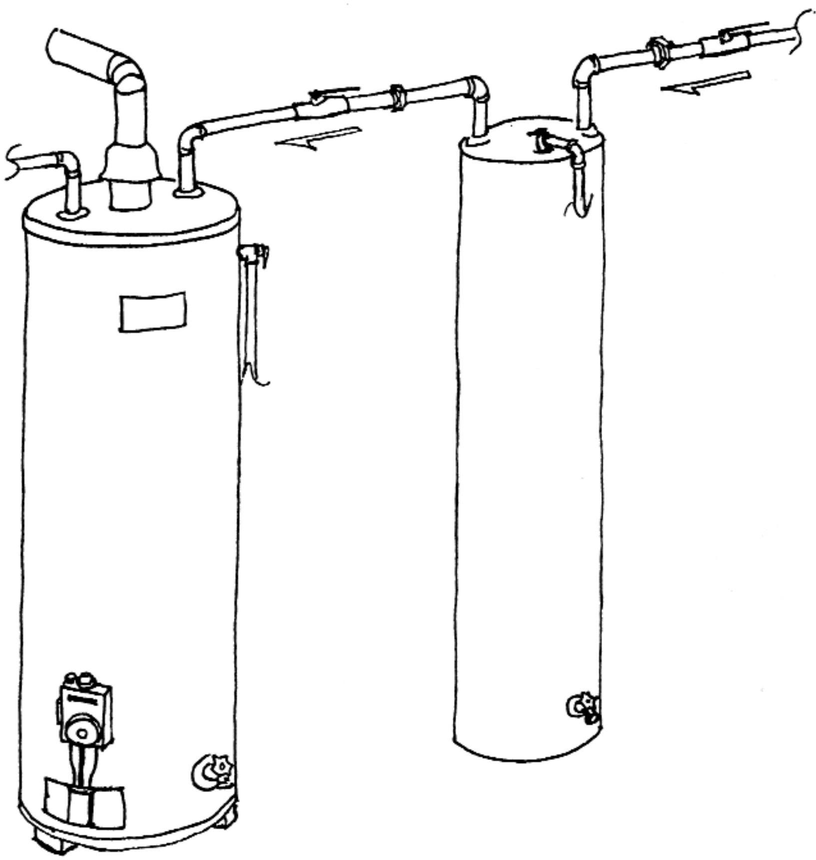

**Diag. 47 BUBBLE ACTION PUMP SYSTEM**

primarily in winter, when an efficient space heater can also heat your water for relatively little added cost. There can be a drawback in summer, when the heater must come on only to heat water. In this case, its heat may not be fully utilized. There are a wide variety of combined systems, and new technology is constantly improving them. Much more information is needed than we can provide here to make an informed decision. Cutter Information Corporation has done its homework and is a good source of information on this and other energy-related topics.

**Wood-Burning Heaters** Another type of combination system uses a coil mounted in or on a wood stove. While the stove heats your room, water is warmed in the coil and moved to a storage tank. Wood stoves are sometimes used in conjunction with a solar heater; the solar is used in summer and the wood heat in winter. This requires more owner participation than automatic heaters, but can work well. Care must be taken in system design to ensure safe operation.

**TEMPERING TANKS** There is an old-fashioned way of increasing your hot water supply — the tempering tank (Diagram 48). This is an uninsulated tank where the cold water enters and sits for a while before it enters your water heater. Here, it is warmed by the ambient air temperature, perhaps rising 10 to 20 degrees. This warmed water then goes to the water heater to be brought up to service temperature. Tempering tanks are particularly useful if you have cold ground water and a warm equipment room or greenhouse.

Men and nations behave wisely once they
have exhausted all the other alternatives.
— Abba Eban (1915-2002)



Diag. 48 TEMPERING TANK

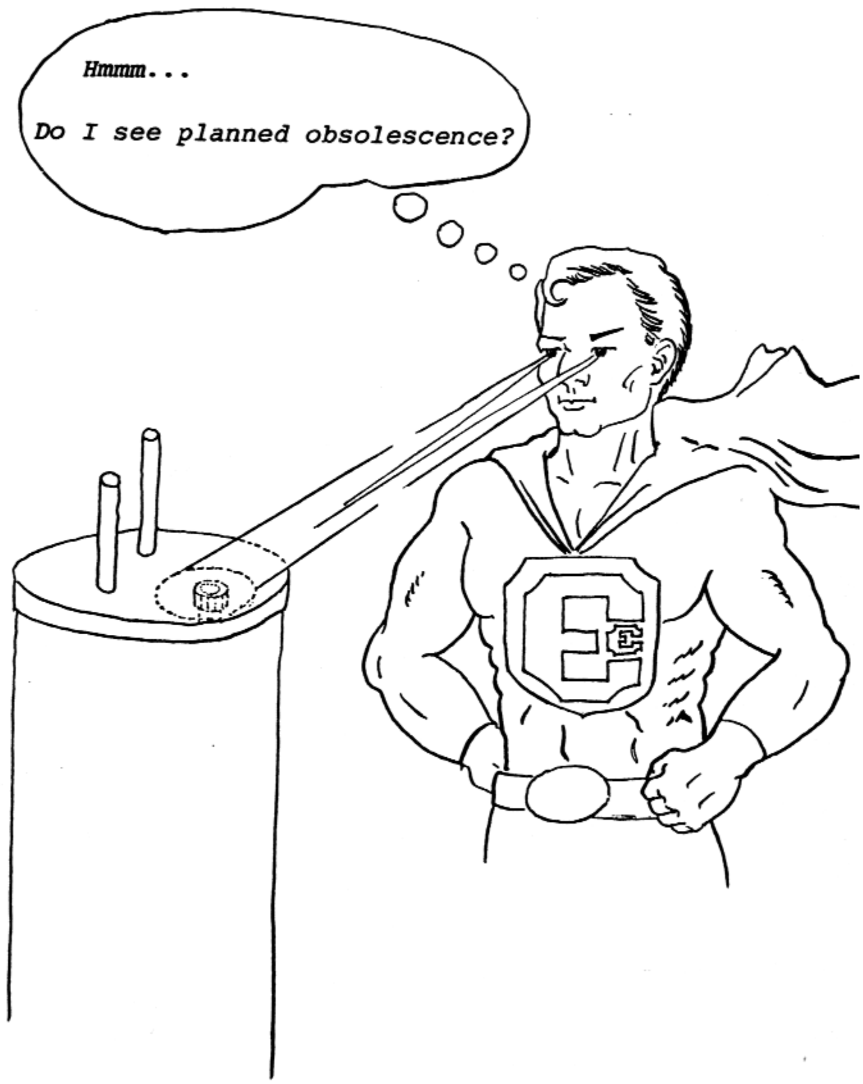
**IF YOU CHOOSE A TANK-TYPE HEATER** If, after all these choices, you decide on a system that has a glass-lined tank, there are a few other things to consider.

**Anode Accessibility** When shopping for a water heater, look to see if you can locate the anode. If the hex head is not visible and if the anode is not combined with the hot water outlet, then it must be hidden under the sheet-metal top. If so, look for a different heater. There is no point in getting a heater that will be difficult to maintain (see illustration, next page).

**Insulation** Be sure the tank has R-16 or better insulation. While such heaters are more difficult to find than the usual R-6 to R-8 models, they are made by all the major manufacturers and are worth looking for. (See pp. 72-3 for pros and cons of water heater blankets.)

**Warranty** Next, look at the warranty and consider the difference in cost between the normal 6- and 12-year terms. A second anode is the main (if not only) physical difference. We suggest buying the 6-year tank and installing a second anode yourself. (An anode costs $40-$60, far less than the additional amount you'd usually pay for the longer warranty.) This approach doesn't give you the longer warranty, but it does give a longer-lived tank. Any manufacturing defect should appear within six years. Use proper maintenance (see Chapter 3) and you will not need a new tank for a long time. Once you have decided on the best water heater for your situation, Chapter 6 will help you install it in the best way possible.

> When you see a situation you cannot understand,
> look for the financial interest.
> — Tom Johnson (1854-1911)




**YOU SHOULDN'T NEED X-RAY VISION TO FIND YOUR ANODE**

**Chapter 6**

## INSTALLING/UPGRADING YOUR WATER HEATER

This chapter is for those who are thinking about installing a new tank-type glass-lined heater or upgrading their present installation.

**CODES** Codes vary from place to place, and some cities require a permit to replace an existing water heater. Some may not allow anyone but a licensed plumber to do the work. Check with your local building department.

Heaters come with installation instructions which detail gas and electric hook-ups, venting, combustion air requirements, clearance to combustibles, and the like. The instructions are to ensure a safe job to protect you (and the manufacturer). Please follow them.

**LOCATION** Should the water heater be inside the house or not? In cool climates any heat lost by a water heater located indoors might be a welcome addition. Otherwise, consider locating in a garage, basement or separate outside closet. Placing the heater close to taps that get frequent use, such as the kitchen, can be considered to help reduce heat lost from long plumbing runs.

Another consideration in new construction or remodeling is placement of the water heater for maximum safety in the event of an earthquake. Walls are an effective way to keep heaters put. Place the water heater in a corner made by two walls or, better yet, three walls. This will eliminate the need for com-

I ought, therefore I can.
— Immanuel Kant (1724-1804)

plex strapping to hold the tank in place.

**CONNECTIONS** There are basically two types of piping used for hot water lines: metal and plastic. Copper and galvanized steel are the common metals. Cross-linked polyethylene (PEX) and CPVC are the plastics. Each type of piping has its merits.

While steel is rigid and nail-proof, it is relatively difficult to install and can clog with rust over time. Copper installs faster and usually does not scale up. However, it does not handle acidic water well, nor is it as strong as steel. Freezing will readily rupture copper.

PEX is very lightweight and easy to install. It is unaffected by water quality, tolerant of freezing, and economical. Still, PEX does not stop nails, it needs plenty of support, and sunlight will damage it. Also, the installer must be trained in correct installation procedures.

CPVC (chlorinated poly vinyl chloride) has ease of installation in its favor. Anyone with a hacksaw and a can of glue can install it (or attempt to), which may be why some plumbers take a dim view of it. It is unaffected by water quality, but it is not resistant to sunlight or freezing, and it can cost the same as copper. Codes and their enforcement are different across the U.S. Although plastics are allowed by all major codes, some localities prohibit their use.

It is important to know what kind of plumbing your house has in order to make the best connections to the new water heater. If copper plumbing is used,

Men willingly believe what they wish.
— Gaius Julius Caesar (100-44 B.C.)

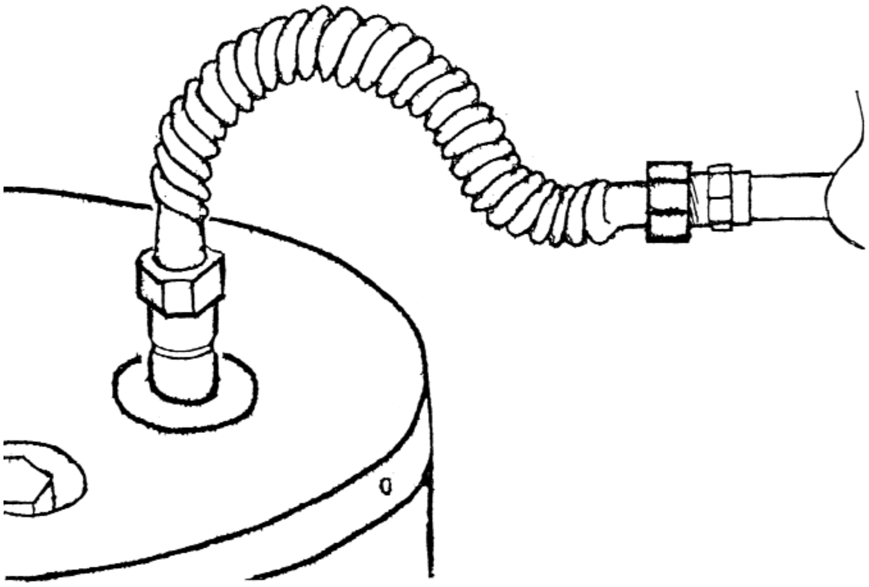
use copper flex-connectors screwed onto adapters on the copper pipe, with plastic-lined steel nipples in the hot and cold ports of the water heater (Diagram 49). The flex-connectors should be screwed to the nipples (incorporating heat traps, as mentioned in Chapter 4). If you have a combination anode, a nipple will be part of the rod in the hot port; and a nipple will be an integral part of the curved dip tube, if you purchase one for the cold inlet. Tanks that already have a curved dip tube usually will need a separate plastic-lined nipple added. Three inches is the normal length for these nipples.

If the house has steel plumbing, there are two approaches. The preferred method is to use plastic-lined nipples on the ends of the hot and cold lines coming from the wall, plastic-lined nipples in the tank, and copper flex-connectors between them, with heat traps, of course (Diagram 50). The other way is to install galvanized unions to the plastic-lined nipples on the tank, and from there, to run galvanized pipe directly into the wall. Those who enjoy threading pipe may prefer this method.

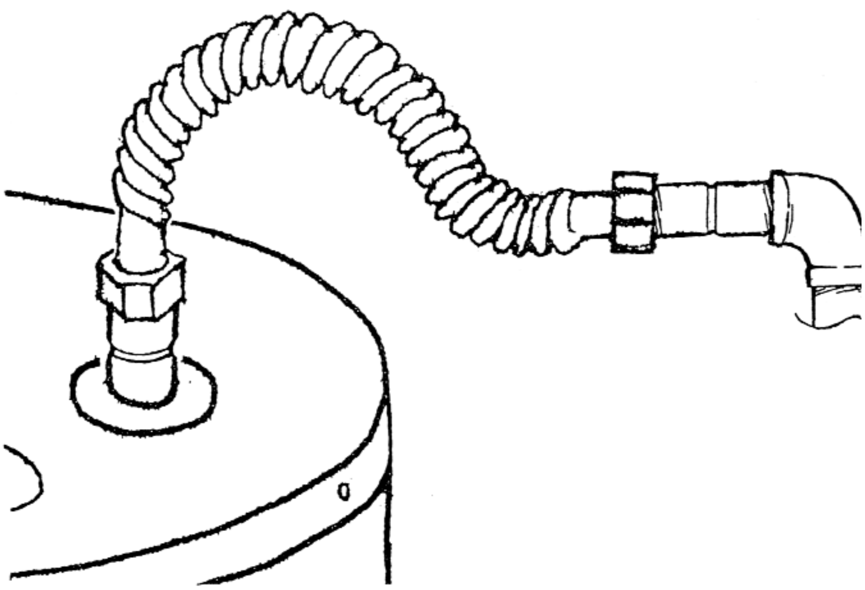
Galvanic corrosion is not a concern with plastics. PEX and CPVC each have transition fittings for adapting to metal plumbing that may be screwed into long flex-connectors (which are attached to the water heater as previously described).

**SECOND ANODE** As mentioned in the prior chapter, a second anode rod in the tank is cheap insurance. On all but the largest residential

> Our lives, as we live them, are passed on to others, whether in physical or mental forms, tinging all future lives forever. This should be enough for one who lives for truth and service to his fellow passengers on the way.
> — Luther Burbank (1849-1926)



Diag. 49 PLUMBING TO COPPER



Diag. 50 PLUMBING TO STEEL

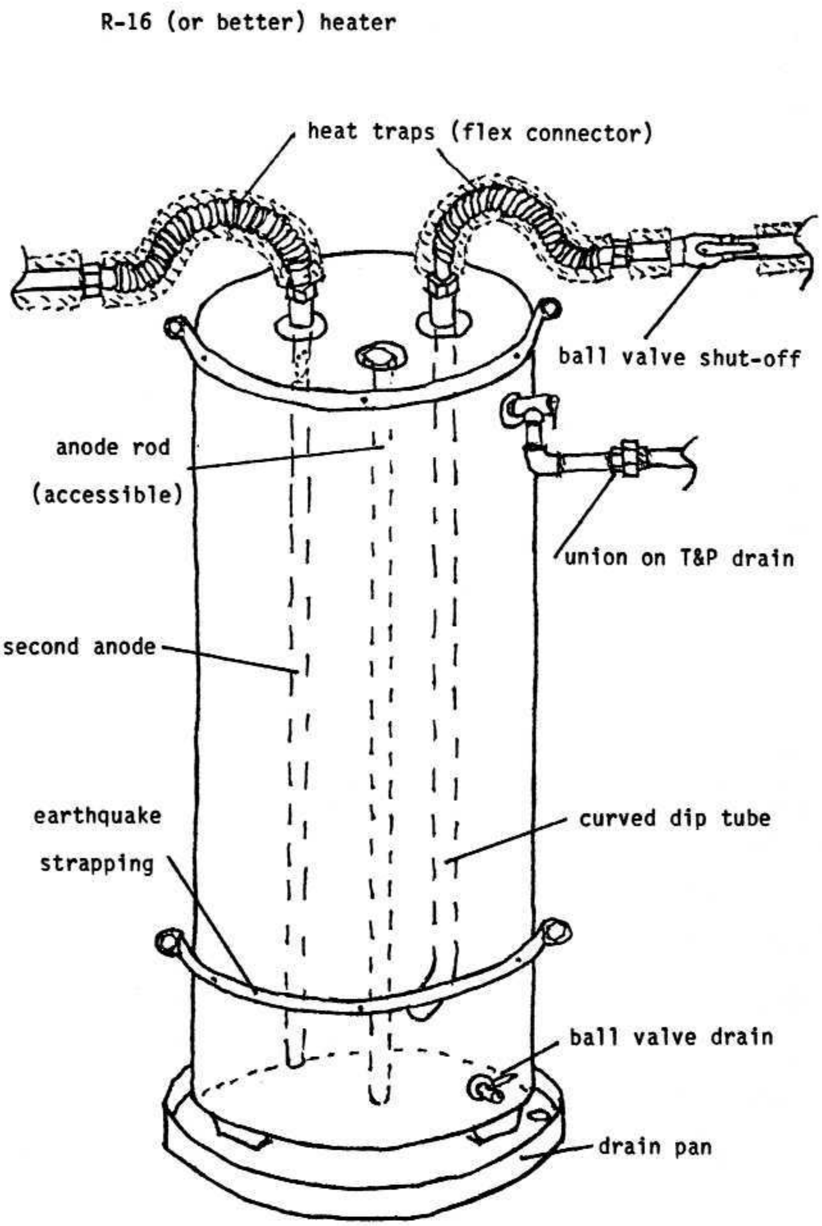
heaters, a second anode will need to be the hot-outlet type and is installed with a pipe wrench (see Ideal Water Heater, Diagram 51). Both rods should be as long as the tank can accommodate. In tanks that don't use a hex-type anode, you might not be able to install a second anode.

**DIP TUBE & DRAIN VALVE** Adding a curved dip tube along with a ball drain valve is highly recommended, as it is the best way to prevent sediment accumulation. See Chapter 3 for installation instructions.

**T&P** A new temperature and pressure relief valve must be installed in a new heater. There will be a port labeled specifically for it, and directions for installation are quite specific. The 1991 Uniform Plumbing Code (section 1007) requires that relief valves located inside buildings have full-size drains. Drain lines can be galvanized steel, copper, CPVC or polybutylene. Both drain pipe and fittings must have internal diameter as large as the relief valve outlet itself. A drain line must extend to the outside of the building, where it must end "not more than two feet nor less than six inches above the ground and pointing downward. Such drain may terminate at other approved locations. No part of such drain pipe shall be trapped and the terminal end of the drain pipe shall not be threaded."

When you hear "Don't trap the drain," it means the pipe must slope steadily toward the drain so that water cannot be trapped in it. Trapped water could cause corrosion or freeze, blocking the pipe. When installing this line, use a plastic-lined or brass nipple in the T&P. We suggest using a copper flex-connector and attaching it to either copper or gal-

It would have made a cat laugh.
— James Planche (1796-1880)




**Diag. 51 IDEAL WATER HEATER**

vanized pipe. This provides a union for access to the T&P and tank. (Since T&Ps may need replacing on occasion, access is necessary.) If freezing is a concern, the drain line should be run to a drain or sink indoors. The end of the line must be higher than water could possible stand, to prevent any chance of dirty water being pulled into the potable water lines.

All this talk of relief valves might seem boring. However, a tank without a working relief valve is anything but boring when it explodes. Picture a rocket blasting off into space. Like that, an exploding tank will be hurled through a building’s roof and then sent flying several hundred feet into the air. The unfortunate building will often have its walls blown out, as well. A 30-gallon tank (smaller than the average tank today) explodes with the power of two pounds of dynamite.

This devastation happens because a pound of steam is 1,700 times larger than the pound of super-heated water the steam was made from. When water in a tank is heated above the boiling point, it is not unlike rocket fuel. In this emergency condition, a working relief valve will bleed off excess energy.

In our work, we find about one in four valves does not work correctly. Most commonly, the T&P will simply leak after being tested. Others actually cannot open or are completely clogged with mineral build-up. These are the ones to worry about. It is fortunate that modern controls work as well as they do, so that overheated water is a rarity. Otherwise, water heater explosions would be a common occurrence, just as they were in the past before relief valves were mandated.

Force Is only a desire for flight; it lives by
violence and dies from liberty.
— Leonardo da Vinci (1452-1519)

Unfortunately, most plumbers don't test relief valves because of the annoyance and extra expense of replacing them when they drip. But, surely, replacing a relief valve is worth the trouble when compared to the difficulty of rebuilding a house ... or a family.

We cannot emphasize strongly enough the need to test the relief valve at least once a year.

**DRAIN PAN** Is the heater located where its leaking could conceivably cause any damage? If so, install a drain pan under it and hook up a 1" line from the pan to carry water away to a safe location. Too many water heaters have caused extensive damage when they leaked, because there was no pan. Drain pans are inexpensive, so don't take the risk. If there is nowhere to run a drain line, put a water alarm in the pan, and check its batteries regularly. (See Appendix for sources.)

**RECIRCULATING SYSTEMS** In larger homes and in apartments, it is common to use a recirculating system to provide hot water quickly at the taps. Usually, these systems are installed by tying into the hot water plumbing farthest from the heater and running a small line back to the bottom of the water heater, at the drain. Hot water circulates from the heater through the supply line and back to the heater for reheating. There is a check valve where the plumbing hooks up at the drain to prevent cool water or sediment from travelling backwards and causing trouble.

These systems are powered either by gravity or by a pump. If the water heater is in a basement, the

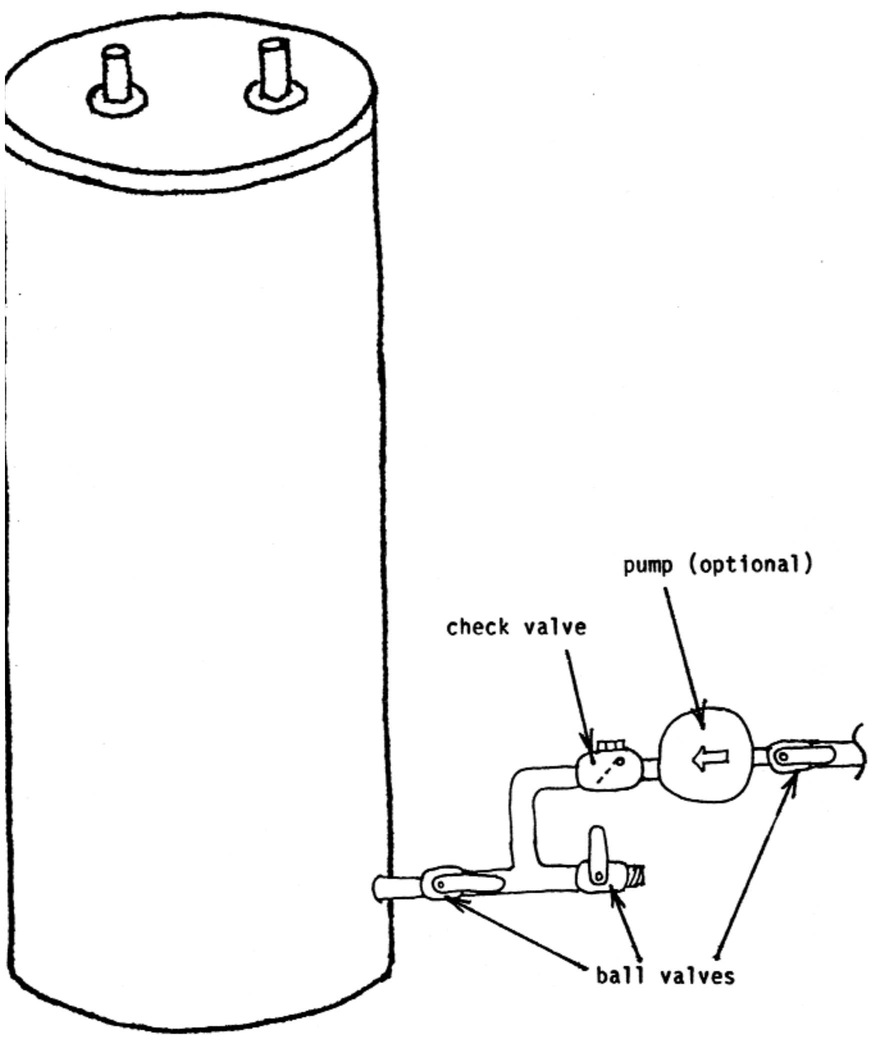
> Science may have found a cure for most evils; but
> It has found no remedy for the worst of them all —
> the apathy of human beings.
> — Helen Keller (1880-1968)

buoyancy of hot water can drive the system. If it is run by a pump, a time clock and/or thermostat can be useful to control it and help to reduce the amount of energy lost. If times you use hot water can be predicted, a time clock can keep the pump off during periods of non-use. A thermostat can keep the temperature in the loop at 105° or 110° instead of the (probably higher) temperature that the water heater is set to.

Some interesting, efficient new choices are available for people who have or need a recirculating system. ACT Distribution, Inc. makes controls for recirculating systems that activate the pump on demand, only when you’re about to use hot water. This eliminates the energy waste standard recirculating loops have. Another system they have does the same job without using a separate recirculating loop at all. Water is pumped into the cold line from the hot, just until it warms, and then the lines are separated. (Contact them for more information. See Appendix.)

There are usual and better ways to install recirculating loops. In homes, generally a ½-inch pipe is attached to a "T" in the drain of the water heater. A check valve, maybe a pump, and a gate valve are in this ½-inch line. Usually, no provision is made for flushing the loop or maintaining the pump and check valve. A better method is shown in Diagram 52. Ball valves on the water heater and recirculating loop allow flushing of either one and provide a way to work on the check valve and pump without draining the heater. Check valves often get stuck in the open position, causing distinctive problems (see Troubleshooting, Chapter 7). If your system is pumped, consider using a spring check valve.

> One of the great pains to human nature is the pain of a new idea.
> — Walter Bagehot (1826-1877)




Diag. 52 RECIRCULATING LOOP PLUMBING

**FIRE PREVENTION** Water heaters are a common cause of house fires. This is not due to poor installation as much as storing things like brooms, rags and boxes on and around the heater. Use caution! Check local codes and installation instructions regarding clearance to combustibles. There will be dimensions given for clearance needed from sides, front, top and bottom.

It should go without saying (particularly in this book) that you need to leave room to do maintenance work. Can you get to the drain valve? Will overhead clearance and plumbing allow anodes to be removed and checked? Can electric elements be pulled out and thermostats adjusted? Place your tank so all serviceable parts are readily accessible.

Whether gas or electric, any heater you install in a garage (or any other place where flammable liquids might spill) must be at least 18 inches off the floor, on a stand strong enough to support its weight and then some (in case of an earthquake). Even if the heater you're replacing is on the garage floor, the new one must be installed according to today's codes.

**EARTHQUAKE STRAPPING** The threat of earthquakes does not apply equally to everybody, but the California shakers in 1989 and 1994 are recent examples of what a moderate quake can do. Neither complex nor expensive, strapping your water heater could keep your house from burning down. A number of strapping methods have been proposed. Some possibilities are shown here (Diagrams 53). In California, when buying ready-made straps, be sure to get only brands that are state-approved. They have survived rigorous testing.

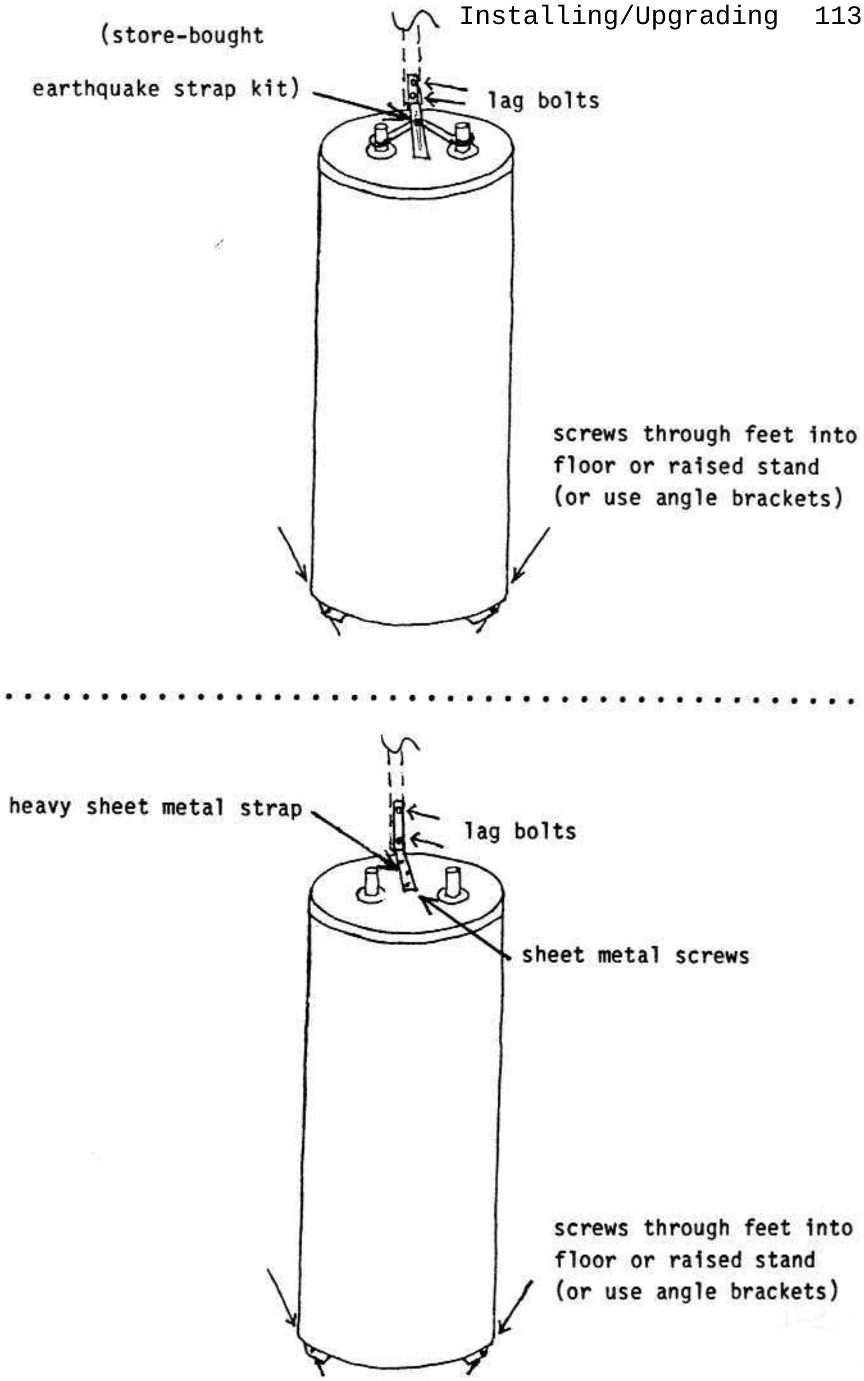
If you have a gas heater, it is important to use a

> Facts are stubborn things.
> — Alain Rene Le Sage (1668-1747)

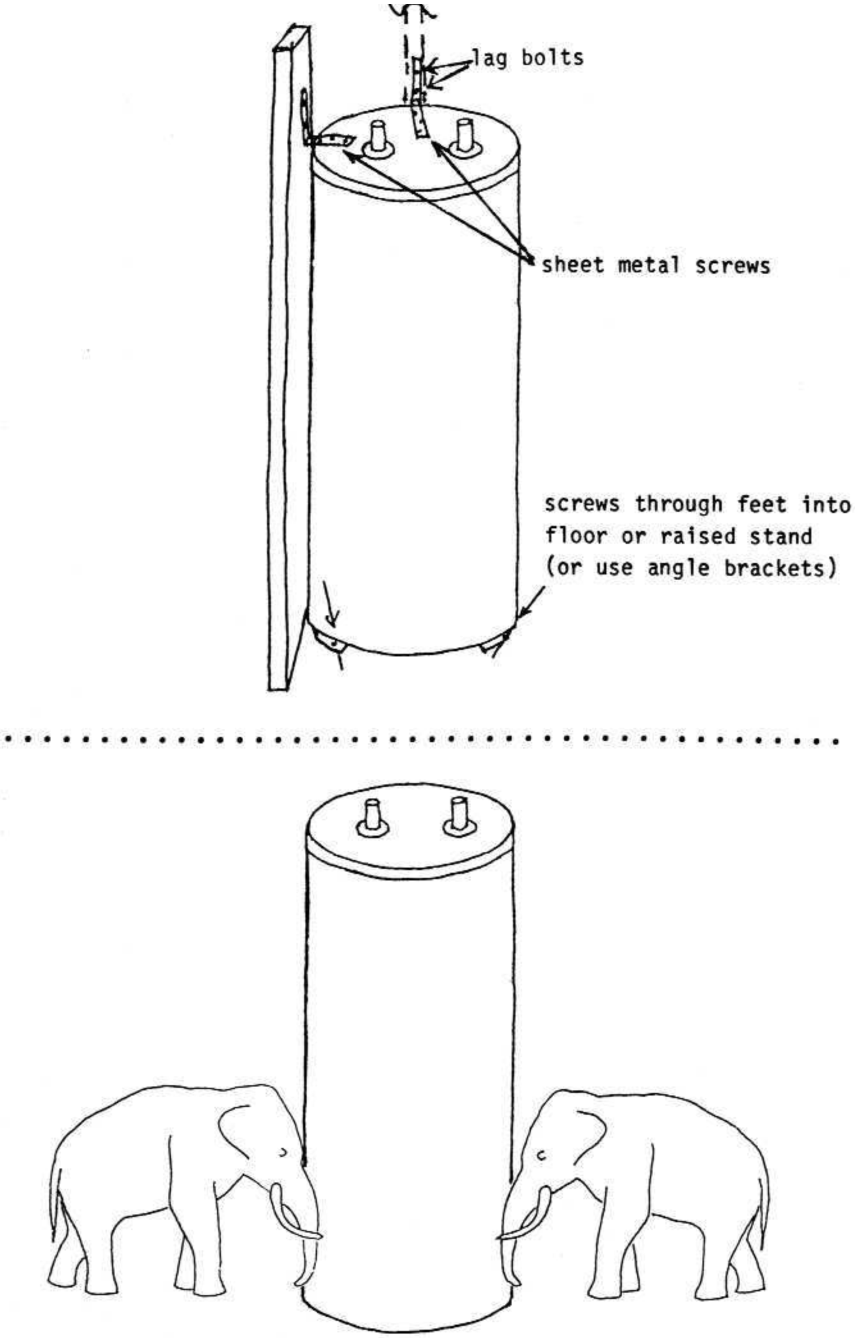
flexible supply pipe to absorb any movement. Also, check to see that the vent is securely fastened.

Your heater is now set up to last nearly forever and be quite energy efficient. However, sometimes trouble strikes. Find out what to do in the next chapter.

Human history becomes more and more a race between education and catastrophe.
— Herbert George Wells (1866-1946)




**Diag. 53 EARTHQUAKE PROTECTION**




**Diag. 53 EARTHQUAKE PROTECTION**

**A True Story:** Their electric water heater was no longer producing hot water. The element had burned out and needed replacing. It was obvious it had been replaced before, because there was a hole in the kitchen cupboard beside the heater. We had to remove the pots and pans and then reach through the cupboard to remove and replace the electric element. MORAL: A thoughtful installation will facilitate maintenance later.

...Thinks I, this is what comes of my not thinking.
— Mark Twain (1835-1910)

Another True Story: An apartment complex in our drought-stricken area was using more than its allotted water and faced expensive penalties. It turned out the recirculating line had ceased working, and the residents were wasting a lot of water waiting for the hot to come. Someone finally brought this to the attention of the owner, who called for help. We found the check valve in the line had stuck open, allowing sediment from the heater to jam and then burn out the pump. Eventually, the recirculating line became plugged with sediment. If someone had mentioned the long wait for hot water early on, it would have been a quick fix and saved the pump, but, at this point, it took three hours to unblock it, and thousands of gallons of water had been wasted. MORAL: Watch for the clues your plumbing provides. Timely maintenance will prevent untimely trouble.

"Tut, tut, child," said the Duchess. "Everything's got a moral if only you can find it."
— Lewis Carroll (1832-1898)

**Chapter 7**

## TROUBLE-SHOOTING

Noise, odor and insufficient hot water are three areas that may not be fully covered in product literature on trouble-shooting water heaters.

**NOISE** As outlined in Chapter 2, noise occurs in gas heaters when sediment slows heat transfer, causing overheating and boiling at the bottom of the tank. This boiling under pressure causes a noise which is sometimes annoying or even alarming. To rid yourself of the noise, remove the sediment. Be sure to install a curved dip tube and an adequate drain valve, so you can flush your tank periodically to keep the problem from recurring.

**ODOR** Odor can also be a plaguing problem. A sulphur or rotten-egg odor is caused by sulphate-reducing bacteria, which thrive in the warm environment created inside a water heater. The situation is aggravated by hard water and by leaving the tank unused for long periods.

Several things can be done to treat the condition. First, it is important to remove any sediment because it serves as a breeding ground for the bacteria. Second, replace the anode. While most tanks come equipped with magnesium anodes, you will need an aluminum/zinc anode to control odor in unsoftened water, or a powered anode to control it in softened water. (See Chapter 3, Anode Selection, for information on anodes.) These are less reactive than magnesium and will generate less of the tasty (to bacteria) hydrogen gas. Zinc is preferable because it combines with the sulphites produced by the action

Do not let what you cannot do interfere with what you can do.
— John Wooden (1910-2010)

of the bacteria and helps to eliminate the odor. Third, put at least one pint of hydrogen peroxide (3% solution, $H_2O_2$) into the tank for every 40 gallons of capacity. (In severe cases, you might want to double the dosage.) This will help to get rid of the anaerobic bacteria by oxygenating the water.

After introducing the hydrogen peroxide into the tank and repressurizing it, run water out the hot taps just until it warms. This will fill the piping with treated water and help to clean it of any bacteria. Leave the water undisturbed for at least one hour. For maximum benefit, leave overnight. In either case, the tank will not need draining, as hydrogen peroxide at this strength is non-toxic.

Some people try to solve the odor problem by simply removing the anode rod. Don’t do it! This will void the warranty and condemn the tank to an early and certain death. Another trick that does not work is to temporarily turn the heat up as high as it will go. These bacteria will quickly reappear unless the condition in the tank is made less hospitable to them. In addition, the scald risk is tremendous with 160° or 170° water.

There’s another thing you can do to discourage odor. If you leave home for more than a few days, turn the heater off if it’s electric, or turn it to pilot if gas. The reduced heat will slow bacterial growth. Leave yourself a note in an obvious place as a reminder to turn on the heater upon your return.

> This world presents enough problems if you believe it to be a world of law and order; do not add to them by believing it to be a world of miracles.
> — Louis Brandeis (1856-1941)

**INSUFFICIENT HOT WATER** There are various causes of insufficient hot water, but one that usually isn’t mentioned is a damaged dip tube. If the dip tube has fallen in, broken off, or split down its length, cold water will mix with the hot water near the top of the tank and short showers will result (see illustration, next page). To remove and check your dip tube, follow the instructions in Chapter 3, in the section headed Curved Dip Tube Flush.

**LEAKS** Leaks are covered in the Plumbing Maintenance section of Chapter 3. Most manufacturers’ literature also covers the topic. See Diagrams 19 and 20 in Chapter 3 for leakage checkpoints.

**FLAMMABLE VAPOR IGNITION RESISTANT ISSUES**

It used to be that if a gas water heater stopped working and you couldn't relight the pilot, you just replaced the thermocouple.

But that got a bit more complicated around the turn of the century (our century - not the 1900s).In July 2003, the federal government started requiring residential water heaters to have a Flammable Vapor Ignition Resistant system (FVIR). This consisted of an arrestor plate that would detect flammable vapors and shut down the water heater before its pilot could ignite an external source of such vapors. Some systems also shut down if inadequate combustion air is detected.

We are all here on Earth to help others; what on Earth the others are here for, I don’t know.
— Wystan Hugh Auden (1907-1973)

There were a few cases a year of people using gasoline or some other highly flammable substance too near a water heater's pilot light, with death or injury resulting from the subsequent explosion. FVIR systems were designed to prevent that, and they probably have, although at a high cost, figured in a substantial increase in the price of all water heaters, and untold frustration on the part of water heater manufacturers and end users. That's because countless water heaters across the country have suddenly stopped working, leaving their owners in cold water, and often without a clue to what just happened.

Each water heater manufacturer came up with its own system. Some worked better than others.
There were a lot of unexpected problems with FVIR systems and unintended consequences. There are a lot of people now who won’t use certain brands of water heaters, as a result of their experiences. There was even a class-action suit and settlement against American Water Heater Co., which is now a subsidiary of A.O. Smith. But bit by bit, the FVIR problems are being resolved.

However, gas water heaters, because of the FVIR issues, have become more complex than before and require maintenance from the people they serve. This is much different from previous decades, when the water heater mostly worked whether any attention was paid to it or not.

Ninety percent of the problems have come because people did not do that maintenance. Another issue is that plumbers are not trained properly in the art of troubleshooting. Still another problem is that the

> For a successful technology, reality must take precedence over public relations, for Nature cannot be fooled.
> — Richard P. Feynman (1918-1988)

manufacturers' own phone support people are not always properly trained. The day likely is coming when the government mandates electronic ignition in residential water heaters. The major manufacturers and their systems are:

**A.O.SMITH/STATE/KENMORE/ AMERICAN/WHIRLPOOL/ MAYTAG/RELIANCE/CENSIBLE**

A.O. Smith is the parent company of all these, but it wasn't always so. American and State were once independent manufacturers. The other names here are their sub-brands. All manufacturers have had problems with their FVIR systems.

Key issues involved the position of the air intake screens. American's have them on the bottom of the heater. State's are on the side, but very near the bottom. These often need to be cleaned of dust buildup. If the pilot goes out and won't relight, this is the first thing to consider.

A.O. Smith changed its FVIR design from a ceramic flame arrestor to a stainless steel one and it now uses an infrared design. When this was first introduced, there were problems with faulty thermostats. The problem usually took a year to appear with the valve that dropped the pilot.

Once the problem was discovered, there were thousands of valves that had to be changed out. People associated this failure with the class action suit against American's old design, especially because, by then, American was a subsidiary of Smith.

> Technology... is a queer thing. It brings you great gifts with one hand, and it stabs you in the back with the other.
> — C.P. Snow (1905-1980)

**RHEEM/RUUD/RICHMOND/ GENERAL ELECTRIC** These heaters have their air intake screens mounted on the side, so they are less prone to be shut down because of dust. Rheem employed a fusible link known as a thermal release device (TRD). Once the device was triggered, though, the heater was junk -- unusable and not designed to be repaired. Also, it was possible to break the TRD by banging or dropping the heater too hard.

Rheem was reportedly quite good about replacing such heaters while still under warranty, but anybody's whose tank was outside of warranty was out of luck. In 2010, Rheem introduced a replacement kit, but it must be installed by a qualified technician. If none is available, Rheem still replaces the heater.

So for these brands, if the pilot goes out and won't relight, it might be well to call Rheem and ask for a replacement TRD.

Rheem heaters once flooded by rain or other water sources are deemed unsafe. They have four gaskets that must be replaced once opened and require a special thermocouple. The side air entry still must pass through an arrestor at the bottom of the tank. Any water caught in the bottom of the heater blocks this flow.

**BRADFORD WHITE** Just looking at complaints, its heaters seem to have the most most reliable FVIR system. Air screens are on the side and less prone to dust problems, while its system has a simple push-button reset switch. Bradford Whites have historically been sold through plumbers.

> The system of nature, of which man is a part, tends to be
> self-balancing, self-adjusting, self-cleansing. Not so with technology.
> — E.F. Schumacher (1911-1977)

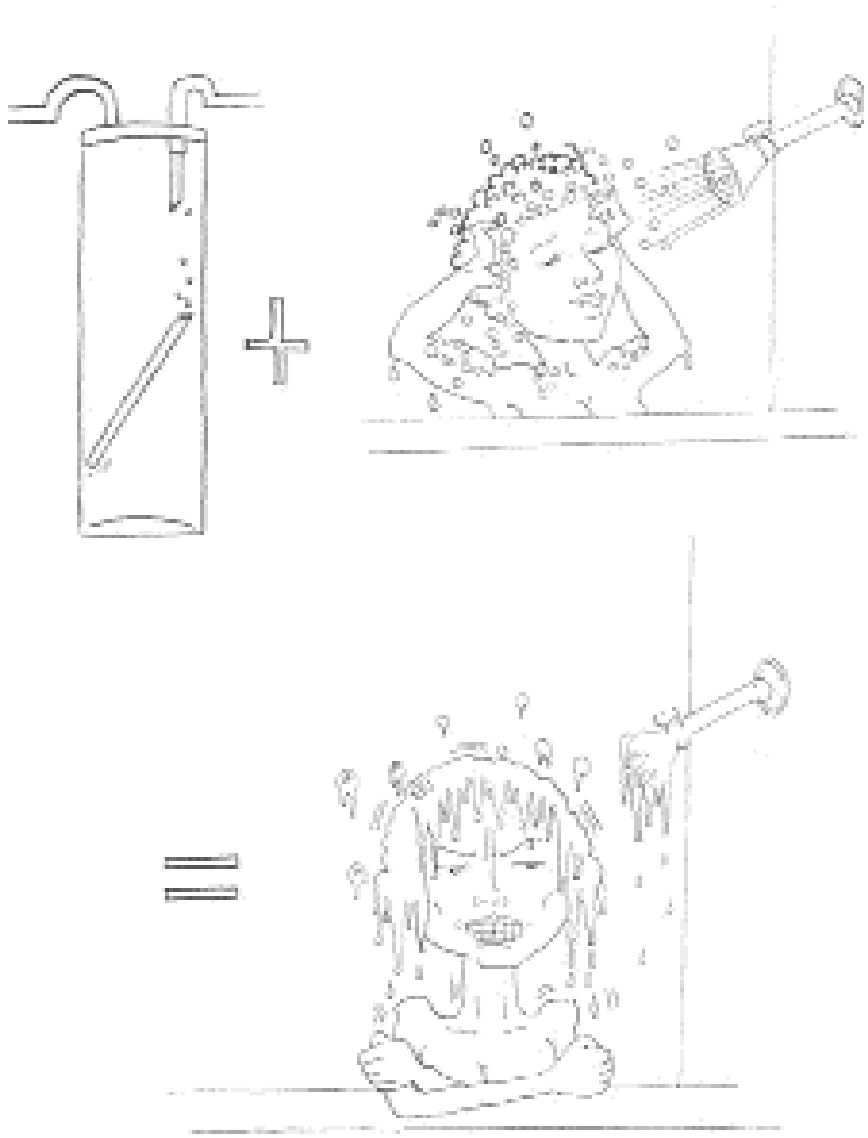
**LOCHINVAR** Lochinvar's system seems similar to Bradford White's with a resettable thermal switch and a piezo pilot light igniter.

**BOCK** Bock's heaters are all above the 75,000-Btu ceiling the government decided on for FVIR systems, so they don't have FVIR devices.

The next several pages contain trouble-shooting guides for both gas and electric water heaters and for recirculating systems. If you are not certain of your skills in any area, please get qualified help. We do not go into the details of FVIR troubleshooting. This is a changing landscape and it's best to get current information directly from the manufacturer.

When you finish the trouble-shooting charts which follow, if you have any appetite left, take a look at Chapter 8, which is a brief discussion of commercial water heaters. And don't forget Dessert!

Conquering any difficulty always gives one a secret joy, for it means pushing back a boundary-line and adding to one's liberty.
— Henri Frederic Amiel (1821-1881)



**DON'T LET A BROKEN DIP TUBE LEAVE YOU COLD**

## TROUBLE-SHOOTING GAS HEATERS

| Symptom | Cause | Remedy |
|---|---|---|
| No hot water | Gas is shut off ------------ | Turn gas on |
| | No gas --------------------- | Clean obstruction from line |
| | Pilot is out --------------- | Relight (see instructions on tank) |
| Inadequate hot water | Debris in gas valve -------- | Clean out valve (must have experience) |
| | Valve not fully open ------- | Open valve |
| | Thermostat too low --------- | Turn up thermostat |
| | Top thermostat knob not "on" ----------------- | Set to "on" position |
| | Leaking hot water ---------- | Repair leak |
| | Tempering valve stuck open (common in solar systems) ------------- | Repair valve |
| | Low gas pressure (small flame) -------------- | Have gas company check pressure |
| | Very cold incoming water --------------------- | Spread out water use or get a larger heater |

| Symptom | Cause | Remedy |
| --- | --- | --- |
| Inadequate hot water | Damaged dip tube | Replace dip tube |
| | Water loses heat in plumbing | Insulate plumbing |
| | High water use | Use low-flow showerheads and aerators |
| | Incorrect plumbing | Check: for cross connections, dip tube placement, and tempering valve operation |
| | Control calibration is inaccurate | Replace control |
| | Recirculating line check-valve is missing or stuck open | Repair or replace check-valve |
| | Heater too small | Spread out or reduce usage or get a larger heater |
| | Inadequate air supply | Provide combustion air inlet |
| | Heavy sediment build-up | Clean out sediment |
| | Incorrect burner orifice | Replace with correct size |
| | Flue clogged | Clear out debris |
| | No baffle in flue | Install baffle |

| | | |
|---|---|---|
| | Main burner not operating correctly | (See section on burner) |
| | Pilot not operating correctly | (See section on pilot) |
| Pilot does not light | Debris in pilot orifice | Clean orifice |
| | No gas | Check gas supply |
| | Gas not getting through control | Replace control and add drip leg to catch debris |
| Pilot does not stay lit | Low pilot flame | Clean orifice; have gas company check: for low gas pressure |
| | Faulty thermocouple | Replace thermocouple |
| | Faulty "magnet" | Replace control |
| | Flame lifts off burner | High gas pressure; check with gas company |
| | Inadequate ventilation | Add air supply |
| | Loose thermocouple nut | Clean and tighten |
| | ECO switch open | Replace control |
| | Drafty conditions | Find and seal off draft source |

| Symptom | Cause | Remedy |
| --- | --- | --- |
| Main burner will not light | No gas | Check supply |
| | Burner line clogged | Find source of debris; clean out |
| | Burner orifice clogged | Clean out |
| | Defective control | Replace |
| | Faulty "magnet" | Replace control |
| | Thermostat set too low | Adjust |
| | Control calibration off | Replace control |
| | Insufficient air supply | Add to air supply |
| | Debris on burner | Clean burner |
| | Wrong pilot location | Move closer to burner |
| | Pilot will not light | (See section on pilot) |
| Main burner flame is too small | Low gas pressure | Check with gas company |
| | Main line clogged | Clean out |
| | Flue clogged | Find obstruction and clean out |
| | Insufficient air supply | Add to air supply |
| Main burner flame is too high | High gas pressure | Use adjustment to derate or check with gas company |

| | | |
|---|---|---|
| | Flue disconnected | Reconnect |
| | Excessive draft | Find source and seal |
| | Defective regulator | Replace control |
| | Oversized orifice | Replace with correct orifice |
| Main burner does not shut off (water too hot) | Defective control | Replace |
| | Thermostat set too high | Reduce setting |
| | Thermostat out of calibration | Replace control |
| | Dirt on valve seat | Replace control and add drip leg |
| | High gas pressure | Check: with gas company |
| Combustion odor or smoking, discoloration by burner | Vent clogged or broken | Check and clean out |
| | Insufficient air supply | Add to air supply |
| | Incorrect gas pressure | Check with gas company |
| | Orifice too large | Replace with correct size |
| | Defective control | Replace |
| Condensation | Debris in burner orifice | Clean out |
| | Vent clogged or broken | Check and clean out |
| | Insufficient air supply | Add to air supply |
| | Heater too small | Determine correct size for use |

| Symptom | Cause | Remedy |
|---|---|---|
| Condensation (puddle at heater base | Temperature set too low | Adjust temperature |
| | High water use | Install low flow fixtures and/or spread out water use |
| Gas odor | Leak at valve or fitting | Air out then check for leak with liquid soap at all fittings |
| | Backdrafting because of poor venting or inadequate air supply | Take appropriate measures |
| Rumbling or popping noise | Sediment in tank | Clean out sediment |
| High operating cost | Thermostat set too high | Reduce setting |
| | Sediment in tank | Clean out sediment |
| | Wrong pipe connection | Check for correct dip tube placement |
| | Hot water leaks | Fix leaks |
| | Gas leaks | Fix immediately! |
| | High water use | Install low-flow fixtures |

| | | |
|---|---|---|
| | Long plumbing runs | Insulate pipes |
| | Recirculation line pump runs too much | Install control system |
| | No flue baffle | Replace missing flue baffle |
| | No heat traps | Install heat traps |
| | Poor tank insulation | Add blanket |

**TROUBLE-SHOOTING ELECTRIC HEATERS**

| Symptom | Cause | Remedy |
|---|---|---|
| No hot water | Circuit breaker or switch off | Turn on |
| | Blown fuse | Replace fuse; locate cause |
| | Incorrect wiring (no power) | Check for short/overload, and leak to ground |
| | High limit tripped | Defective thermostat or element, loose wiring, or defective high limit switch |

| **Symptom** | **Cause** | **Remedy** |
| --- | --- | --- |
| Inadequate hot water | Defective upper element ----- | Replace upper element |
| | Heater too small for use ---- | Reduce use or get larger heater |
| | Burned out lower element or thermostat --------------- | Replace defective part |
| | Leaky plumbing -------------- | Fix leaks |
| | Upper thermostat not switching power to lower thermostat ------------ | Replace upper thermostat |
| | Incorrect wiring ------------ | Check and redo as needed |
| | Low voltage ----------------- | Use appropriate elements |
| | Incorrect plumbing ---------- | Check: for cross connections, dip tube placement, and tempering valve operation |
| | Thermostat set too low ------ | Raise setting |
| | Long plumbing runs ---------- | Insulate pipes |
| | Very cold incoming water ---- | Allow time to heat; add tempering tank |
| Very hot water | Thermostats too high -------- | Lower setting |

| | | |
|---|---|---|
| | Thermostats in poor contact with tank | Move to good contact |
| | Control calibration off | Replace thermostat |
| | Tank insulation missing over thermostat | Replace missing interior insulation (however, keep external blanket insulation away from thermostat area) |
| | Defective thermostat | Replace |
| | Partially grounded element overheating | Replace damaged element |
| | Incorrect wiring | Check schematic supplied with tank |
| Noisy operation | Scale build-up on elements | Clean scale from tank and elements |
| | Thermostat chattering | Replace thermostat |
| High operating cost | Excessive hot water use | Use low flow fixtures |
| | Thermostat set too high | Lower setting |
| | Wrong pipe connection | Check for correct dip tube placement |

| Symptom | Cause | Remedy |
|---|---|---|
| High operating cost | Hot water leaks | Fix leaks |
| | Long plumbing runs | Insulate pipes |
| | Recirculating line pump runs too much | Install control system |
| | Poor tank insulation | Add blanket |
| | No heat traps | Install heat traps |
| | Grounded element | Replace element |

## TROUBLE-SHOOTING WATER HEATERS IN GENERAL

| Symptom | Cause | Remedy |
|---|---|---|
| Water on floor beside heater | T&P valve leak: Excess pressure condition (expanding heated water cannot back up the cold | |

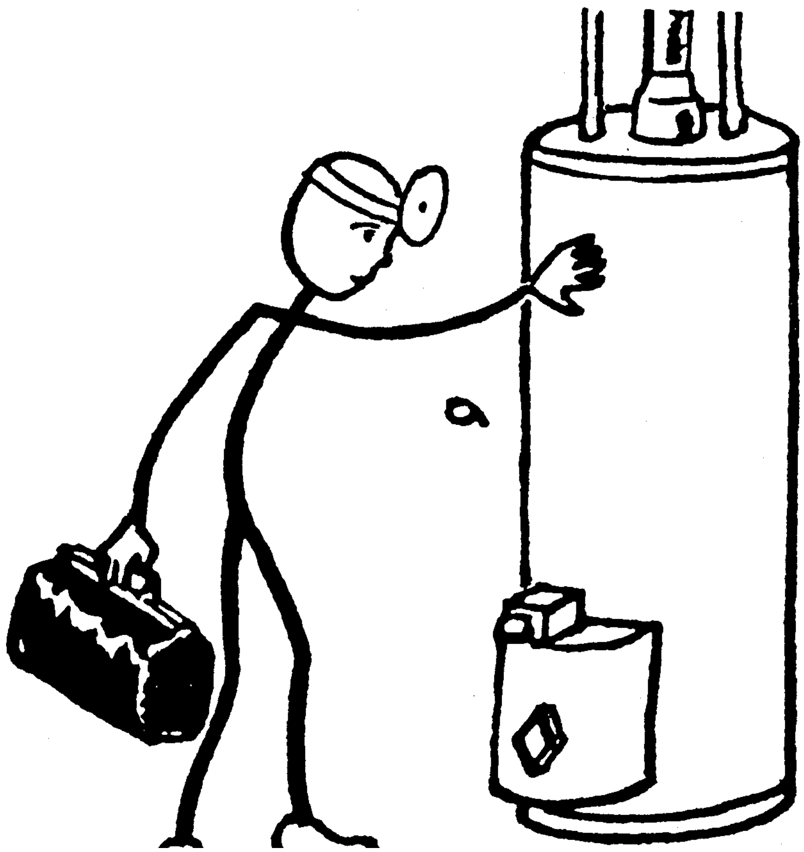
| | |
|---|---|
| inlet line because of check-valve or pressure reducer) | Install pressure relief valve on house side of pressure reducer and set to release 20 pounds higher than pressure reducer setting, or install expansion tank |
| T&P valve leak: Overheating condition caused by incorrect thermostat operation or frequent small draws causing "stacking" which overheats upper part of the tank | Adjust or replace thermostat as necessary; set thermostat down to mitigate stacking |
| T&P valve leak: Valve stuck or scale in seat prevents closing | Operate to flush debris; if leak persists, replace valve |

| Symptom | Cause | Remedy |
|---|---|---|
| Water on floor beside heater | T&P valve leak: Surge from washing machine or dishwasher solenoid valve | Install water hammer arrester |
| | Condensation: Very cold incoming water or high use | Spread out or reduce use |
| | Plumbing leak: Seeping fittings at or near tank | Locate leak and remake joint; replace fittings as needed |
| | Rain coming down vent | Check vent cap and flashing |
| | Leak through tank | Replace tank |
| Rusty water | Glass lining is failing | Replace anode (see Ch. 3) |
| | Old steel plumbing | Replace plumbing |
| | Iron bacteria in water | Consult your water supplier or a water testing lab |

| | | |
|---|---|---|
| Smelly water | Reaction between heat, bacteria, anode and sulfites | Treat for odor (see Ch. 3) |
| “Air” in system | Hydrogen gas produced by anode; develops when the heater is unused for a while (approx. 2 weeks) | Open hot tap and run until air stops; switch to a less active anode (see Ch. 3) |
| Milky cold water | Water supply contains air | Add float-vent at hot outlet on water heater |
| Chattering noise when running water | Balls vibrating in heat trap nipples as water runs by | Replace heat traps with inverted "U" type trap |

**TROUBLE-SHOOTING RECIRCULATING SYSTEMS**

| Symptom | Cause | Remedy |
|---|---|---|
| Sediment clogging aerators, dishwasher, or washing machine | Check valve missing or stuck in open position ---- | Repair or replace valve |
| Intermittent hot/warm water from faucets | Check valve missing or stuck in open position ---- | Repair or replace valve |
| Not giving quick hot water | Air or sediment blocking recirc line --------------- | Flush loop (see Ch. 6) |
| Pumped system not giving quick hot water | Pump stuck, clogged, or air-blocked --------------- | Free up pump, clean impeller and flush loop, flush system |
| | Pump impeller broken ------ | Replace pump |
| | Controls set incorrectly -- | Reset controls |



**A True Story:** The owner was dismayed that he had to call us to replace a leaking solar tank which was only a year and a half old. When we arrived, we turned his water back on to locate and confirm the leak, but we couldn't find anything. A bit of detective work located some wet sponges sitting in the bottom of his laundry tub, blocking the drain. It turned out that when the water softener cycled and discharged into that tub, the blocked drain caused the water to overflow. The water then traveled across the garage floor to a low area by the solar tank, where it pooled and looked like a tank leak. MORAL: Avoid making assumptions. Find all the clues before acting.

Make haste slowly.
--Benjamin Franklin (1706-1790)

# Chapter 8

## COMMERCIAL WATER HEATERS

**DEFINITION** "Commercial" is a label applied to water heaters which differ from residential heaters in one or more of the following ways: commercial heaters have a 75,000 or higher Btu input, they have a clean-out hatch on the side of the tank, they often have multiple flues (if gas), their cold water may enter from the side (near the bottom) instead of from the top through a dip tube, and they may have electronic ignition and an automatic vent damper (if gas).

If your water heater is a commercial model, it needs maintenance for the same reasons a residential-type does. Both sediment control and anode inspection are important, but there will be some differences in methods or equipment needed. With commercial heaters costing thousands of dollars, it is particularly important to provide complete and regular maintenance.

**SEDIMENT REMOVAL** Cleaning sediment from a commercial heater requires shutting off gas and/or electricity (and the recirculating pump, if applicable). The tank usually must be completely drained. Often these heaters will be installed with shut-off valves on hot, cold and recirculation lines. All of these valves should be closed. The T&P may be opened to bleed off pressure and to allow air in to facilitate draining through a hose attached to the drain. If little or no water empties out, the drain is probably blocked by sediment or rust. Remove the drain valve and use a screwdriver or other rod to break loose any sediment which is

Necessity never made a good bargain.
--Benjamin Franklin (1706-1790)

blocking the port. You can use a shallow bucket or pan beneath the drain, but expect to make a small mess!

Once the heater is emptied, its hatch can be removed. The hatch might need unbolting, or it might have a single bolt in the center, which catches a cast iron web and pulls the hatch snug against a gasket (Diagram 54). In this case, loosen the bolt, remove the web, and tap the oval hatch into the tank, where it can be turned and pulled out. Once the hatch is removed, a wet/dry vac can be used to pull out sediment. Unfortunately, the hatches on most commercial heaters are too small to allow you to do a good job. A long, lean, abrasion-resistant arm could be an asset here.

Many commercial gas heaters have multiple flues running up the inside of the tank. These promote rapid heat exchange, but can be a challenge to clean around. To rinse loose sediment from the far reaches of the tank, attach a 3/8-inch aluminum or copper tube about 3 feet long to a hose and use it as a nozzle. If the deposits are hardened into place, they might be removed chemically (see Dissolving Sediment, Chapter 3), but do not try to chisel sediment out, as this might damage the glass lining.

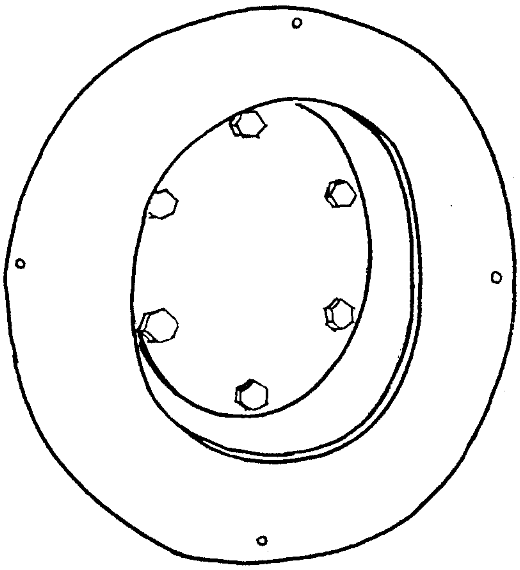
With the hatch removed, you may be able to get a look at the anodes and see if they need replacing. A new gasket should be installed when the hatch is replaced. All sediment or debris on hatch surfaces must be cleaned away to ensure a good seal.

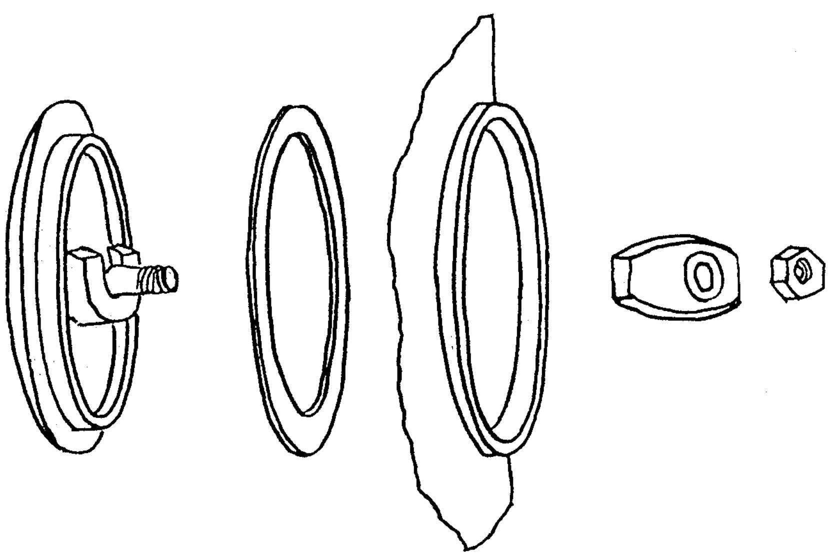
**ANODES**

**Sacrificial Rod**

Multiple flues add greatly to the surface area needing protec-

Delays have dangerous ends.
- -William Shakespeare (1564-1616)





**Diag. 54 HATCHES**

tion by anodes. Consequently, up to five anodes might be used in one commercial tank. The anodes will have either ¾-inch or 1-inch threads. The hex head sizes are 1-1/16 inch" and 1-5/16 inch.

To gain access to the anodes in a commercial gas or electric heater, the outer sheet-metal top must be removed. When removing a cover, always mark it so that during reassembly there will be marks to align. If you are dealing with a single-flue gas or any electric heater, the anodes will be visible.

If you have a multiple-flue gas heater, the inner cover might need to come off. This will expose the upper ends of the flues and anode hex heads. Three-quarter-inch anodes can be difficult to remove, but 1-inch ones are worse. Use a 3/4-inch drive bar and a 3-4-foot cheater bar. It might even make sense to buy a torque multiplier, a device that greatly increases the force you can apply. (One model that works well is the Sweeney #290, made by Hydratight. Various sources of supply for tools and materials are listed in the Appendix.)

It is suggested that you invest in new anodes for your water heater before taking it apart. If they are not needed on first inspection, you will be ready for the next time. (Check the size of the hex heads in order to know what size to buy. In multiple flue heaters, you can usually remove the draft diverter and peer under the sheet-metal top to see the anode heads.) Anodes should always be installed with Teflon tape to make future removal less of a chore.

**Powered Anode** Discussion of anodes so far has related only to sacrificial rods.

We must stop letting today be the effect of yesterday,
and begin to make it the cause of tomorrow.
- -William Denis Kendall (1903-1995)

Another type exists, called the impressed-current or power-driven anode. Its energy comes from an external electrical supply, while sacrificial anodes generate their own current. The wiring diagram on the heater will indicate if power-driven anodes have been used. They are not considered a normal wear item like sacrificial anodes. Although they might need cleaning, they should not need replacement. When the heater is drained and the hatch removed, look around the interior for rusting. If rust is present, the power anodes are not doing their job and you should consult the manufacturer, or you might prefer to install sacrificial anodes, if possible.

**TROUBLE-SHOOTING** See Chapter 7. We will not attempt to discuss the broad field of trouble-shooting commercial controls; specific manufacturers' literature and experienced plumbers are your best sources of information.

You know my methods. Apply them.
- -Sir Arthur Conan Doyle (1859-1930)

## DESSERT

Tell the truth, and so puzzle and confound your adversaries.
 -- Henry Wotton (1568-1639)

The inquiry of truth, which is the love-making, or wooing of it, the knowledge of truth, which is the presence of it, and the belief of truth, which is the enjoying of ft. Is the sovereign good of human nature.
 -- Francis Bacon (1561-1626)

It takes two to speak the truth,-one to speak, and another to hear.
-- Henry David Thoreau (1817-1862)

It is a luxury to be understood.
-- Ralph Waldo Emerson (1803-1882)

Difficulties lie in our habits of thought, rather than in the nature of things.
-- Andre Tardieu (1876-1945)

The best way to succeed in life, is to act on the advice you give to others.
-- Henry Major Tomlinson (1873-1958)

A little rebellion now and then is a good thing.
-- Thomas Jefferson (1743-1826)

The justice of it pleases.
-- William Shakespeare (1564-1616)

**APPENDIX**

## SOURCES OF SUPPLY: MATERIALS

**Water Heater Manufacturers, Parts & Service**

American Water Heater
P.O. Box 1597
Johnson City, TN 37605 (800) 999-9515
www.americanwaterheater.com

A.O. Smith
Rochelle Park #200
600 E. John Carpenter Fwy.
Irving, TX 75062 (800) 845-1108
www.hotwater.com

Bradford White
725 Telamore Drive
Ambler, PA 19002 (800) 538-2020
www.bradfordwhite.com

Rheem Manufacturing Co.
2600 Gunter Park Drive East
Montgomery, AL 36019 (800) 432-8373
www.rheem.com

State Industries
500 Bypass Road
Ashland, TN 37015 (800) 365-0024 ext. 1120
www.stateind.com

Check with these manufacturers also for direct and power vent heaters and repair parts.

**Heat Pumps**

All major manufacturers

**Power Vent Kits**

The Field Controls Co.
2308 Airport Road
Kinston, NC 28504 (252) 522-3031
www.fieldcontrols.com

Tjernlund Products Inc.
1601 Ninth Street
White Bear Lake, MN 55110 (800) 255-4208
www.tjernlund.com

**Vent Dampers**

Air Balance, Inc.
7310 International Drive
Holland, OH 43528 (419) 865-5000
www.american-warming.com

American Metal Products Co.
6100 Bandini Blvd.
Los Angeles, CA 90040 (213) 726-1941

Johnson Controls
1007 South 12th Street
Watertown, WI 53094 (800) 356-1191
www.johnsoncontrols.com

**Energy Conservation Equipment**

Advanced Conservation Technology (ACT)
Distribution, Inc.
22349 La Palma Avenue, #113
Yorba Linda, CA 92687 (800) 638-5863
(makes Metlund hot water demand systems)
www.gothotwater.com

Bubble Action Pumps Ltd.
121 Counter Street
Kingston, Ontario
Canada K7K 6C7 (613) 542-4045
(makes bubble pumps and heat exchangers
for a passive solar system)
www.bubbleactionpumps.com

**Water Heater Parts**

ANODES, DIP TUBES, NIPPLES

Gull Industries
2127 S. First Street
San Jose, CA 95112 (800) 748-6286
(anodes, curved dip tubes, plastic-lined nipples;
residential & commercial)
www.waterconnection.com

www.waterheaterrescue.com
(anodes, curved dip tubes, plastic-lined nipples,
information, and a problem-solving bulletin board)

**Water Alarms**

Entratech Systems
202 E. Fox Road

Sandusky, OH 44870 (419) 433-7683

Sonin, Incorporated
672 White Plains Road
Scarsdale, NY 10583 (800) 223-7511
www.sonin.com

Zircon Corporation 1580 Dell Avenue Campbell, CA 95008 (800) 245-9265
www.zircon.com

**Tools**

Hydratight Sweeney
12508 E. Briarwood Avenue, Unit 100 Englewood, CO 80112 (800) 448-2524 (torque multiplier)
www.hydratight.com

www.waterheaterrescue.com
(carries torque multipliers)
see listing under Water Heater Parts

**SOURCES OF SUPPLY: INFORMATION**

Affordable Comfort Inc.
1030 Washington Trust Bldg.
Washington, PA 15301 (800) 344-4866
("about improving the way old and new homes perform in terms of health, safety, durability and the reduction of energy use, cost")
www.affordablecomfort.org

American Council for an Energy-Efficient Economy (ACEEE)
1001 Connecticut Ave., NW, Suite 535
Washington, DC 20036 (202) 429-8873

("gathers, evaluates and disseminates information to stimulate greater energy efficiency")
http;//aceee.org

American Gas Association (AGA)
400 N. Capitol St. NW
Washington, DC 20001 (202) 824-7000
(trade association, acts as a clearinghouse on gas energy information)
www.aga.org

American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE)
1791 Tullie Circle NE,
Atlanta, GA 30329 (404) 636-8400
("for the exclusive purpose of advancing the arts and sciences of heating, refrigeration, air conditioning and ventilation, the allied arts and sciences and related human factors for the benefit of the public")
www.ashrae.org

California Energy Commission (CEC)
1516 9th Street
Sacramento, CA 95814 (800) 772-3300
(wide range of information on energy use)
www.energy.ca.gov

Energy Efficiency And Renewable Energy Clearinghouse (EREC)
P.O. Box 3048
Merrifield, VA 22116 (800) 363-3732
("EREC provides information and technical assistance on energy efficiency and renewable energy technologies.")
www.eren.doe.gov

Gas Appliance Manufacturers Association (GAMA)

1901 N. Moore Street
Arlington, VA 22209 (703) 525-7060
(trade association of manufacturers has equipment information)
www.gamanet.org

Gas Technology Institute (GTI)
1700 S. Mount Prospect Road
Des Plaines, IL 60018 (847) 768-0500
("provides energy and environmental products and services with a focus on natural gas")
www.gri.org

Home Energy Magazine
2124 Kittredge Street, #95
Berkeley, CA 94704 (510) 524-5405
("the magazine of residential energy conservation")
www.homeenergy.org

Home Power Magazine
P.O. Box 520
Ashland, OR 97520 m(800) 707-6585
("The Hands-on Journal of Home-made Power")
www.homepower.com

National Association of Corrosion Engineers (NACE)
1440 S. Creek Drive
Houston, TX 77084 (281) 228-6200
("devoted exclusively to the technologies needed to control the degradation of materials in engineering systems")
www.nace.org

National Center for Appropriate Technology (NCAT)
P.O. Box 3838
Butte, MT 59702 (406) 494-4572
("individualized help with any project that uses renewable energy or involves energy efficiency")
www.ncat.org

Rocky Mountain Institute (RMI)
1739 Snowmass Creek Road
Snowmass, CO 81654 (970) 927-3851
("a non-profit research and educational foundation whose goal is to foster the efficient and sustainable use of resources as a path to global security")
www.rmi.org

**SELECTED BIBLIOGRAPHY**

Baer, Steve. Sunspots. Cloudburst Press, 1979. ISBN 0-88930-061-5.

"An exploration of solar energy through fact and fiction."

Brumbaugh, James E. Audel Heating, Ventilating and Air Conditioning Library. MacMillan Publishing Co., 1986. ISBN 0672-23380-0.

Provides the layman with "an introduction to the fundamentals of installing, servicing and repairing the various types of equipment used in residential heating, ventilating and air conditioning systems."

Butti, Ken and Perlin, John (revised by Perlin). A Golden Thread; 2500 Years of Solar Architecture and Technology. AATEC Publications, 1997. ISBN 0-937948-12-8.

"This comprehensive, pioneering book places solar energy today in a rich historical context....an amazing story." NOTE: Currently in revision. Look for previous edition (1980) in libraries or used book stores.

The Earth Works Group. 50 Simple Things You Can

Do To Save The Earth. Earthworks Press, 1989.
ISBN 0-929634-06-3.
"A practical, entertaining, and informative guide to the things YOU can do to help protect the Earth."

Hemp, Peter. Installing & Repairing Plumbing Fixtures. The Taunton Press, 1994. ISBN 1-56158-075-9.
"...takes the mystery out of installing and repairing your own plumbing fixtures."

Lovins, Amory and Hunter. Energy Unbound. Sierra Club Books, 1986. ISBN 0-87156-820-9.
"An energy primer with a refreshing twist."

Ontario Hydro Research Division. C E A Electric Water Heating Manual. Canadian Electrical Association, 1988.
"Deals exclusively with systems that use electricity as the energy source for heating water."

Smith, Ken. The Gas Fitter's Guide To Domestic Hot Water. KLS Training Corporation, 1993. ISBN 1-895258-06-5.
"Everything the gas fitter needs to know to install, troubleshoot and repair modern gas water heaters."

Wilson, Alex. Consumer Guide To Home Energy Savings. Council for an Energy-Efficient Economy, 1991. ISBN 0-918249-15-5.
"Listing of the Most Energy Efficient Products You Can Buy ... and Much More."

Wing, Charlie. House Warming. Atlantic-Little, Brown and Co., 1983. ISBN 0-316-94669-9.
"How to retrofit your old house so it both conserves energy and suits your individual needs."

**A True Story:** A water heater owner had tried everything to solve a rotten-egg odor problem: chlorine bleach, hydrogen peroxide, magnesium anode, aluminum anode, aluminum/zinc anode, powered anode, raising and lowering the temperature, turning the water softener on and off. But it only smelled in the shower, which meant it couldn’t be the water heater. Bacteria in the shower drain were causing the odor,which was most noticeable when people used hot water. MORAL:Troubleshoot before spending money.

Knowledge is of two kinds: We know a subject ourselves, or we know where we can find information upon it.
-- Samuel Johnson (1709-1784)

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