Water Heater

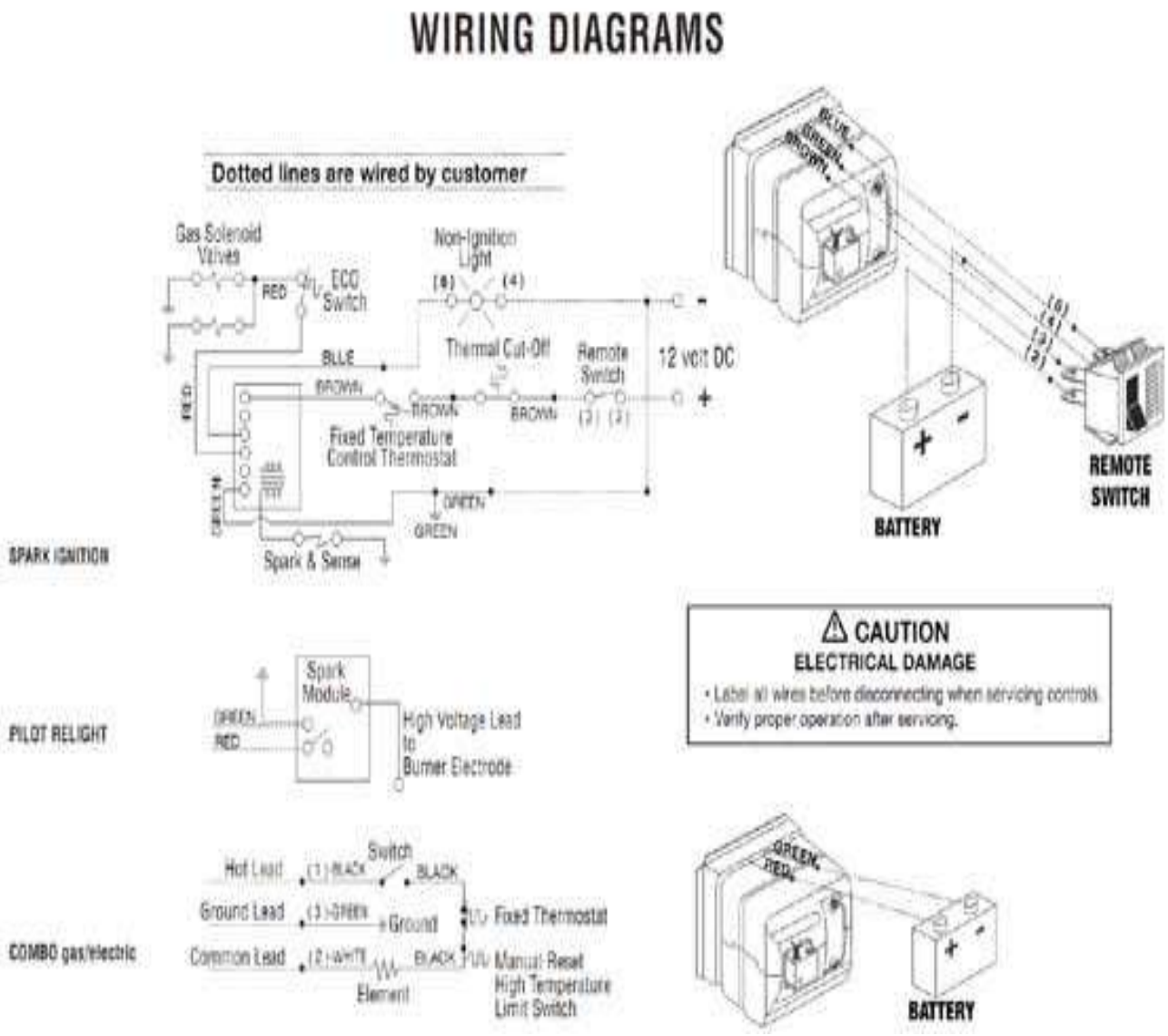

Figure 1 Water Heater Diagram

Figure (1) illustrates a typical water heater schematic diagram which has both gas and 110 VAC operating modes. Almost all of the early trailers had a gas only heater. Reference (1), http:// bryantrv.com/owners.html provides an excellent collection of RV Manuals and Service Documents. This includes various brands of water heaters, refrigerators and furnaces that have been used by Airstream over the years. You can also obtain free manuals directly from many of the manufacturers by going to their support section on the Internet. For Dometic equipment, Reference (2), http://dometic.com/enus/Americas/ USA/Customer-Support/Operation--Installation-Manuals/

Operation

In Figure (1), the +12 volt line goes thru three switches: (1) Remote on-off, (2) eco and (3) temperature control. The remote is the switch in your RV which turns the water on and off. The eco opens if the temperature of the water gets too hot and could burn a user (usually 180 degrees). The fixed control thermostat sets the operating temperature of the water by closing if the water is below its set temperature (usually 140 degrees). This thermostat is available in several different values if you want to change the water temperature. You can obtain a variable thermostat which can be screw driver adjustable so that you can change the water temperature when desired, Figure (2). We used one of these for many years to reduce the water temperature when we had the grandchildren with us.

The three switches are in series with the 12 volt supply to the gas valve, so unless they are all closed, the valve cannot operate and feed gas to the burner. The -12 volt return line is connected to the RV chassis and then thru the green wire ground to the heater. A non-ignition light is connected in series with the -12 volt line. When you turn on the heater switch the light goes on and once the burner is successfully lit and the senser circuit detects the flame the light goes off. If the burner is not on and running the non-ignition light stays on continuously to indicate an ignition failure. There are also timing circuits and built in delays all controlled by the circuit board. The circuit board also provides the high voltage signal (spark & sense) used to generate a spark for lighting the gas burner. In some water heater systems, the spark is provided by a module separate from the circuit board. Older RV propane equipment usually uses a **Manual Pilot** technique. The gas valve has a pilot lighting position where you open a small pilot burner, light the gas and release the lighting control knob after about 30 seconds. The pilot flame heats up a thermocouple that supplies a signal to the main gas valve which causes it to stay open. This starts the main gas flow which is ignited by the pilot. Heat is now being applied to the appliance and it is in full operation. If the flame goes out the gas valve will close and shut everything off. You do not need an electronic circuit board or 12 volts DC for this type of system, however, you must manually re-start it (light the pilot) each time it stops running.

Figure 2 Adjustable Water Temperature Thermostat

Newer propane equipment incorporates an **Electronic Ignition System** that operates from 12 volts DC. These use a 12 volt powered circuit board which automatically turns on the main gas supply and directly lights the propane. Once the burner is lit then the appliance essentially functions the same as the manual models. For these systems, you need a good 12 volt source since they will not function if the coach batteries are in a discharged state. Directly lighting the gas supply is done with a high voltage applied to a spark probe assembly. A thermocouple (which provides millivolts of signal to the gas valve) can actually be part of the spark probe or in some cases a separate sensor is used. A special wire from the circuit board carries the high voltage to the spark probe and also the millivolt signal back to the board. The spark probe has two heavy wires in close proximity, Figure (3), with one side grounded.

Figure 3 Spark Probe

If a separate sensor is used there will be three heavy duty wires, Figure (4). Spacing between them is critical in order to get a good spark. Further, the sensor probe must be properly placed within the pilot flame to send back the sensor voltage which the circuit board uses to control the main gas valve. The circuit board creates a high voltage using an inverter which takes 12 volts DC and converts it to an AC voltage and then using a transformer raises the AC to a voltage level which will provide the spark. If the propane does not light the gas valve is turned off and the system recycles by itself until the gas ignites and a flame is present.

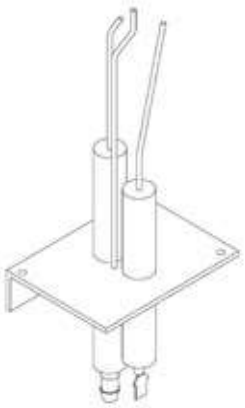

Figure 4 Separate Sensor Spark Probe

Water heaters can be purchased with built-in 110 VAC operation capability as illustrated in Figure (1). In this mode we again have three switches in series in the 110 volt line including an on-off switch, temperature thermostat and a high temperature limit. These serve the same function as the 12 volt propane system except in this case we are getting our heat from an electric element which operates from 110 VAC.

You can purchase an aftermarket 110 VAC heating element that screws into the drain plug socket on an Atwood heater. These units come with a special adjustable thermostat which mounts on the tank via some double sided high temperature stick-on tape. You wire through a switch to one of your 110 VAC circuit breakers. The add-on 110 VAC system is not recommended for suburban water heaters since they use special anode rods which should not be removed. These rods keep the water tanks from corroding. Make sure your 110 VAC wires can be disconnected directly at the heating element. This allows you to easily remove the heating element, clean it and drain your tank.

The early water heater electronic systems had unpotted circuit boards which were mounted in the external part of the heater. This exposed them to the elements and resulted in a high failure rate. The manufacturers changed the design by potting the boards in epoxy so that the only electronic components exposed to the elements were the input and output connections. This resulted in a signifcant reduction in failure of the circuit boards. If you have an older water heater with an exposed circuit board, then purchase a new one and either replace the old board or carry it as a spare.

The gas solenoid valve, Figure (5), is a mechanical switch which opens and closes the gas line. It is operated by dual 12 VDC electrical solenoids which create a strong magnetic field. You can hear a loud click when 12 VDC is applied to or removed from the valve. This click can be a valuable troubleshooting clue when trying to diagnose a problem with your heater. Figure (5) illustrates a typical gas valve.

Remember your water heater may be somewhat different than this example. There are several manufacturers as well as many different models. However, they all operate in a similar manner and utilize the same basic components. Understanding how a water heater operates and knowing the main failure modes should really help in finding the problem yourself.

Howard's Rule: When a system has failed, usually only one component has gone bad! Find this component and replace it to restore the system to normal operation.

When something was working fne and now it has failed, usually only one part has caused the problem. It is very rare when a problem is the result of multiple parts failures. However, on rare occasions I have seen this rule violated when the failure of one part causes other parts to fail i.e. a short in the gas solenoid could blow a component on the circuit board or the 12 volt fuse.

Figure 3 Gas Valve

Troubleshooting

When troubleshooting for an electric problem, make sure the tank gas supply valve is turned off. When you cycle the heater for testing make sure you wait until any released propane has dissipated before you re-test the heater.

Nothing Works

The switch light in the coach does not go on; nothing is clicking, no propane smell and no hot water. The usual suspects in order of frequency of occurrence:

1. The green ground wire is loose. This is one of the most common problems with water heaters. Sometimes the screw thread is too worn and the screw cannot be tightened to get a solid connection. First make sure the area under the screw head is clean, then use the next larger screw size. This connection must be tight as it provides the ground for the entire water heater. 2. The plug wires going to the circuit board are not making contact. Remove the multi-pin plug clean the board with a pencil eraser and circuit cleaning spray and plug back in. Circuit board spray is sold by Radio Shack, Staples, and WalMart. It leaves no residue when it dries and is designed specifically for electronic circuit boards.

3. The next check is to determine if the 12 VDC is getting to the heater on/off switch. Do you have 12 volts at the RV circuit breakers? How about from the batteries?

4. If you have voltage at the input terminal of the on/off switch and not at the output, then the switch is bad or your wire terminals have come loose.

Gas Valve Not Going On

If you cannot hear the gas valve click when the heater is turned on or off, check for 12 volts from the coil terminals to ground. If there is no click sound, either the solenoid valve is defective or we are not getting the 12 volts.

1. Check for 12 VDC at the brown wire terminal on the temperature thermostat, as measured to ground, or at the thermal cut-off fuse terminal whichever is easier. Voltage at this point means that everything in the RV is OK and the problem is in the heater. Usually the temperature thermostat is on the right side with the eco switch next to it on the left. There should be 12 volts on both terminals of these switches. The temperature thermostat is normally closed and opens when the water temperature reaches 140 degrees F. The eco switch is normally closed and opens when the water temperature reaches 180 degrees F. You can check both of these switches and the cut-off with an ohmmeter. Usually it is the temperature thermostat that fails in the water heater.

2. Check for 12 VDC on the gas valve terminals. If the valve does not click when turning on the heater then the gas valve is probably defective. Either the solenoid coil is open or the valve has corroded and frozen in the off position. Check the coil with an ohmmeter (it should measure about 45 ohms) to verify that the solenoid is OK. I have seen many corroded valves especially when heaters have not been used for several years.

3. In newer heaters there is a thermal cut-off, Figure (6), which is usually mounted near the burner tube. Its purpose is to provide a fusible link which will melt and cut off the gas valve if there is any flame flashback due to propane trapped behind the external cover. If this fuse is open, it will prevent the 12 volts from reaching the gas valve.

Older heaters did not have this protective device so check your RV heater. I suggest you add the cut-off since it is a safety feature designed to protect against a fire. The installation is quite simple and easily done.

Figure 4 Thermal Cut-off

Burner Will Not Light

You can hear the gas valve click and smell propane but the burner will not light.

1. Check for a spark which you can both hear and see. If there is no spark, check the spacing of the spark probe wires which should be 1/8 inch. 2. The circuit board spark voltage generator could be defective. Or the spark module, if it is separate from the circuit board in your heater, could be defective.

3. The connector or wire from the spark generator to the probe could be defective.

4. Your gas pressure should be 11 inches of water. A simple test is to turn on all of the gas appliances (furnace, cook top, oven, and refrigerator). If they all work and the cook top has a good adjustable flame, your pressure is probably OK. If this is not the case, you either have a bad tank regulator or it needs adjustment.

Burner Lights OK But Will Not Stay Lit

1. The most common cause is a partially clogged burner jet. You can soak the jet in alcohol by removing the burner assembly and then unscrewing the jet. Let it soak for at least an hour to remove the deposits. **Do not put any wire or metal object through the jet opening.** This is a precise size which forms the gas flow so that it will provide the proper flame pattern. One quick fix is (after removing the burner assembly) use a round toothpick, wet it and twirl it in the jet opening. This will remove any deposits without affecting the opening. If you are on a Caravan or Rally, with no alcohol available, you can use vinegar except it takes about twice as long to get the jet clean.

2. Your water heater bypass valves may still be set for the winter, which will result in the burner lighting and then immediately turning off.

3. Your spark probe thermistor is not in the flame so it does not heat properly and send the correct signal to the circuit board and tell the circuit board to "keep the gas flowing." The thermistor should be right in the main part of the flame. It is also possible that it is defective.

Burner Makes Loud Noises

1. The burner stays lit but the flame is mostly yellow and not blue. The flame changes size and may pop and make noise. This can be because of the air/gas mixture. Loosen the screw on the jet cover and adjust for a quiet blue flame.
2. You may have insect nests or excessive soot in your heat chamber restricting the proper air flow. After removing the burner assembly, take a rag and push it through the chamber several times being sure to clean it thoroughly. A wire coat hanger is handy for this job.

Circuit Boards

Some of the problems listed above can also be caused by a defective circuit board; however, this is rather rare unless you have an older board. The early heaters had open boards which were covered by a Bakelite cover. These were not waterproof and thus subject to moisture and dirt. Over the years they developed short circuits and blew out components. Later models were converted to much more reliable epoxy potted boards with just input and output terminals exposed to the elements. If you have one of the early boards, I suggest you purchase a new one and either change the board or carry it as a spare, since you are living on borrowed time. Take the old board to make sure you get the correct high voltage terminal connection (there are two types of lugs). You may also have to purchase a new spark probe.

Electric Operation

As illustrated in Figure (1) troubleshooting the electric part of the water heater is relatively simple. If you have 110 VAC present at the off/on switch then you can easily check the fixed temperature thermostat, high temperature limit switch and

the heating element with an ohmmeter. The usual failure mode for the electric part of the system is the heating element or the connecting wires. Since all components are in series, simply isolate the defective part or wire connection and replace it. Do an end to end ohmmeter check to verify all of the components.

The Pressure Relief Valve Leaks

This valve is not designed to be water tight and usually when it is leaking the problem is that there is no air cushion at the top of the tank. Before you replace the valve do the following:

Turn the pump off and set the valve lever in the open position. Then open the tank drain valve and let several gallons of water out. Snap the valve shut and refill the tank. This should re-establish the air layer at the top of the tank and stop the leak.

Maintenance

Keep the water heater compartment clean. Periodically make sure the electrical grounds and connections are free from corrosion and are tight. Clean the gas jet at least once per year and it will never give you a problem. Clean the burner compartment at least once per year and make sure nothing has taken up residence. I like to drain my hot water and fresh water tanks after every trip. In over 60 years of camping I have never had to clean my tanks of any growths, smells or spoiled water. Think about it, if the tanks are empty when you are not using the RV there is no way for anything to grow in them.

continued next month