THE CARE AND FEEDING OF YOUR RV III

Troubleshooting and Repair of Your Propane Equipment

(Water Heaters, Furnaces & Refrigerators)

by

Howard Lefkowitz
Airstream Tech Help Group
WBCCI #6077
techhelp@wbcci.org
wa3vez@comcast.net

INTRODUCTION

One of the key secrets to troubleshooting a piece of equipment is to have some idea about how it works. We usually know what the input and output are supposed to be but have no idea how we get from here to there. A water heater takes cold water and delivers hot water using propane; a furnace provides hot air using propane; an air conditioner provides cool air using 120 VAC; a refrigerator provides cool and frozen food using propane or 120 VAC or sometimes 12 VDC; a generator provides 120 VAC from either gas, diesel or propane; a charger keeps our batteries working properly using 120 VAC or an alternator; an inverter changes our 12 VDC into 120 VAC; a solar panel helps keep our batteries charged using sunlight; etc., etc.

We take all of this equipment, stick it into a box, leave it outside all year long and subject it to extremely hot and cold temperatures. We dump water and dirt all over it and then periodically shake the heck out of it. No wonder our RV appliances and equipment constantly need care and feeding. Lots of little critters like the smell of propane so they build nests in the equipment that can block the flow of air or gas. Exposure to the weather and dirt can cause short circuits on printed circuit boards. Occasionally, manufacturers may have done a poor design or used an unreliable component which will eventually cause a failure. I know it's hard to believe but some of us might actually not take care of our expensive RV systems (sometimes referred to as MAINTENANCE) resulting in failures at the most inopportune times.

Home appliances usually last for many years without continuous maintenance but they live in a benign environment and with millions of each item sold receive the ultimate in design for

reliability and cost. Most of our RV equipment is designed to survive in the environment in which it has to live, but periodic maintenance is a requirement not an option. The, don't touch it

until it goes bad, philosophy just does not work on RV's. Most of the equipment has specified periodic maintenance schedules, just like your Tow Vehicle or Motor Home. It may be as simple as cleaning the area around the equipment, changing a filter or tightening an electrical connection. Read your individual instruction manuals, check the RV manufacturer's service and maintenance manuals and down load any available appliance service information. 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/ .

In this Seminar we are going to cover Water Heaters, Furnaces and Refrigerators. This is not intended to be a detailed step by step troubleshooting manual for a technician. We will provide a basic outline of how the equipment works, maintenance you should be doing on a routine basis and an outline of what usually goes bad. Many of you should be able to do the simpler repairs yourselves and gain some knowledge in order to make the decision when you need to visit a professional repair shop.

PROPANE APPLIANCES

Fundamental to any propane or natural gas operated equipment is the following items:

1. Uses the heat from burning gas

2. An electrically operated valve which turns on the gas

3. A method of automatically lighting the gas jet

4. The ability to turn off the gas valve if the flame goes out

5. A means of setting and/or changing the operating temperature

6. A turn off protective device if it gets too hot

7. Several protective circuits involving timing of turn on and turn off cycles

8. A good source of 12 volt DC power to run the circuitry

9. A source of propane that provides the correct gas pressure (11" of water).

Let's define a few terms:

Thermometer	Sensor that measures temperature and usually provides a visual reading
Thermocouple	Generates a voltage as a function of temperature (millivolt levels)
Thermostat	Opens or closes a switch as a function of temperature
Thermistor	Changes resistance as a function of temperature
eco or E.C.O.	Temperature activated electrical cut-off switch.

I have two gas furnaces in my house that operate from natural gas. They are used in a zoned two area system. One is an original unit over 50 years old and the other, a much larger furnace that was replaced about 8 years ago. The older unit has a pilot which burns all of the time. The gas line goes into a valve which controls the main gas input for the furnace. A separate smaller gas line feeds around the gas valve through a small manual cutoff switch to provide the pilot flame. You open the small cutoff, light the pilot flame and then hold a spring loaded switch till the flame stays on. A wall mounted thermostat can now close a switch when the ambient temperature reaches the level you have set. This provides the final voltage to the relay controlled gas valve that turns on the furnace. If the flame goes out the gas valve turns off and you must go thru a re-light cycle by resetting the spring loaded switch.

The newer furnace does not have a pilot flame but uses a direct-spark ignition that effectively turns on the main gas valve and lights it using an electrical spark. Once the preset temperature has been reached the thermostat (inside the wall thermometer) opens and shuts off the gas supply. It has several electric circuit boards that control the turn-on and turn-off cycles. Home furnaces usually use 24 VAC which is supplied by a transformer connected to the 110 VAC. Our RV furnaces operate in a similar manner except for using 12 VDC to operate the gas valve and electronic circuits.

GENERAL

The following sections will consider the propane operated Water Heater, Furnace and Refrigerator. All of these are fundamentally the same in terms of how they operate in generating heat, controlling it and providing suitable protection systems. They all have similar gas systems and use a high voltage to create a spark that will automatically light the gas jet. If the flame goes out they will wait till any gas fumes clear and then automatically re-light the appliance.

Good trouble shooters are worth their weight in gold to any service shop. You usually find two basic types; (1) Those who learn how a system works and understand the different functions which must occur and (2) those who have fixed so many systems over the years and learned what usually goes wrong. The technician who has fixed a hundred refrigerators can look at a problem, check the Model number and go right to the defective component. He may not know how the

fridge actually works or the operating principles behind it but who cares. He quickly finds the bad component, has it in stock (because he knows what usually fails) and makes the repair. Actually fixing the problem (replacing a bad component, tightening a wire, fixing a ground lead, etc.) takes a minimal amount of time and effort. Determining the problem (troubleshooting) is what is most difficult and takes the longest.

Since it is not likely that we will be spending enough time to gain years of experience in fixing our RV appliances our best approach is (1) learn how it works, (2) learn how to isolate the problem, (3) learn how to make some simple safe tests and (4) learn when to stop and get an expert.

The first step is to clearly define what the problem is. This is not always as easy as it sounds. My refrigerator does not work?? On gas? On electric? The freezer is not cold enough? Food in the main box is too cold? Ice cubes are not freezing? Etc, etc.

Check carefully and determine what is working correctly. If the food is spoiling put a thermometer in the Fridge freezer or the main food box and determine the actual temperature. Check the ambient temperature when you measure the box. Make sure your refrigerator is set on high if it is a hot day.

Being able to succinctly state the problem as well as any applicable environmental factors is needed regardless of whether you tackle the problem yourself or take it to a repair shop. The better you define the problem the less trouble shooting time that will be required. If you can you should also try to isolate the problem to a subsystem. For propane appliances the subsystems could include:

(a) Gas components (Valve, sparker, gas connectors, combustion chamber, jet)
(b) Electronic section (Circuit Boards, fuses, High voltage source, switches)
(c) Electrical parts (heating element, thermostats, motors, connectors, wiring)
(d) Mechanical components (motors, fans, ducts, covers)

Instead of just wading in and testing components one after the other get the instruction manual out and read how the sequence of operation is supposed to occur. Observe each step and try to verify that each operation is correct.

WATERHEATER

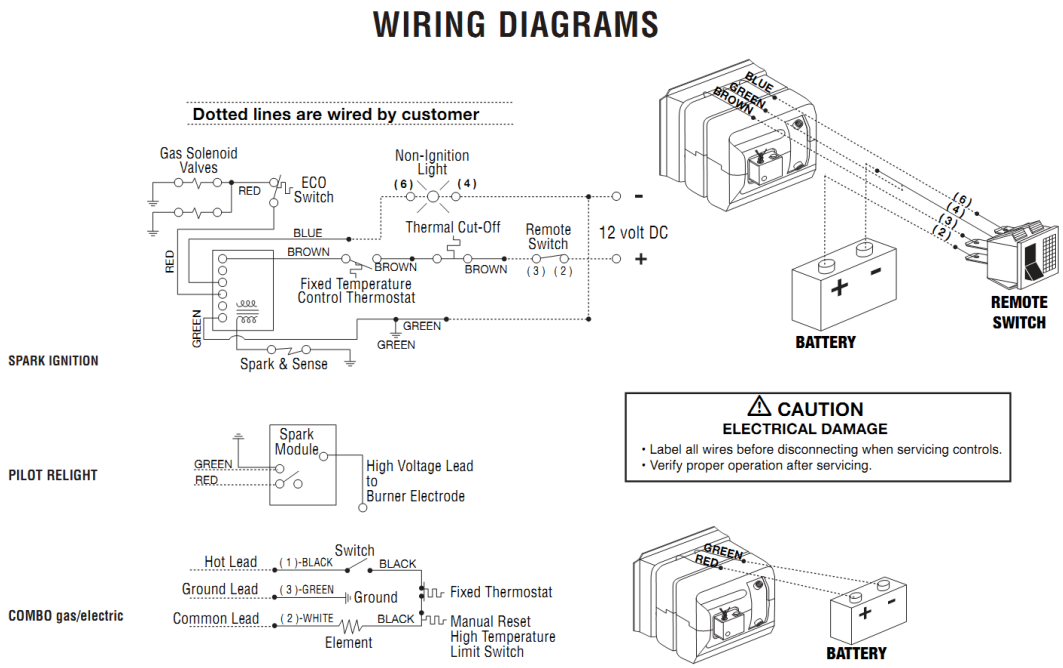

Figure (1) Water Heater Diagram

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.

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.

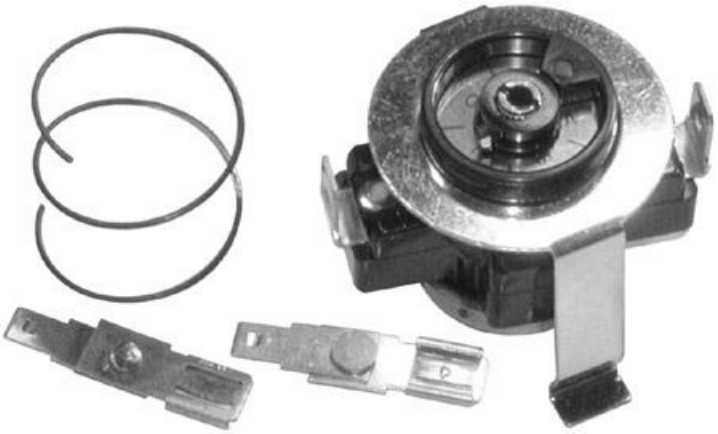

Figure (2) Adjustable Water Temperature Thermostat

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 contunuously 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.
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 dis-charged 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.

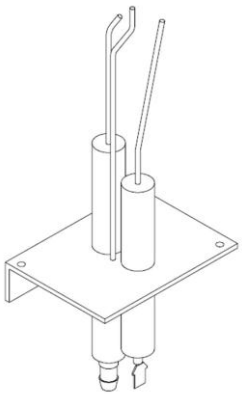

Figure (4) Separate Sensor Spark Probe

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 un-potted 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 significant reduction in failure of the circuit boards. If you have an older water heater with an exposed circuit board than 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.

Figure (5) 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.

Howards 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 fine 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.

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 (6) Thermal Cut-off

<u>Burner Will Not Light</u>

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, spade or push-on like a spark plug). 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 ValveLeaks

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.

FURNACE

Operation

Figure (7) illustrates the typical furnace configuration that we use in our RV's.

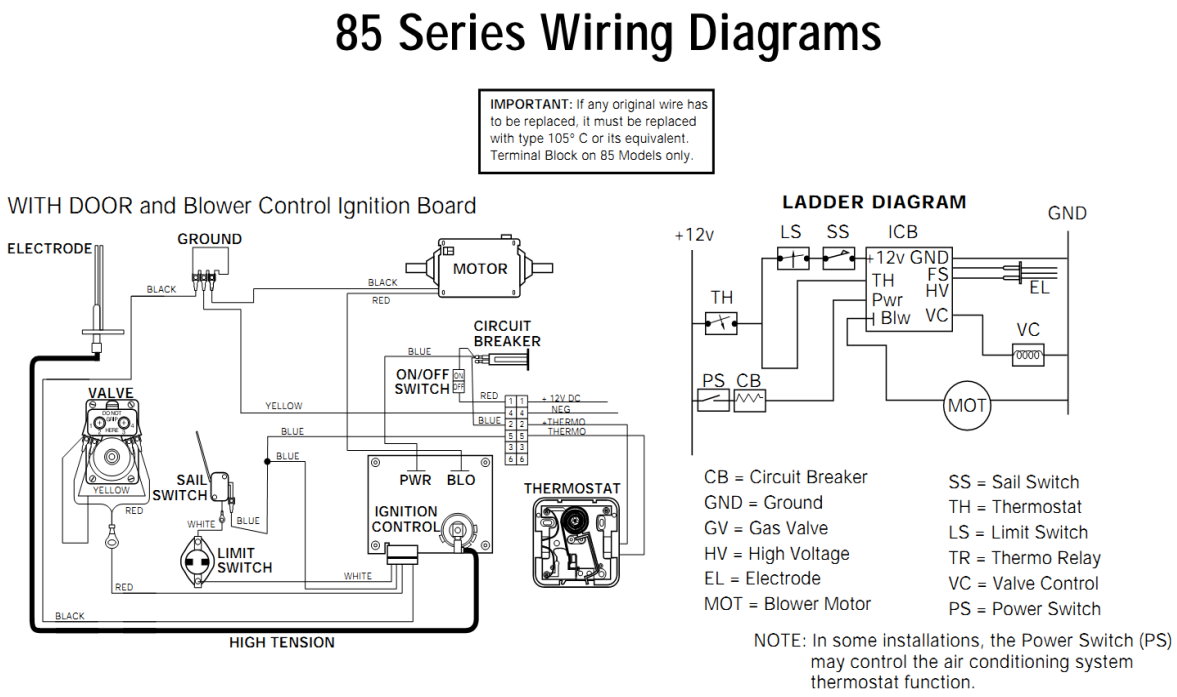

Figure (7) Typical Furnace

The previous discussions about propane appliances are directly applicable to an RV Furnace. With a furnace we are heating the air which must be circulated throughout the RV, usually by providing a duct type distribution system. This means we need a blower to distribute the heated air inside the RV and also a separate blower for the combustion system. The combustion blower draws outside air into the burner and exhausts burned gases from the chamber.

Figure (8) Blower Motor

This is accomplished by using one motor with a double shaft, Figure (8) and two different type squirrel cage blower blades, Figures (9) and (10), both having their own separate housings.

Figure (9) Combustion Blower

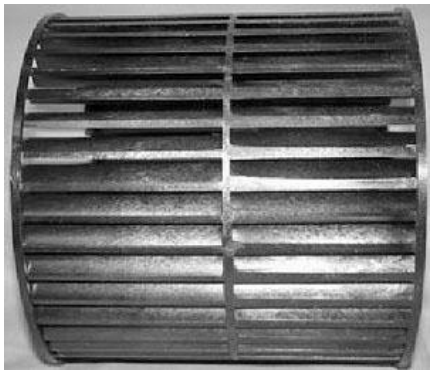

Figure (10) Circulation Blower

The combustion chamber is isolated from the RV interior and uses the smaller blower to draw air in and exhaust the burned gases. This chamber provides the heat for the air flow going through the interior duct system. A much larger squirrel cage blower is needed for the large volume of interior air flow required. Since hot air rises most furnace installations use ducting on the floor level for maximum heating efficiency. Conversely, cold air drops so for maximum efficiency air conditioners should be located on the ceiling and use ceiling duct systems. Since our RV's are poorly insulated compared to our homes maximizing efficiency should be a major concern for designers.

The 12 VDC enters the furnace through a circuit breaker which limits the maximum current draw. This can also serve as combination on/off switch. The power then goes to the wall mounted Thermostat which allows you to set the desired RV ambient temperature. This can be a simple analog device which uses a mercury switch. In newer RV's, the thermostat is usually a

digital unit which can be used to control all of the temperature appliances in the RV. This could include multiple air conditioners, heat pumps, furnaces, heat strips and fans.

When the temperature gets below the set point the contacts close and apply 12 volt power to both the circuit board and a heavy duty relay. The relay starts the air flow by applying power to the motor. Power is also applied to the circuit board, Figure (11), which controls timing, motor functions and gas ignition. A furnace requires some special timing since we are circulating air throughout the RV and coordinating the flow with the heat source.

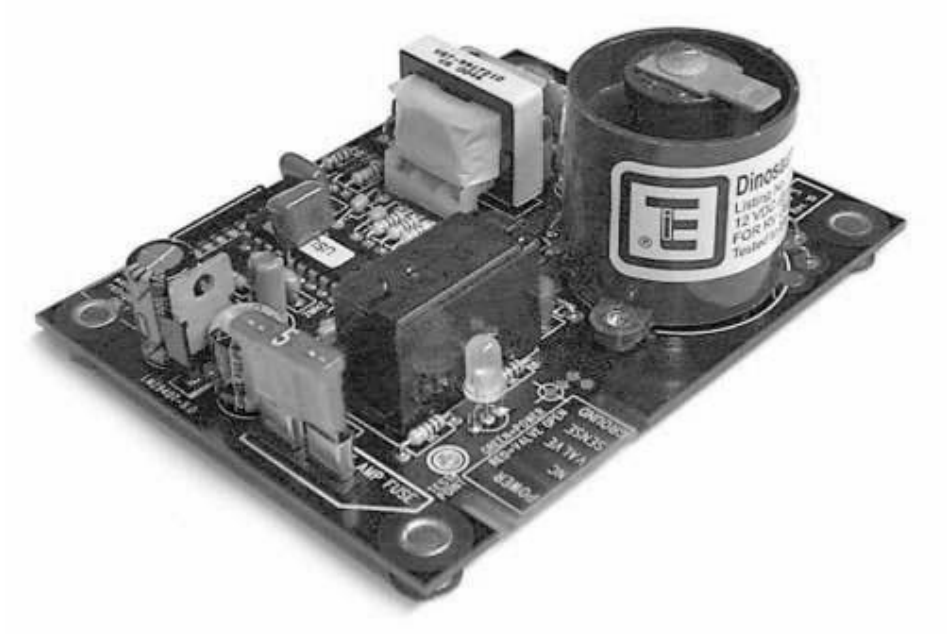

Figure (11) Furnace Circuit Board

The timing circuit keeps the blower running for about 15 seconds to purge the combustion and air chamber. A sail switch is included, Figure (12), which monitors the interior air flow to insure that the burner cannot be lit unless air is circulating through the heat ducts.

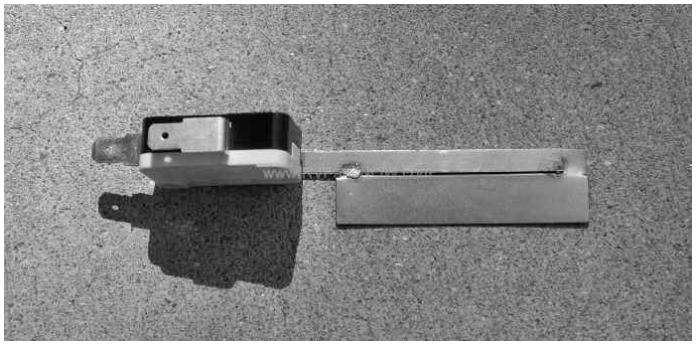

Figure (12) Furnace Sail Switch

With the sale switch closed power will be supplied to the gas valve, Figure (13). Similar to the water heater 'eco' a high temperature limit switch in series with the gas valve, Figure (14) and is normally in the closed position. If the furnace overheats this switch will open and cut off the propane supply be removing power from the gas valve solenoid.

Figure (13) Furnace Gas Valve

Figure (14) High Temperature Limit

Once the gas valve has opened the circuit board generates a high voltage which is used to automatically light the gas burner through a spark probe, Figure (15). There are two types of spark generators each with a thermocouple, much the same as the water heater. Again the thermocouple must be in the flame in order to generate the millivolt signal that tells the circuit board to keep the gas valve open and thus the burner operating.

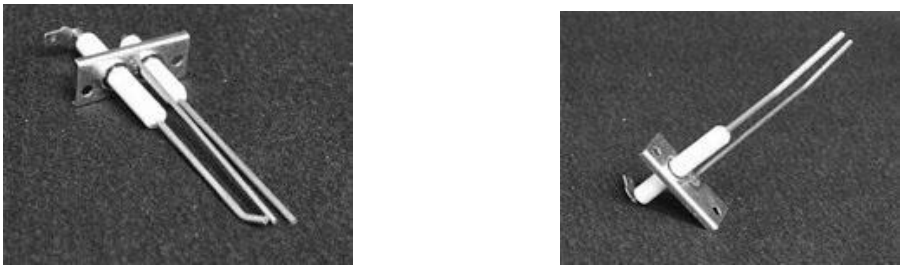

Figure (15) Furnace Spark Probes

If the thermocouple does not detect a burning flame within 6 or 7 seconds then the valve will automatically be turned off, effectively turning off the gas supply. After a 25 sec purge of gases and any leftover propane from the combustion chamber the system will try again to light the burner. The burner is similar to the water heaters and also uses a jet to shape the gas for optimum heating.

As long as the Thermostat is below the set point the blower will continue to operate. So even if the burner has been turned off the blower will still be operating. To start the system again you must turn off the thermostat manually and then restart the furnace.

When the thermostat senses that the set point has reached the proper temperature it will open the switch removing power from the ignition system and turning off the gas valve. The blower will

run for about 90 seconds clearing out the air and combustion chamber and then automatically shut down the system.

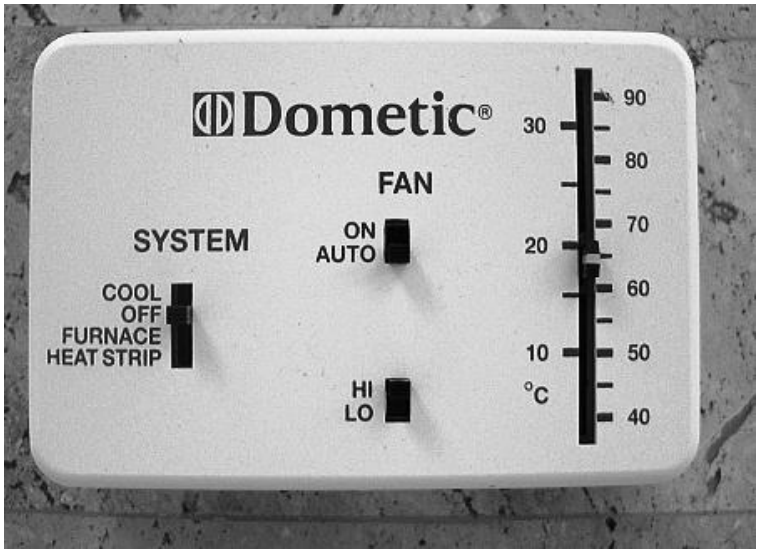

Figure (16) Analog Thermostat

Figure (16), illustrates a typical analog thermostat which is designed to control your furnace, air conditioner and if available a heat strip. These new combination thermostats are nice because they use one temperature monitoring system (with sensor and temperature setting) that serves the entire climate needs for the RV.

Older RV's have a simple thermostat which just handles only the furnace that is virtually identical to the older home units. These are inexpensive and available at any Hardware store. Older units have controls for the air conditioner and heat strip on the ceiling unit itself, with a manual temperature adjustment.

The most advance thermostats are the digital Climate Control Centers which provide control for all of the RV temperature related equipment. These can include multiple location sensors, air

conditioner, furnace, heat pump and heat strip. There can be four different zones with a different set of climate control equipment in each zone. This one CCC allows you to monitor and adjust different temperatures for each piece of equipment in the RV. Once it is set up correctly and you learn how to use it the CCC, illustrated in Figure (17) it provides the ultimate in RV comfort.

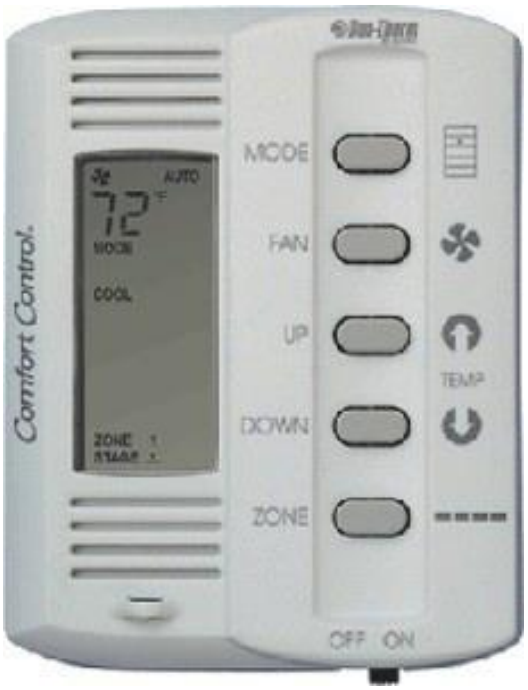

Figure (17) CCC Digital Thermostat

The wall unit is coupled to a control board installed in the front main air conditioner using a 4-wire telephone plug type cable. The control board has a set of dip switches which allows you to set-up each zone with its individual sensor and climate control equipment. You can have air conditioning in the front and heat in the rear at the same time.

The CCC converts its sensor inputs and desired equipment settings into a computer signal and feeds it into the control board computer. The control board converts the computer signals into analog voltages and operates a set of relays which are used to operate the physical equipment through contact closures. Essentially instead of you turning off the furnace when it is getting too hot you tell the CCC what temperature you want it uses its computer to tell the control board computer to turn the furnace off or on for you. Fortunately this complex system is pretty reliable and trouble free.

Troubleshooting

When troubleshooting for an electric problem, make sure the tank gas supply valve is turned off. When you cycle the furnace for testing it has built in time delays which will make sure you wait until any released propane or exhaust gases have been dissipated.

The furnace is much more reliable than the water heater because its electronics and major components are located inside the RV and not exposed to moisture and dirt. However, it is also much harder to get to the components for testing or replacement. This means for many tests you will have to remove it from the RV. For older RV's you remove the furnace from the inside. For newer models you usually remove it from the outside. In either case you must disconnect the gas line, electrical connections, several round ducts and remove mounting plates and sealing material on the outside furnace flanges. Once you have decided which area might be causing the problem thoroughly check those accessible components before you remove the entire unit. .

Nothing Works

1. Check the 12 volt source, circuit breaker, main input wire plug and particularly the ground lugs.

2. Check the heater circuit breaker and on/off switch. You can use several terminal lugs (which are accessible without removing the furnace) to see if 12 VDC is getting into the unit.

3. The motor relay has burned contacts or is burned out and is not feeding 12 volts to the motor. This prevents the motor from starting and with no air flow the sail switch will not turn on. Older units have a separate relay while newer furnaces have the relay as part of the circuit board.

Air is on but burner is off

1. Similar to the water heater the 12 volts must get to the gas valve so listen for the valve click about 15 seconds after the blower has turned on. The 12 volts must go through the thermostat, sail switch, temperature limit switch and finally the circuit board to get to the gas valve.

2. The thermostat should be checked next by setting it so that it calls for heat. Using the six pin plug, figure (7), the wires on pins 2 and 5 are from the thermostat. If you short these together the gas valve should click and you should hear arcing from the spark probes. **Of course only do this with the gas turned off.** You can also use an ohmmeter (should measure about 45 ohms) to see if the solenoid has continuity.

3. Check for 12 volts on the gas valve solenoid. If it is not present the sail switch is the next best candidate. You can usually get to this component and remove it for an easy ohmmeter test. Be sure to operate the sail during the test by pushing and holding it so the switch is in the on position.

Air and Gas Valve are OK

1. Similar to the water heater the board may be defective and not generating the high voltage or the spark probe wires may not be close enough together (1/8 inch).

Burner will not stay lit

1. Again check the position of the thermocouple in the flame or it may be defective.

2. If the thermocouple is good then you may have a defective circuit board.

Burner making loud noises

1. Air-gas mixture incorrect or burner chamber has foreign material in it and needs to be cleaned.

Defective Thermostat

If you have either a four or five button digital CCC and you have determined it might not be working correctly you are faced with a dilemma. Since it is essentially a computer and it is connected to another computer (control board mounted in the air conditioner) how do you know which end is bad? Or could the 4-pin telephone type connection between the computers be bad?

The first step is to remove the thermostat from the wall and unplug the cable. This is a special cable and not a standard phone cable. Remove the air conditioner cover and unplug the CCC cable. Do an ohmmeter test to determine if any of the wires are broken or shorted. Especially check for shorts to ground. If you find a problem you can make a new cable, just make sure the wire color sequence is configured as shown in Figure (18). You can also build a test cable to make sure the built in wires are not shorted or broken. Home Depot has a phone cable kit for about $11 which has RJ11 plugs, the proper crimping tool and a good set of instructions.

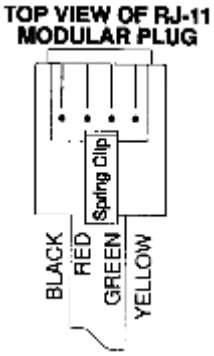

Figure (18) CCC Cable

If the cable is OK the best option you have is to connect a new CCC to the built in cable and if the problem is still there the control board is defective. Other than finding a dealer or repair shop with Dometic board testers (I have never found any repair shop with this equipment) I know of no other way to determine which component is bad.

If your furnace does not work and you or your service shop has determined that the problem is in the control board. It is most likely the control board furnace relay. This requires replacement of the complete board which is quite expensive. If everything else on your control board works than you can just purchase an inexpensive house thermostat (less than $20), install it somewhere near the CCC and run two new wires from the furnace.

Maintenance

The principle maintenance for the furnace is to keep the burner area and the jet clean and remove any nests. At least once a year check all of the wire connections and grounds. Also check the flange seals on the outside of the RV to make sure they are properly caulked. Periodically turn on the furnace during the summer months to make sure it is working. Most campers do not use the furnace very often but when it's really needed you don't want any surprises.

REFRIGERATOR

Operation

Home refrigerators (fridge) use motor driven compressors to circulate Freon (R134a) to remove heat from the food compartment using what is called a vapor compression cycle. This is essentially the same type of system used in your automobiles where the compressor is belt driven from your engine. The compressor is large, heavy and requires 110 VAC to operate.

An RV fridge (absorption type) uses a source of heat and a closed ammonia based system to cool the food box rather than a mechanical compressor. Figure (19) shows the rather complex cooling system that serves to remove heat from the food box and extract it from the fridge food area.

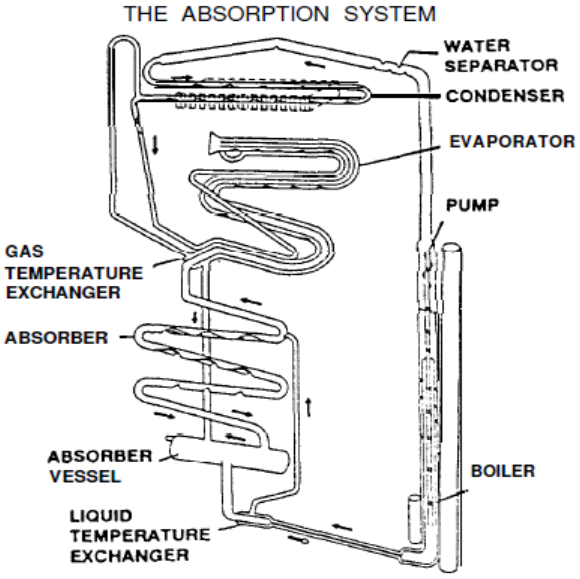

Figure (19) Cooling Unit

After about an hour of operation, the temperature at the absorber should be about the same as at the boiler regardless of the ambient temperature. This is a good indicator that the fridge is operating properly. Since this is a completely closed system if you ever smell ammonia your cooling unit has sprung a leak (usually from rust) and must be either repaired or replaced.

There are three heating systems available for an RV fridge; propane gas, 120 volts AC and 12 volts DC. All fridges, as a minimum, have a two way system which consists of propane and 120 VAC. Units that include a 12 volt DC mode are useful when the RV tow vehicle or Motor Home engine is operating. The battery drain in the 12 VDC operating mode is about 25 amps so it is really only useful when the engine is operating.

The basic fridge propane system is just like the water heater system with similar components and potential problem areas. Figure (20) illustrates the various components that make up a two way fridge. Major components are labeled with Letters and wire colors are labeled with the actual color or with numbers. There are two circuit boards; (D) the main power board and (C) the display and control board.

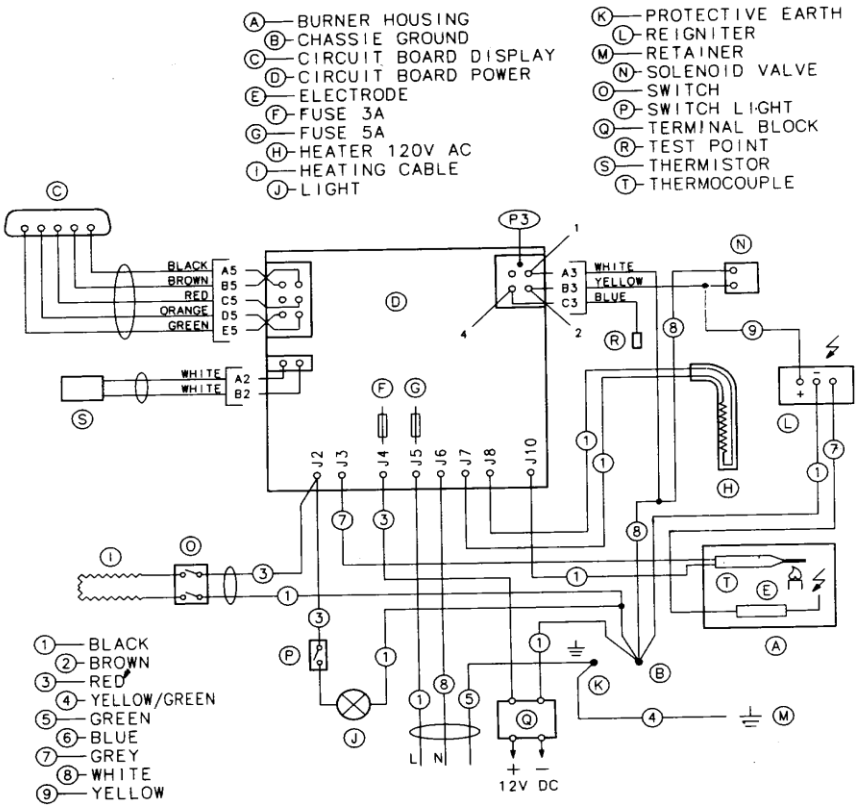

Figure (20) Two Way Refrigerator

Figure (21) illustrates the display/control panels for both two and three way fridges. The first button all the way to the left turns the fridge on. The next button selects auto, ac or gas operation. You use the same button for each of the modes by just pressing it multiple times till the proper light indicating the desired mode goes on. In auto the system automatically selects the heat source depending on what is available. AC is given priority when 120 VAC is present otherwise gas is selected. You can force the fridge to gas operation when both heat sources are present, if there is only limited AC available (just push the #2 button till the gas light goes on). For the three way fridge there are three buttons with #2 able to select DC only. When the DC only is turned off then the #3 button can be used just like a two way fridge.

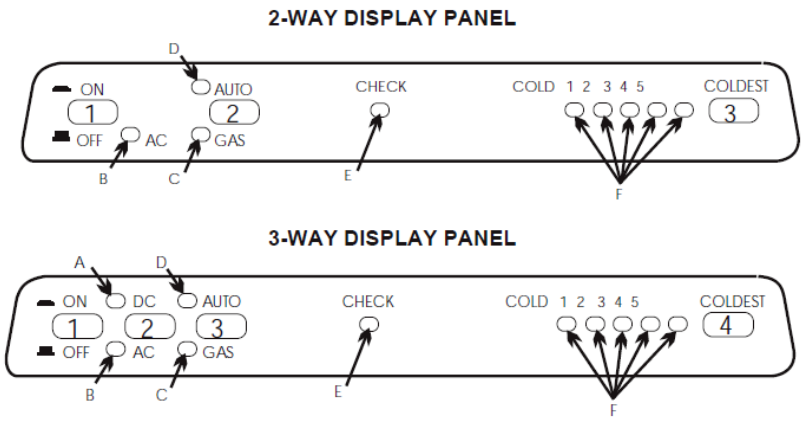

Figure (21) Display/Control Panel

The check light will go on if the gas system stops functioning, the 12.6 VDC for the circuit board gets too low or the circuit board fails. In order to re-start the system you must turn off the fridge for 45 seconds and allow everything to reset.

Note: All letters refer to components labeled on Figure (20).

For refrigerator operation both circuit boards require 12.6 VDC to operate in any mode. This is fed from the terminal block (Q) to the circuit board via the 3amp fuse (F). In the AC operation mode the heating element (H) is fed via the 5 amp fuse (G) from the circuit board. For 12 VDC a separate 12 VDC heating element is fed through a 35 amp fuse. The fuse locations are illustrated in Figure (22). For some models these have been moved to other positions on the power circuit board.

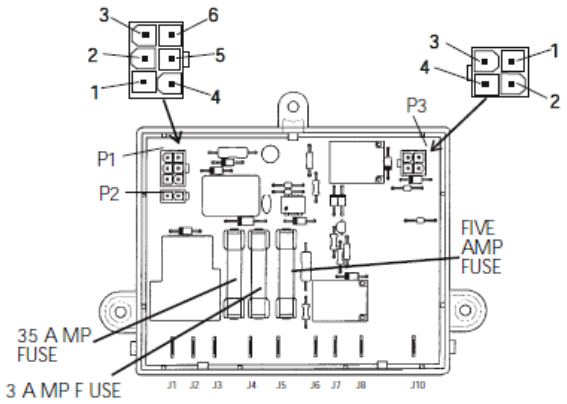

Figure (22) Fuse Location

In AC mode the 120 VAC element, (H) is mounted in the lower section of the boiler with two screws. In this mode the power circuit board connects the element to the AC voltage input cable, through the 5 amp fuse, to apply heat to the cooling system. In all modes the thermistor, (S), monitors the fridge temperature and based upon the temperature button setting turns off the AC heater as well as the gas valve. When the temperature goes above the set point it turns on the heater or gas valve to start the cooling unit again.

In gas mode, similar to the water heater, DC voltage is applied to the gas valve solenoid (N) and the re-igniter (L), Figure (23), at the same time. The gas flows to the burner (A) and the re-igniter sends a high voltage to the spark probe (E) which lights the propane gas. Once the gas is burning the thermocouple (T) sends a signal to the circuit board (D) indicating everything is working correctly. If the burner flame goes out then the signal from the thermocouple goes away and the circuit board turns off the gas solenoid. After about 45 seconds the cycle maybe repeated and the gas burner re-started. Figure (24) illustrates the burner and thermocouple placement in the gas assembly. The orifice is also called the jet which serves to shape the gas flow to the burner.

Figure (23) Igniter

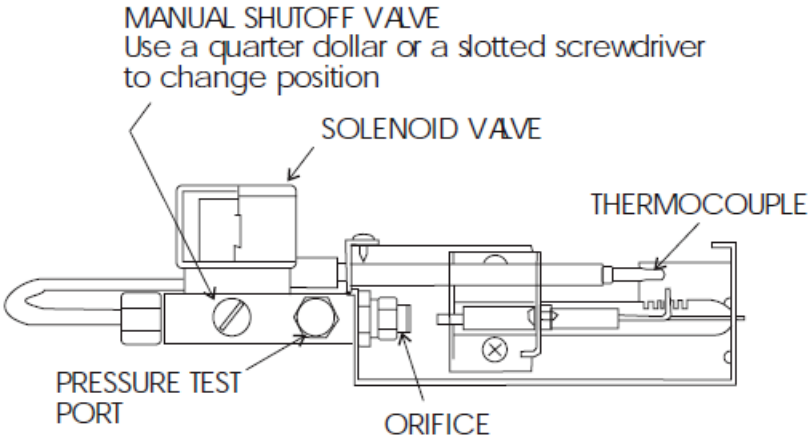

Figure (24) Burner Thermocouple

The spark probe wire must be adjusted (3/16 inch from the burner tube) as shown in Figure (25) in order to ignite the gas. The thermocouple must be in the blue flame in order to send the millivolt signal to the circuit board that indicates the flame is on.

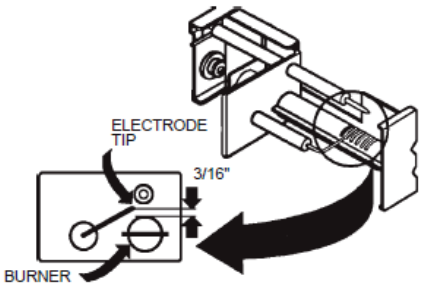

Figure (25) Spark Probe Adjustment

Figure (26) illustrates the placement of the major fridge components. In order to gain access to the burner, thermocouple or jet you must remove the sheet metal cover over the assembly. The power circuit board is protected with a Bakelite cover which must be removed to gain access to the fuses. Both the 12 VDC and the 120 VAC wall plug are easily accessible for testing the source voltages.

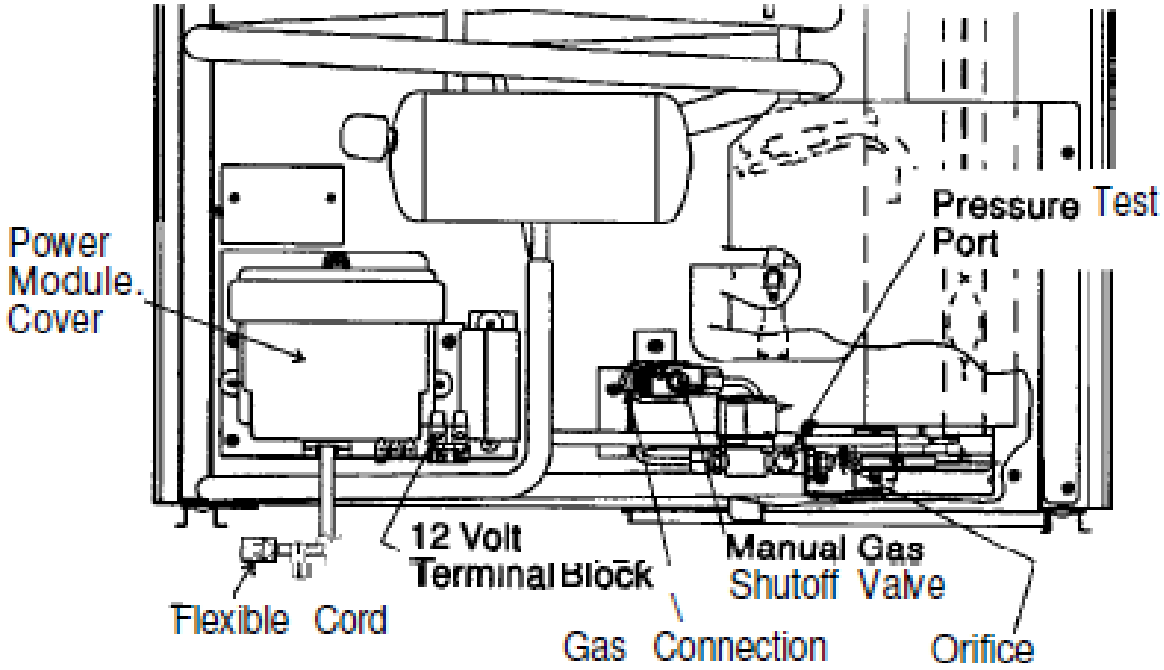

Figure (26) Major Component location

Absorption refrigerators are considerably less efficient than our normal home type units. You should pre-cool the box to its operating temperature (at least a day) before your start putting food in. You should pre-cool the food and beverages before you put them in the fridge and let any hot foods cool to room temperature. Buy cold beverages whenever possible. Don't leave the door open for an extended time while searching for an item. Particularly in hot weather, if you have a significant drop in the box temperature it can take hours to recover

Troubleshooting

When troubleshooting for an electric problem, make sure the tank gas supply valve is turned off. When you cycle the fridge for testing it has built in time delays which will make sure you wait until any released propane has been dissipated.

Before you start your trouble shooting, obtain a set of at least two each of the needed fuses (two or three way unit). You need two because if the first replacement blows again you will need the second fuse after you find out what is shorting out

Nothing works

1. If you have no lights at all check for 12.6 volts at the terminal block in the rear of the fridge. Again you may have a problem with your circuit breaker or batteries not providing sufficient DC voltage for operating the power board or you may have a bad connection.

2. If the voltage is at the terminal block check the 3 ampere board fuse located at (F). You should remove the fuse to check it with an ohmmeter.

3. You may have loose or dirty connectors which attach to the circuit board. Remove and clean each connector with radio circuit spray.

4. If none of the above works you probably have a bad board.

Refrigerator is not working in Gas Mode

1. Go through the same sequence of checks that was used for the water heater. Listen for gas valve operation (click), listen for spark probe arcing, check for 12 volts on the gas solenoid valve, check gas pressure etc.

2. If there is no spark voltage check to make sure the igniter is getting 12 volts on its input terminals. If it is, unplug the high voltage lead and see if it will arc to the chassis. You could have a bad lead or a defective igniter.

3. Check the jet to be sure the opening is clean. I have found that a clogged jet IS THE MOST COMMON PROBLEM with the gas refrigerator mode. On one WBCCI Caravan I fixed 10 refrigerators by simply cleaning the jets. This is a 10 mm unit and the opening is so small you cannot use a toothpick to clean it. If you have alcohol use it to soak the jet until it is clean. In a pinch I have used vinegar which works OK except you have to soak it for at least two hours.

Burner lights but flame goes out

1. Check the jet for cleanliness (as above).

2. Check thermocouple to make sure it is in the nice blue flame. Test the thermocouple by removing its connector and measuring the output voltage (should be 15 to 35 millivolts).

3. Check the gas pressure as described in the water heater section.

Fridge not cooling adequately

1. Thoroughly clean the jet (as above). Use the correct 10 mm wrench so you do not damage it.

2. Check the seals on the fridge doors. Close a piece of copy paper in the door seals and try to pull it out. It should have significant resistance.

3. Check the thermistor by removing it from the fridge, hooking up an ohmmeter, put it in a glass of ice water and measure the resistance (should be between 7000 to 10000 ohms).

4. Make sure the 'O' ring seals used on the thermocouple are installed and in good shape.

Fridge not cold freezer OK

1. On units with fins check the location of the thermistor on the fridge internal fins at the rear top of the main food box. The vertical position of this thermistor allows the temperature of the box to be changed. Just move this up to decrease the box temperature (make the fridge colder) and conversely if the food is too cold, move it down. Do this in small increments with a thermometer in the box. This actually allows you to balance the freezer/food compartment temperatures.

Fridge works on gas but not electric

1. Check for presence of 120 VAC at the electric wall outlet in the external compartment.

2. In electric mode carefully check for heat on the flue. If it is cold unplug the 120VAC line to the wall plug remove the power circuit board cover and check the 5 amp fuse. If it is good remove the heating element plug from the board and test it with an ohmmeter (it should measure about 45 ohms). The heating element is located in the flue.

3. If you have a three way fridge and the 120 VAC works but not the 12 VDC mode then it is either the 35 amp fuse or the 12 volte heating element. Go through the same steps as above (it should measure 0.67 ohms) for the 12 volt heating element which is also located in the flue.

Works OK but on hot days not so good

You have got to get the heat out of the cooling unit cabinet. On extremely hot days you need some additional air flow from the outside cover to the roof mounted exhaust vent. I have used an auxiliary fan mounted in the cabinet as high as you can get (as close as possible to the roof vent). You need a quiet sealed motor fan that can take the moisture and dirt. Put a switch, which lights in the on position, inside on the wall near the fridge to control the fan. When the ambient

temperature gets to 90 degrees and above just switch it on. This will help an older unit that has lost some of its initial cooling ability.

MAINTENANCE

At least once per year clean the outside compartment (by hand not with a water hose). You do not want to get any water near the circuit boards. Moisture on a board will collect dirt and eventually cause a short circuit and a burned out board. Remove the burner shield and clean the burner housing and the jet. Remove the jet using a 10 mm wrench and soak it in cleaner fluid. For a quick repair you can spray the jet opening with the Radio Contact Cleaner. You can clean the burner with a small wire brush, compressed air and some alcohol. Before you clean the compartment tap the flue gently and get all of the dirt and deposits out. A special long handled brush is available if it is particularly dirty. Don't forget to clean the cooling unit and fins. Remove the circuit board cover and use a low pressure air spray followed by the Radio Cleaner Spray. Remove each connector spray with cleaner and tighten each wire connection.

REFERENCES

Find the instruction, installation and troubleshooting manuals for your model. There are significant differences in the circuits and parts in the different models even from the same manufacturer. Your units' components may be located and look different than the examples illustrated above. There may be additional circuits and more protective devices in newer equipment. Get the correct manuals and spend some time reading them. Often there are excellent descriptions of how it works and the sequence of events that occurs when you turn them on. The more you learn the easier it will be for you to handle some of the simpler repairs. The rewards are obvious and soon you will be helping your neighbor fix his Propane Appliances.

1. http://bryantrv.com/owners.html

2. http://dometic.com/enus/Americas/USA/Customer-Support/Operation--Installation-Manuals/