# Troubleshooting and Repair of Your Propane Equipment Refrigerator

## 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.

# 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.

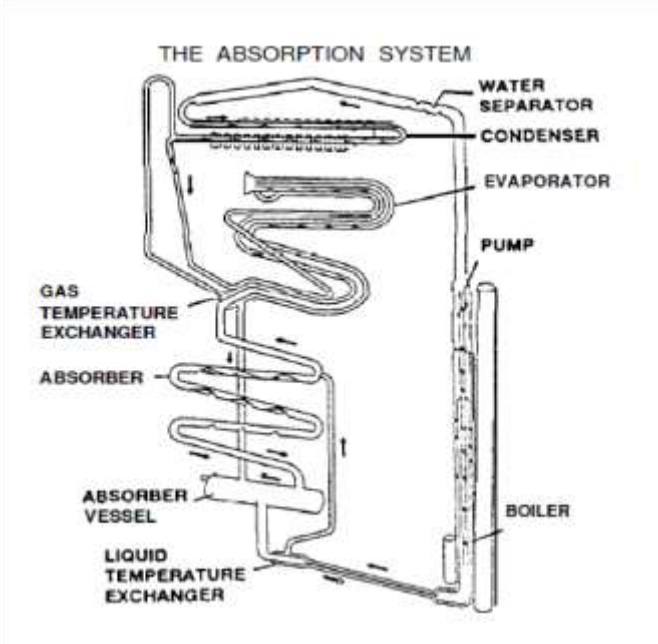


**Figure (19) Cooling Unit**

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.

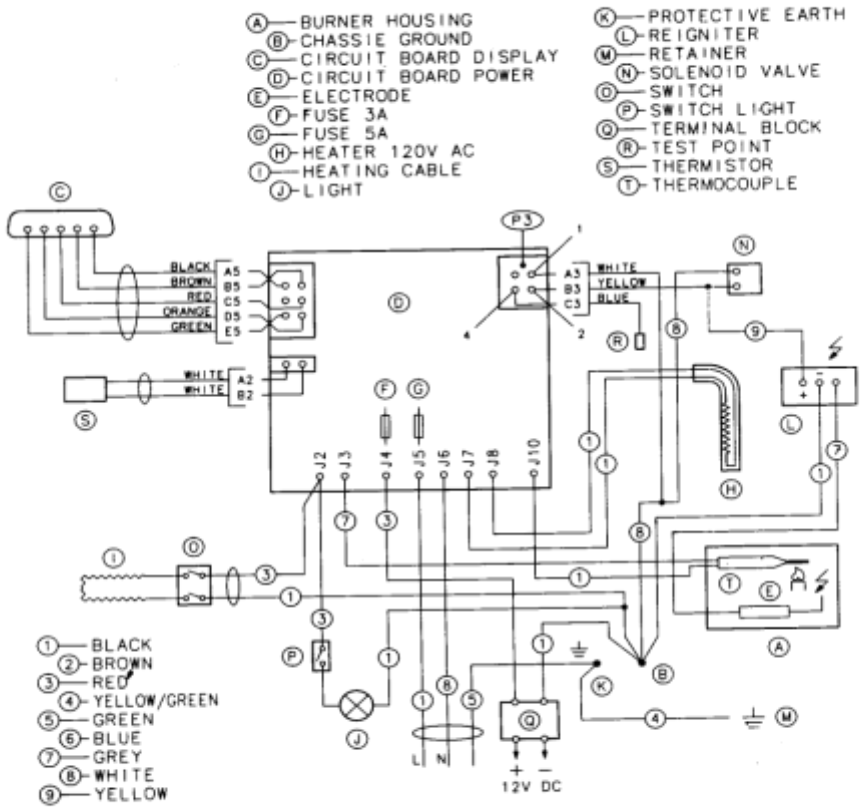


**Figure (20) Two Way Refrigerator**

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.

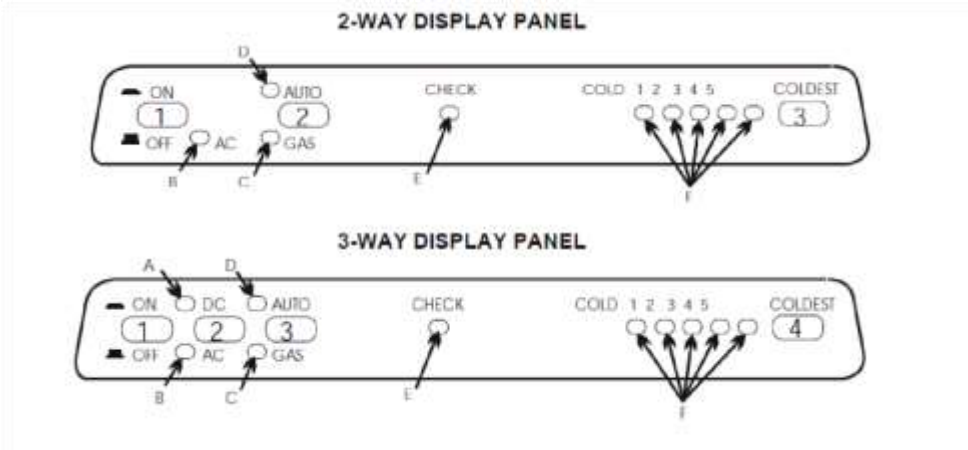


**Figure (21) Display/Control Panel**

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.

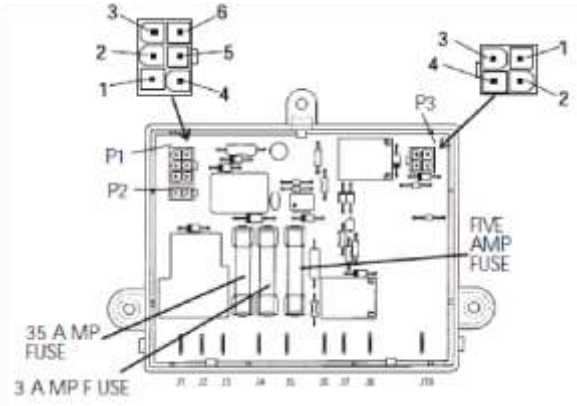


**Figure (22) Fuse Location**

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 reigniter 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**

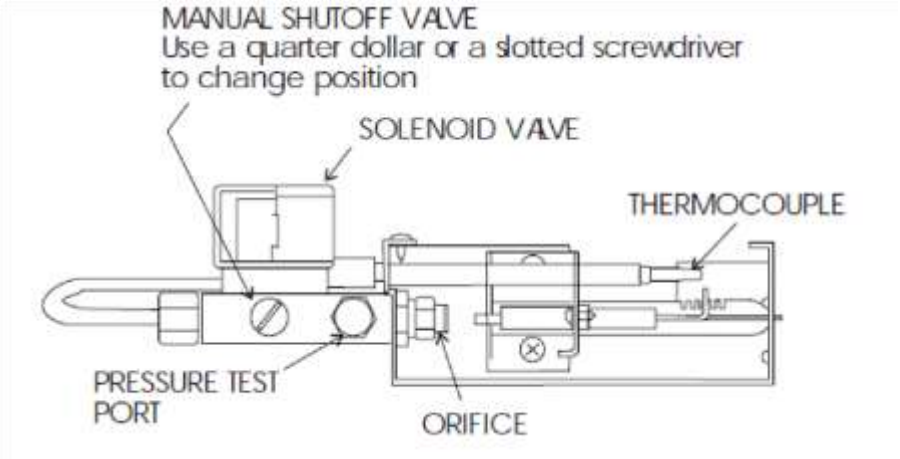


**Figure (24) Burner Thermocouple**

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.

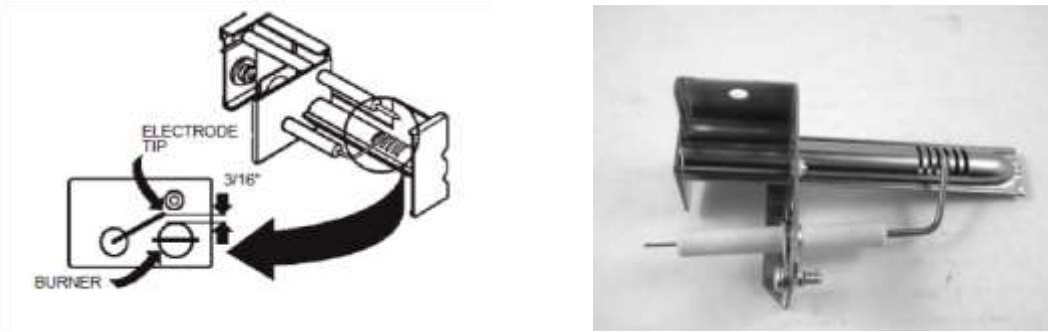


**Figure (25) Spark Probe Adjustment**

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.

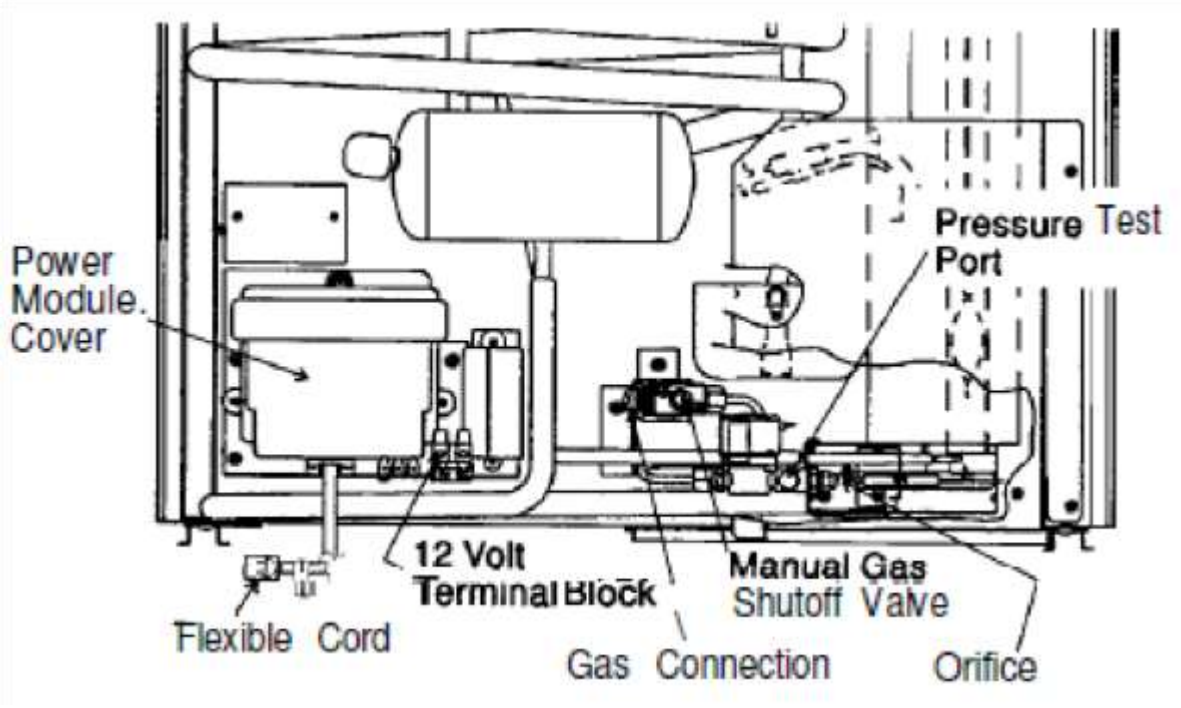


**Figure (26) Major Component location**

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/