Airstream Tech Help Group

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This group, part of the WBCCI Technical Standing Committee, has been established to help the membership with any of their technical RV problems. Examples of questions that might be of interest to many members will be published in the Blue Beret. We will respond directly to you, in response to your email or letter describing a problem you are having. We hope you will find this new service of value in the care and feeding of your RV. You may contact us as follows: techhelp@wbcci.org or by mail: Howard Lefkowitz, 11508 Colt Terrace, Silver Spring, MD 20902

THE CARE AND FEEDING OF YOUR RV III

Furnace Operation

by Howard Lefkowitz

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

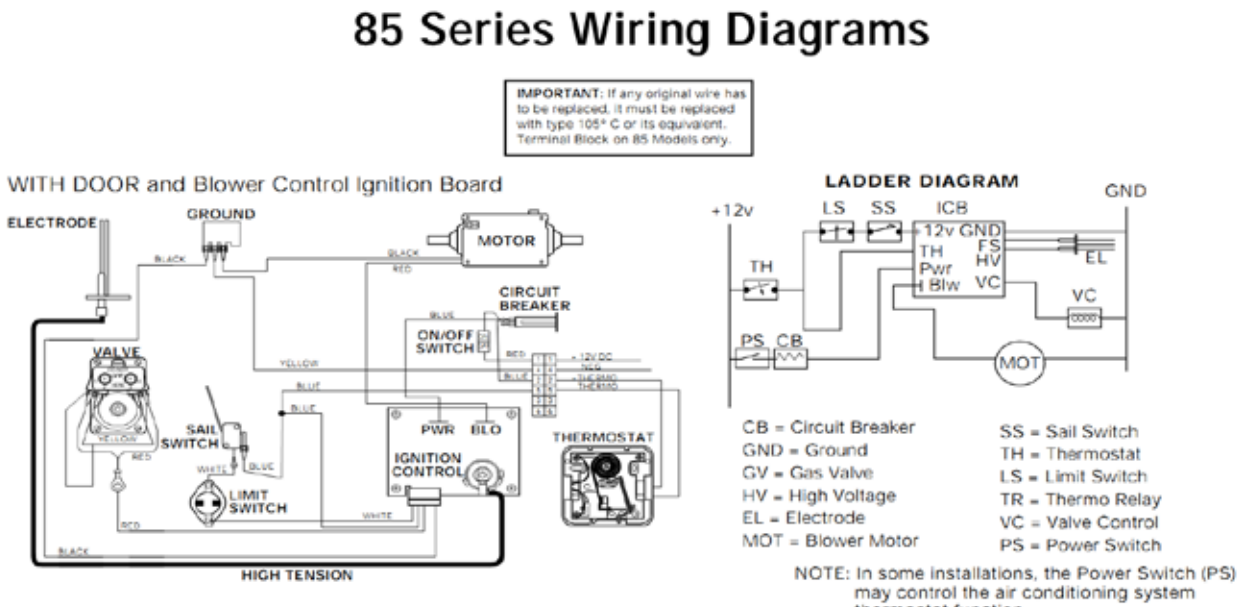

Figure (7) Typical Furnace

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.

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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

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.

Figure (10) Circulation Blower

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.

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 sail 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 by 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

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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), 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

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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.

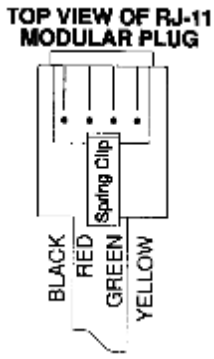

Figure (18) CCC Cable

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, then 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.