

RV FURNACE TROUBLESHOOTING

You've had a fun day but now it's getting chilly, so you decide to fire up the RV furnace. You flip the thermostat on, set the temperature and wait expectantly, but no heat comes from the outlets. It's Saturday night and you are camped far from civilization in that secluded spot by the lake. You tell the kids to put their sweaters on, but it's going to be really cold later tonight. What are you going to do to get the furnace running?

This brief will attempt to provide you with some basic furnace troubleshooting advice. We will go over symptoms and their causes, but first you need to understand a little about how an RV furnace operates and know of few basic terms.

FURNACE OPERATION OVERVIEW

This is generic description of RV furnace operation and applies to most DSI type furnaces.

1. The Thermostat calls for heat, sending DC current to the furnace.
2. A Time Delay Relay is energized and passes battery DC power to the blower motor.
3. The blower motor and fans spin, pulling air from the Air Return and generating a stream of air through the Heat Exchanger and out the Ducts. At the same time another fan pulls air from the Combustion Air Intake into the Combustion Chamber and out the Exhaust.
4. The fan air stream causes the Sail switch to close as the blower gets near full speed.
5. Power flows to the High Limit Switch and onward to the Control Circuit Board.
6. The Control Circuit Board opens the gas valve and generates a spark at the DSI Igniter.
7. The Burner ignites, building heat in the Combustion Chamber.
8. Heat passes through the Heat Exchanger, warming the air circulating through the Ducts.
9. The Thermostat reaches the Set Temperature and opens.
10. Power is removed from the Control Board and the Burner shuts down.
11. The fan continues to run to cool the furnace, until the Time Delay Relay opens again.

For a **Pilot Light** model of furnace, the operation is similar but ignition does not depend on a control board to trigger an igniter. Once the pilot is lit (manually), it stays lit and is the ignition source. The furnace cycles on/off by control of the gas flow alone, with the gas valve opening or closing in response to the thermostat demand.

An RV furnace runs strictly on **12 volt power** (12 VDC) and does not depend on shore power or generator to operate. As long as the RV's batteries have sufficient voltage and amps, and there is a supply of propane to produce heat, the furnace will function.

TERMINOLOGY

Air Return – an opening in the RV interior that allows inside air to enter the Blower Motor and be recirculated out the Ducts. This air is not used to burn the propane in the combustion chamber – there is a separate air source for that (see Combustion Air Intake).

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Blower Motor – A 12VDC motor driving a pair of “squirrel cage” fans that circulate air through the furnace. One fan brings RV interior air in via the Air Return and through the Heat Exchanger and out the Ducts while the other brings outside air into the combustion chamber and out the exhaust.

Circuit Breaker & On/Off Switch

Newer furnaces have an On/Off switch and a Circuit Breaker [CB] in the power feed to the Blower Motor. The switch is for manual control, especially while serving the motor or burner. The Circuit Breaker limits the power to the motor. If the CB has opened, it can be reset but the conditions that caused it to open must be repaired for a lasting fix.

Combustion Air Intake – A fan with an air inlet on the exterior of the RV that provides air to the Combustion Chamber. This air is used when the propane burns.

Combustion Chamber – The metal box where propane and air are burned.

DSI – is an acronym for Direct Spark Ignition. It refers to the use of an electronic *Igniter* to fire the propane instead of a pilot light.

Ducts – round or rectangular tubes that carry heated air from the furnace to the RV interior.

Exhaust – An air outlet on the exterior of the RV that vents exhaust gases, including carbon monoxide and carbon dioxide, from the Combustion Chamber. Exhaust gas contains carbon monoxide and carbon dioxide and must never be allowed to enter the interior of the RV. Injury or death can result if it does!

Fan Speed Controller – On models with two or more fan speeds, this small circuit board sets the motor speed and thus governs the speed of both fans. This also affects the BTU (heat) output delivered by the furnace – lower fan speed means lower BTUs and so the *Gas Valve* opening is also reduced.

Heat Exchanger – A metal box that uses heat conducted from the Combustion Chamber to warm the circulating air.

Gas Valve – an electrically operated valve which opens to allow propane to flow into the burner chamber. It is controlled by the *Control Circuit Board*.

High Limit Switch – a normally closed switch that opens if it gets too hot. Its purpose is to monitor temperatures in the Heat Exchanger and to prevent overheating that could burn a hole in the metal. Opening this switch turns off power to the gas valve and the Controller Board, shutting down the furnace. A hole in the Heat Exchanger would allow deadly poisonous gases to enter the RV interior, so this is a crucial safety device.

Igniter – An electrical device that generates a spark to ignite the propane. In DSI furnaces, the igniter serves in place of a Pilot Light. In newer furnaces, the igniter also serves as a flame sensor, providing feedback to the *Ignition Control Board* to verify that ignition was successful.

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Ignition Control Circuit Board – A printed circuit board that initiates gas valve opening and triggers the Igniter. In some furnaces the Igniter sequence may last several seconds and make multiple attempts to light the flame. You may hear a tick-tick-tick sound as the Igniter is cycled repeatedly. Other boards will make three attempts at approximately 60 second intervals. In older models there is only one attempt to light and the thermostat must be cycled off for several seconds and back on again to initiate another ignition cycle. In newer furnaces there is a feedback signal from the igniter to confirm that ignition was successful and a flame is present. If there is no positive ignition feedback within 6-10 seconds, the gas supply will be shut off and the furnace is “locked out”. In some furnaces there are two circuit boards – one for ignition and one for speed control of the blower motor



Lock-out

The *Control (Ignition) Circuit Board* is shut down because an unsafe operating condition has been detected.

Pilot Light – A tiny propane flame that remains continually on (burning) and lights a larger charge of propane when the main gas valve opens. It is initially lit manually and can remain on as long as the furnace is expected to be needed. Not used in a DSI furnace.

Sail Switch - a switch with a paddle arm that extends into the blower air stream. It closes when the blower reaches its rated speed (or nearly so) and allows power to pass to the ignition circuit. This is a safety device to assure there is adequate air circulation in the furnace.



Thermostat – a device that senses temperature in the RV interior and sends a signal to the furnace when the temperature drops below the “set temperature”, i.e. the temperature you wish to maintain. This signal is termed “calling for heat or “demanding heat”. When the thermostat is not calling for heat, it is said to be “satisfied”.

Time Delay Relay – A relay (switch) that generates a slight time delay before the furnace start cycle proceeds. It has an internal heater that warms up as the current from the thermostat passes through it and the relay closes when it gets hot enough.



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A delay of about 10-20 seconds is typical. When the relay closes, 12V power from the battery is passed to the blower motor and the fans start to run.

TIPS and TECHNIQUES

Tools Needed

It is difficult to do much troubleshooting on a furnace without a voltmeter and the basic know-how to use it. Most tests are voltage measurements to see if adequate power is reaching various components of the system. If you buy an inexpensive Volt-Ohm Meter (VOM), it will usually have brief instructions with it. You don't need a fancy one – the measurements used do not require a lot of accuracy.

Diagnostic Light & Codes

Newer Atwood furnaces may have a small red light on the Ignition Control Circuit Board. The light will flash a code (typically 1-5 flashes) to indicate error conditions such as High Limit Switch open. There should be a code chart on the motor housing for that model of furnace.

Blower Motor and Fans

The **fans** are behind the outside access cover. The motor has a shaft running through the center of it with one shaft (usually the left side) driving the main furnace air circulation fan and the other driving the combustion air fan. There are two blowers (fans) but only one motor. Typically there is a casing surrounding the motor and the air circulation fan and the *Sail Switch* may also be inside that casing.

The motor is powered by the RV's 12v system and is affected by low voltage. When the battery charging system is operational (shore power or generator on) the DC voltage usually remains sufficient (12.0 – 13.8VDC), but when relying on battery power alone the voltage drops and may get quite low overnight. The motor will continue to run at lower voltages (down to around 10.5 VDC) but fan speeds may be insufficient to activate the sail switch or provide adequate combustion air to the burner. Corrosion on the wiring or furnace power terminals may also cause reduced voltage at the blower motor. Check the voltage at the motor itself as well as at the batteries or your RV's monitoring panel.

Combustion Air Intake & Exhaust

The external Combustion Air Intake & Exhaust is through the external furnace cover panel and may be either two ports or a mesh intake grill surrounding a single exhaust port (illustrated). Bugs such as spiders and mud dauber wasps and even mice may nest inside and block air flow, so check for blockages.

Some furnaces do not run well with the cover removed, so it may be necessary to replace the outside cover for testing.



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Air Return and Ducts

Return air vents should be kept free of dust and lint and should not be obstructed. Vacuum the intake area and screen (and filter, if provided) to keep good air flow through the heat exchanger and to keep dust and dirt from building up around the fans, sail switch, limit switch, exchanger and ducts. Dirt in these places can cause switch malfunctions and internal heat build-up. Crimps in ducts can also reduce air flow into the room or cause the *high limit switch* to activate.

Lock-out & Reset

Newer furnaces may go into “lock-out” if a potential safety problem is detected. Lock-out simply means that the Control and/or ignition circuits shut down and do not allow furnace operation. Lock-out can be reset by turning the thermostat switch off and changing the Set Temperature to a low enough value so there is no demand for heat and waiting 10-15 seconds. Then turn the thermostat on and set the temperature to the desired level and the furnace should attempt to start again.

Propane Gas Pressure

All propane appliances are designed to operate from a propane (LPG) supply that is at a standard pressure of 11 *water column inches* of pressure (about 3 psi). This is measured with a tool called a manometer. The LP tank pressure is much higher than 11” WC, so the pressure in the system is controlled by an LP regulator at or near the main supply tank. Either high or low pressure can cause the burner to fail to light or work improperly. Oily residue in the tank can clog the regulator, causing it to deliver gas at an incorrect pressure or sporadically. And of course an empty tank has little or no pressure. An LP regulator is not expensive, so if you suspect a problem with the gas supply, replacing the regulator is usually more cost effective than hiring a professional to test it. LP regulators are standard parts, available at any LP gas dealer and many hardware and home stores. You do not need an RV specific part, but do not use a regulator intended for natural gas.

SYMPTOMS AND CAUSES

Find your symptom below and see what the likely causes may be.

Thermostat On but Furnace Fan Does Not Come On

This may be caused by:

1. No voltage from thermostat to furnace (bad wire or no power to thermostat)
2. Bad Time Delay Relay
3. No 12v power from the battery to the furnace Time Delay Relay

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4. Motor circuit breaker is open or manual switch is Off
5. Loose wire
6. Bad blower motor

Low battery voltage can cause excessive current through the motor and trip the circuit breaker and so can excessive load on the motor, e.g. dirt in the fan housing. A defective motor can also cause a breaker to trip.

Fan Runs but No Heat from Ducts

This is a classic condition with several possible causes, most of which should be obvious after reading the Operational Overview.

1. The *Sail Switch* is not closing, so no power to the rest of the furnace. This may be because of a defective switch or because the fan is turning too slowly to push the sail enough to fully close the switch. A slow motor may result from low voltage at the motor (check voltage at batteries and at the fan) or a motor that is simply not turning well due to dirt or corrosion. A blockage of the Return Air Intake can also cause a lack of air flow against the Sail.
2. The *High Limit Switch* has failed and is not closed, so no power reaches the *Controller Circuit Board* and hence no ignition. Check for 12+ volts leaving the switch and/or at the terminal on the controller.
3. The *Control Circuit Board* is failing and either does not open the *Gas valve* or does not trigger the *Igniter*. Check for 12V to the gas valve during the opening cycle.
4. The *Gas Valve* fails to open, so no propane in the burner. Could be a bad valve or simply no 12v power is reaching the valve (check voltage).
5. The Gas Valve is open but no propane flows. Possible causes include no propane or low propane pressure (less than 11 water column inches). Low or no propane can be caused by a clogged line or main propane regulator. Check other propane appliances for proper operation.
6. The *Igniter* fails to spark (or in a non-DSI furnace, the *Pilot Light* is not on). Could be a defective Igniter or no 12v power is reaching it. It is also possible the gap at the ends of the Igniter electrodes is too great (or that they are shorted together).
7. Igniter does not confirm that ignition was successful (no flame is sensed), so the *Control/Ignition board* has shut down (*lock-out*)
8. Propane and spark are present but the burner doesn't light. This can occur if the Combustion Air Intake is clogged and there is insufficient air flow through the combustion chamber.
9. Loose or corroded connections in any of the above components

Furnace Runs for One Cycle but Won't Restart

The typical cause is a blockage in the Combustion Air Intake or Exhaust, resulting in a lack of air into or out of the combustion chamber. Look for spider webs, dauber nests, debris in the air inlet and exhaust. It may also be caused by an inadequate gas supply, e.g. low gas pressure or a partially open *Gas Valve*. See *Propane Gas Pressure*.

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Short Cycling - Furnace Starts and Stops at Short Intervals

This is usually caused by warmed air from the Ducts blowing out onto the thermostat, causing it to be satisfied, but as soon as the warm air stops flowing the thermostat cools and calls for heat again. If the Duct outlets are adjustable, try aiming them away from the thermostat or closing the nearest outlet. A cold draft on the thermostat can have the same effect – look for a cold air current leaking in from somewhere. Sometimes an over-sensitive thermostat will also do this and replacing it will cure the problem.

Fans Run and Heat is Produced but Burner Goes Off and On

This is called “cycling on the limit switch” and results from overheating in the Heat Exchanger, which causes the *High Limit Switch* to engage. The usual cause for this is poor air circulation through the furnace, which is a result of blockage of the *Air Return* or outlet *Ducts*. An accumulation of dust and dirt in the Heat Exchanger can also cause it. And in rare cases it may be an over-sensitive limit switch.

Furnace Runs Normally but Does Not Shut Off When Temperature is Reached

This suggests that the thermostat is still calling for heat. Check the voltage on the wire to the Time Delay Relay to see if this is the case. If voltage is present, the thermostat is defective. If no voltage is present, there is a short in the furnace wiring that is creating the voltage that normally comes from the thermostat. Note, though, that it is normal for the fan to run for 20-60 seconds after the thermostat is satisfied. This cools the furnace internally.

Soot on the outside exhaust vent

Soot is a sign of improper combustion and means there is a problem. Carbon monoxide [CO] is another byproduct of improper combustion and is an extremely dangerous gas, so a furnace showing soot at the outside vent should be repaired BEFORE being used again. Soot and CO result from burning the propane without sufficient combustion air and generally means that either the Combustion Air Intake is blocked or the Intake Blower is running too slowly. See *Blower Motor and Fans* and *Combustion Air Intake & Exhaust*.

Works on Shore Power but Not When Disconnected

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This is a sign of a weak battery or corrosion between the battery and the furnace, resulting in low voltage at the furnace. When on shore power, the charging system keeps the voltage up high and powers the furnace, but without it the voltage drops low enough that it cannot operate reliably. While the furnace specs may say it will run from 10.5 to 13.8v, in practice the furnace may not start and run much below 11.5v.

Furnace Goes Dead Overnight

This is usually just an exhausted battery. The furnace blower uses a lot of electricity and if the RV's charging system is not running the battery can easily go dead overnight. May be bad battery(s) or simply insufficient batteries for the amount of power you are consuming. Low voltage at the furnace (due to corrosion in the wiring) can contribute to this because the motor draws more current when the voltage is very low (under 12.0 vdc).

Fan Motor Makes Screeching Noise

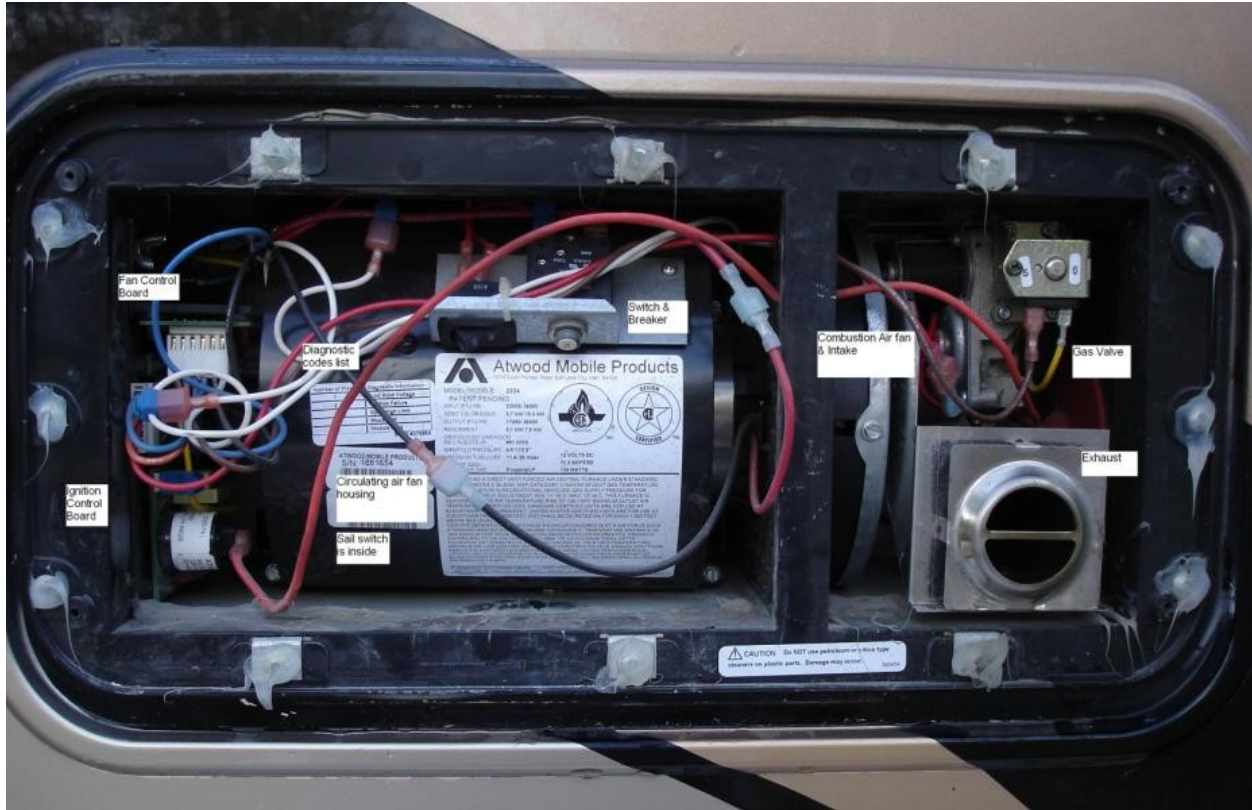
This is typically caused by the fan blades rubbing against the fan housing in either the two blowers in the furnace or a bad bearing in the motor. (see *Blower Motor and Fans*).

Poor Air Flow from Duct Outlets

This is often caused by crimped ducts or excessive length ducts that have extra loops that slow down air flow. Check as much of the ducting as you can reach and straighten loops (removing excess if possible) and eliminate kinks and crimps as much as possible. Also check the outlets themselves – many are adjustable and may be partially closed. Take the outlet off and make sure it actually opens – broken ones are not uncommon.

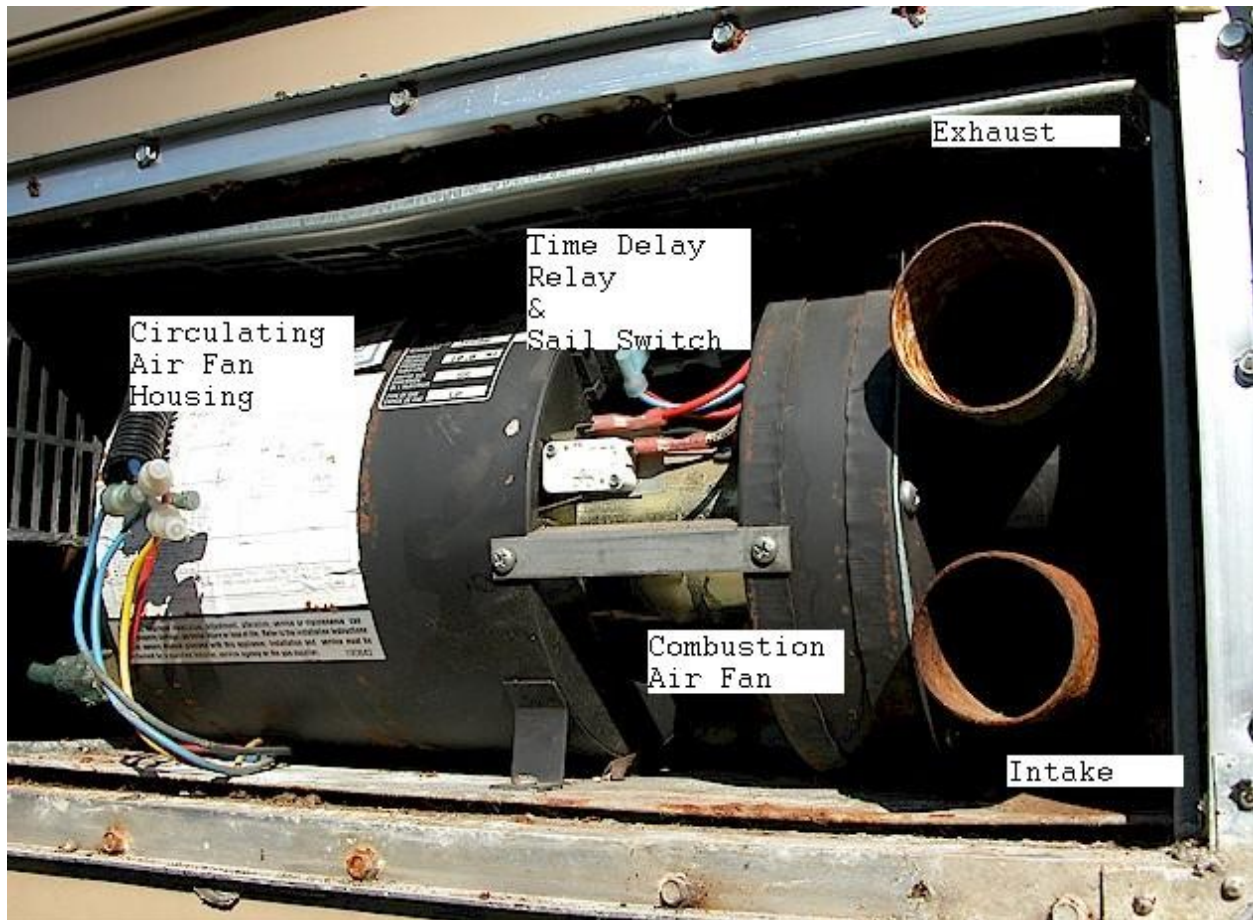
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PHOTOS



Atwood Two Speed Furnace (Model 8500-IV)

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Older Atwood with ported intake & exhaust (circuit board not visible)

LINKS FOR MORE HELP

Atwood Video - <http://www.atwoodmobile.com/Service/Trouble/heatingvid.cfm>

Atwood Troubleshoot - <http://www.atwoodmobile.com/Service/Trouble/dsi.cfm>

Mark's RV - http://www.marksrv.com/furnace_trouble_shooting.htm

DuckTec Parts - <http://www.ducktec.com/furnace-trouble-shooting.html>

RVers Corner - <http://www.rverscorner.com/articles/furnace1.html>

RV Motorhome Answers - <http://www.rv-motorhome-answers.com/rv-furnace.html>

Rx4RVs - <http://rx4rv.com/archives/17>

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Dinosaur Circuit Boards - <http://www.dinsaurelectronics.com/>

SOURCES FOR MANUALS

Atwood Parts - <http://www.atwoodmobile.com/Service/Info/heatinfo.cfm>

Bryant RV – Furnace and Refrigerator manuals: <http://bryantrv.com/docs.html>