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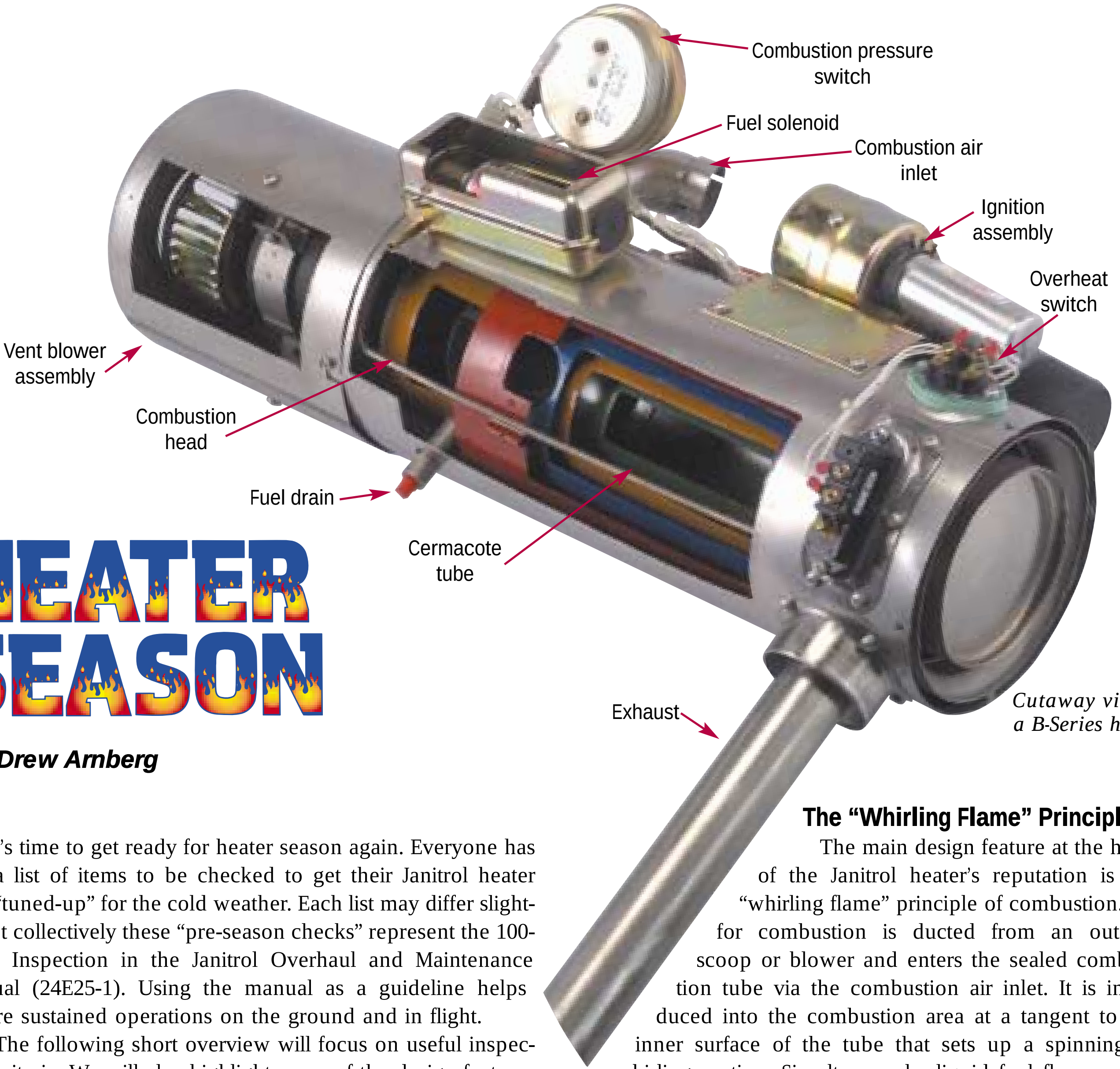


Cutaway view of a B-Series heater.

HEATER SEASON

By Drew Arnberg

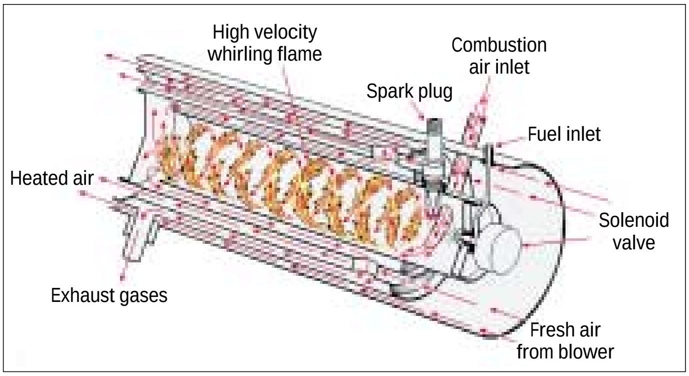
It's time to get ready for heater season again. Everyone has a list of items to be checked to get their Janitrol heater "tuned-up" for the cold weather. Each list may differ slightly, yet collectively these "pre-season checks" represent the 100-Hour Inspection in the Janitrol Overhaul and Maintenance Manual (24E25-1). Using the manual as a guideline helps ensure sustained operations on the ground and in flight.

The following short overview will focus on useful inspection criteria. We will also highlight some of the design features of the Business and Utility class of heaters from the Janitrol Aviation Heater product line. This class of heaters (the B-series) is one of the more common types of combustion heaters in the general aviation industry. The unique design characteristics of the Janitrol combustion heater result in safe, dependable and long-lived performance. This reputation began with the product line's introduction during WW II and continues up until the present.

The "Whirling Flame" Principle

The main design feature at the heart of the Janitrol heater's reputation is the "whirling flame" principle of combustion. Air for combustion is ducted from an outside scoop or blower and enters the sealed combustion tube via the combustion air inlet. It is introduced into the combustion area at a tangent to the inner surface of the tube that sets up a spinning or whirling motion. Simultaneously, liquid fuel flows under pressure from a pump and regulator to the fuel nozzle where it creates a fine spray that is mixed with the whirling combustion air to make a combustible mixture. The fuel/air mixture is ignited by a high voltage spark plug. The resulting "whirling flame" resembles a tightly coiled spring and maximizes the heat production in the short combustion tube.

Combustion gases travel the length of the combustion tube, double back over the outside of the combustion tube,



bypass the vent airflow through a crossover to an outer heat transfer area, and then make one last trip down the length of the heater to exit at the exhaust. The heat transfer process is completed as ventilation air is ducted from an air scoop or blower (separate from the combustion air) through the ventilating air passages between the combustion tube assembly's layered walls. This vent air enters at the combustion head end of the heater, exits downstream and is ducted to the aircraft's cabin.

Temperature control in the cabin is maintained by the adjustment of a duct switch. Besides the duct switch inputs, temperature control in the heater includes a cycling switch and an overheat switch. The cycling switch maintains optimum combustion temperatures by controlling the fuel solenoid. The manual reset overheat switch disables the entire heater system when an overheat condition occurs.

This explanation is old news for most pilots and technicians, but it serves to introduce important features of the Janitrol design. The whirling flame is very stable throughout all attitudes and air velocities. The tight coil ensures continuous re-ignition as the flame whirls around itself. This ensures that the combustion process is complete. To aid in complete combustion, Janitrol uses an "excess oxygen" fuel/air ratio. The excess air is supplied to ensure not only complete primary combustion, but also complete secondary reactions. Within the heated chamber, the secondary oxidation of carbon monoxide yields carbon dioxide. In other words, with proper combustion air and proper fuel pressures, the exhaust will have miniscule amounts of the deadly carbon monoxide.

Ventilation Air Pressure

As long as we are taking a quick look at proper combustion air pressure, let's peek at ventilation air pressure. The Janitrol engineers designed the heater to utilize two different sources and pressures of air for efficient operation and safety. Combustion air pressures are designed to be lower than the ventilating air pressures. This means that vent air will flow into the combustion chamber if the sealed combustion tube is compromised in any way. This safety feature keeps the by-products of combustion in the exhaust instead of the cabin. The increased flow of ventilating air helps to control the combustion process by "cooling" the combustion tube. The vent air absorbs the radiant heat as it is forced through the heater body and into the aircraft. The constant stream of vent air keeps the combustion tube (relatively) cool. Without vent air, the heater will overheat and shutdown.

The point here is that both combustion and ventilation air pressures are critical to the smooth operation and long life of the Janitrol heater. Of course, proper air pressures are not the only requirements for efficient operation. Proper fuel pressure and continued ignition delivery are also critical ingredients. These four conditions are required to properly operate any combustion heater.

Visual and preventative maintenance checks

Start your heater season by making sure you are current on the 100-hour inspection required by either AD#96-20-07 or the maintenance manual (24E25-1). Even if not required, this inspection is the appropriate guideline for a thorough check of the heater.

Comprehensive visual checks start with the air inlets, associated ductwork, and the exhaust outlet. During this check pay particular attention to two items. First, follow the ductwork to the combustion and vent blower motors and from the motors into their respective inlets on the heater body. Look for small cracks, restrictions, secure attachments, loose fittings, etc. This is important as any air leaks between the blower motors and the heater assembly will mean a loss of either cooling vent air (potential overheat) or combustion air (smoking exhaust or excessively rich F/A mixture).

The second item to pay attention to is the exhaust outlet. If there is evidence of soot, your heater is running rich. Remember the explanation about the excess oxygen combustion process? The heater is designed to run "lean" with a F/A ratio of 0.067. If you are getting soot accumulations, you have a shortcoming in either the fuel system or the combustion air system. Presence of soot is also an indication to look at the pressure differential sensing line in the exhaust outlet. You may need to use a wire to clear deposits on the sensing line. To blow out the line, disconnect the sense tube at the differential switch and apply filtered air to blow out the exhaust end of the tube.

Check the fuel lines and system components for any damage or indication of leakage or restrictions. Check and clean strainers, filters, and fuel drain lines as applicable. Follow the fuel lines to the heater body and check for dry rot on the grommet around the fuel feed line as it passes into the fuel solenoid housing and the heater body.

Check the electrical wiring at the heater terminal block and components for loose connections, chafed insulation, and secure attachment. Look at the blower motors and the associated wiring for secure connections and look at the

Clean carbon deposit from combustion head and remove deposits from ground electrode.

radio noise filters for obvious signs of damage. Remember in later troubleshooting efforts, each blower motor plus the ignition assembly have radio noise filters wired in series to the respective units. If the noise filter does not have continuity, the assemblies will not function.

Remove and inspect all brushes for excessive wear. Most technicians use the "one half rule" to determine if it is time to replace brushes. If one half of the original length has worn away, replace the brushes. Replace brushes in pairs. Take a look at the armature for proper coloration (medium to dark brown) and no damage to the commutator is allowed. Inspecting, and replacing as necessary, the brushes will help prolong the service life of the motor.

Check the freedom of movement of the blower fan wheels and inspect them for obvious signs of damage. After you look at the terminal block and wiring harness, find the data plate and see if there is any shrinkage or "cooked" edges that might indicate overheating. Possible culprits in this situation may include blocked or leaking ductwork, fuel solenoid stuck in the open position, or insufficient ventilation air.

Inspect the ignition assembly and the ignition lead. Burning or discoloration of the ignition lead or any of the components of the ignition assembly indicates arcing. Remove and replace as necessary to prevent any damage to the heater and ensure the unit delivers the required continuous spark.

Remove, inspect, and clean the spark plug. Look for evidence of arcing and, also, look at the condition of the electrode and build up of carbon deposits on the spark plug (see plug pictures). The maintenance manual outlines an appropriate test for the spark plug. Do not test the spark plug on the heater body with any other object to avoid personal injury or damage to the ignition unit. Before re-installing the spark plug, clean the electrode and the core with a cotton swab and some appropriate solvent to remove all fingerprints. The oils on your fingers will cause tiny arcing on the surface of the plug and may degrade the performance of the unit. Remember to verify the spark gap.

Pressure Decay Test

You may have to complete a Pressure Decay Test (PDT) in accordance with Airworthiness Directive 96-20-07 if you are at the 100-hour interval and you still have the B1500, B2030, B3040, or B4050 series heaters. A Combustion Differential Pressure Switch test will also have to be accomplished. The AD's PDT requirement does not apply to the Janitrol's Extended Life B-series heaters (B2500, B3500, and B4500 series) which have the CermaKote® ceramic coating used to improve the combustion tube's life to a TBO of 1,500 hours. Additionally, the 94E42 series of combustion pressure switches alleviates the repetitive testing requirement of the AD.

The PDT is used to evaluate the condition of the combustion tube. The test ensures that there are no excessive leaks between the combustion and ventilation sections of the heater. This test relates not only to safe operation of the heater but, more importantly, to the safety of the cabin occupants. What you will hear from the people who have been in the heater business for a long time, is that the AD 96-20-07 PDT (and the original AD 82-07-03) requirement should have applied to all South Wind and Janitrol combustion heaters. The FAA issues Airworthiness Directives to provide corrective action to a condition that has been identified, but does not mandate routine maintenance. And that is the real point after all. The PDT is routine maintenance for all combustion heaters. The test is diagnostic in nature and can be performed without removing the heater from the aircraft.

Operational Checks

After returning the heater system to its original configuration, you move to the power-on checks. External power should be used to preclude excessive drain on the battery or misleading indications caused by a weak battery. Follow the appropriate aircraft operator's manual or the maintenance manual for this check.

Apply power to the heater system by engaging the "Master On" switch. The "Heater Out" light should illuminate. Check the operation of the blower assemblies. Look for unusual vibrations

Remember to check brush wear to prevent premature blower motor failures.

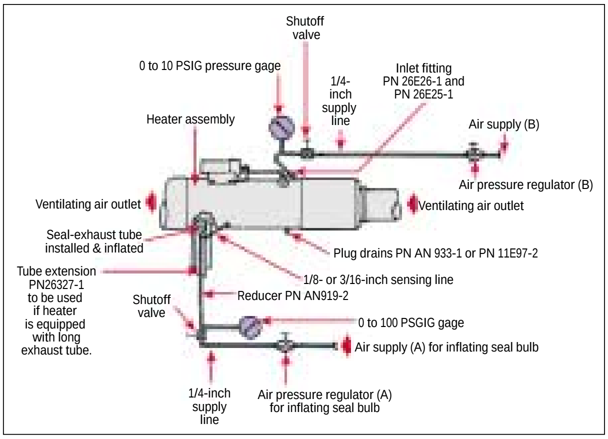
and stuck or rubbing fan wheels. Check for leaks in the combustion inlet line by using a soap and water spray. Check the airflow at the exhaust and cabin vents. If the airflow feels inadequate or slower than normal, check your ductwork connections for tight fittings and obstructions and take another look at your blower motors. Check the motors' current draw; excessive current draw is a sign of a weak motor. If you did not look at the brushes before, look at them now. Verify proper voltage at the motor as well. Remember, airflows and, therefore the blower motors, are critical to the heater's performance.

Next, you energize the "Heater Start Switch." The "Heater Out Light" should go out and the "Heater Running" light should illuminate. The heater will "light off" and continue to operate. While the heater is running, take a look at the exhaust for evidence of smoke. There should be little, if any, smoke at the exhaust. If there is, remember we are talking primarily about either a combustion air or fuel problem. The problem could be coking on the nozzle. The nozzle can be removed and cleaned, but be careful not to damage the nozzle tip. Do not use a wire or wire brush to clean the nozzle face or orifice. The nozzle is critical to the heater's proper operation. Any damage to the nozzle's orifice is grounds to replace the nozzle – it is not repairable.

Follow the manual for shutdown of the heater and note that the indicator lights operate correctly. Allow the blowers to continue to run for a couple of minutes. This cool down helps to prevent metal stresses and purge the combustion chamber of any remaining exhaust or fuel.

Troubleshooting

Always look for the interaction of



Follow the 24E25-1 manual to properly execute the PDT and avoid potential damage to heater components.

the four separate sub-systems (ventilation blower, combustion blower, fuel system, ignition system) in relation to the heater's performance. The manual's troubleshooting steps begins with checking for power to the system. Use external power and make sure the master switch is on and has continuity. Then, with just a multi-meter and the wiring diagram, most problems can be pinpointed quickly.

For example, the heater fails to light. If there is power available there may be a shortage of airflow from the combustion blower. Check for duct leaks, fan operation and current draw on the motor. There could be an open in the circuit at either the combustion pressure switch, cycling switch, duct switch, or overheat switch. These can be checked using a multi-meter. The fuel system possible causes include insufficient fuel pressure (check the pump for proper operation and sufficient power), faulty regulator, fuel solenoid inoperative, or a restriction in the fuel nozzle, fuel lines, or the fuel filter. The only thing left to check is the operability of the ignition unit. The heater needs combustion air, proper fuel pressures, and good ignition to start. Those three elements must remain constant and ventilation air must be present for sustained operations.

If the heater starts and then goes out, the problem could be related to either any of the thermal switches (cycling, overheat, combustion pressure, or duct). Or, it could be caused by either low voltage (use external power) or lack of fuel at heater. It could also be a lack of vent air. If the heater has sufficient combustion air and fuel, plus spark, the combustion process will begin. If the vent blower is inoperative, then the heater will build up heat so quickly and trip either the cycling switch or the overheat switch. The overheat switch has a manual reset, but it is not recommended to keep resetting the switch. The problem must be resolved and the overheat switch should be replaced.

If the heater burns unsteadily, the potential solutions are incorrect fuel pressure, sporadic operation of the ignition unit, faulty spark plug, fluctuating combustion airflows, and either a loose or restricted fuel nozzle. If the heater fails to shut off, the culprit is either a fuel solenoid stuck in the open position, an inoperative duct and cycling switch, or a defective master switch. Problems with either of the blower motors are approached the same way. Power to the motor (switch on, circuit breaker closed, external power, and continuity) is first. Overly worn brushes, defective radio noise filter, or burned out motors result in a loss of the blower assembly. The last two potential causes of blower motor difficulty are jammed blower wheels or a bad ground connection.

Carefully remove coking to assure nozzle functions properly. A damaged tip must be replaced.

Efficient and safe operation

Prolonged heater performance is achieved by proper maintenance and a good understanding of systems. Preflight, periodic and preventative maintenance are all key ingredients to an efficient and safe operating heater. The 100-hour preventative maintenance checks serve as the appropriate guidelines for pre-season heater checks when the actual inspection is not required. AMT

The Short History of Janitrol Heater Products

The origin of the aviation line of Janitrol Heater Products can be traced back to the early 1900's when two noted scientists, Dr. J.A. Bone of London and Dr. Charles E. Lucke of New York, simultaneously discovered a new principle of combustion they called "surface combustion." Patents were granted and resulted in the formation of a new company called Surface Combustion Company of Bronx, NY, in 1915.

By 1930 the company had moved to Toledo and opened additional facilities in Columbus. It was there that the first Janitrol heater designed for apartment heating was introduced. The unit used fuel oil and circulated hot air rather than a coal-fired boiler and steam radiator. Up to this point, large coal burners stoked by the janitor heated most buildings. The coining of the name Janitrol indicated the replacement of the Janitor with the Oil burning heaters.

In World War II, The Janitrol Heating Division of Surface Combustion Corporation, was called on to develop a heater for aircraft flying high over Europe. The aircraft, it seems, if heated at all, were heated by exhaust gas heat exchangers. These proved inadequate to heat the aircraft and were unreliable as well as hazardous. The design efforts yielded a 100,000 BTU combustion heater that was an immediate success. By the end of the Korean War, Janitrol heaters were heating 90% of the commercial and military aircraft then flying.

Since that time the aviation line of Janitrol Heater Products has been the object of numerous acquisitions. The last acquisition was in December of 1991 by Electrosystems, Inc., now Kelly Aerospace Power Systems. The product line is manufactured and factory rebuilt at the Kelly Aerospace Power Systems facility located in Fort Deposit, AL. With over 57 years of proven reliability to their credit, Janitrol heaters still represent the majority of heaters used in general aviation. Additionally, the Janitrol heaters are still proudly serving the military as cabin heaters in a variety of heavy lift helicopters throughout the services.