TECH NOTE

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Author: Tom Carr

Cessna Pilots | Association

P.O. Box 5817, Santa Maria, CA 93456
Phone 805/922-2580 800/343-6416 Fax 805/922-7249
Internet: www.cessna.org
E-Mail: cpa@cessna.org

The Pressurized Skymaster

With the introduction of the 1973 T337G the ability to fly at altitudes in the high teens without having to wear an oxygen mask became a reality. With the 3.35 psi differential pressure, the certified maximum altitude of 20,000 feet gave a cabin altitude of 10,000 feet. An altitude warning light on the instrument panel is illuminated if the cabin altitude exceeds 12,500 feet. This is a simple system that uses compressed air from the front and rear turbochargers to provide cabin pressurization and three components, a manual controller, outflow valve and a safety valve, to control how much air is retained or let out. There is no connection to the vacuum system, and with the valves in the normally open position, less cabin depression occurs at full throttle at lift off. There are manual pull to dump valves to shut off the flow of air from the front or rear engines should the need arise. There are also two air vent valves that are located in the cabin overhead and tied into the rear engine pressure duct that allow outside air to enter the cabin in the non-pressurized mode. As the cabin begins to pressurize, the valves are forced closed and seal off the outside air vents. The emergency oxygen system was a small bottle on the 1973 model and consisted of two oxygen gas generators on the 1974 and later models.

The cabin altitude control is used to select the starting altitude at which the cabin will begin to pressurize or de-pressurize. This initial setting should be set at 1,000 feet above the departure or arrival airport, whichever has the higher elevation. Once set, it is best left alone. The simplistic design of the system is such that there is no minimum flow setting to change the rate of a pressure change. When the knob is rotated, the aneroid inside the controller senses the change in setting, and correspondingly sends a pneumatic signal to the outflow valve to compensate right now. To avoid ear discomfort avoid changing the controller setting, or if a change is necessary, rotate the knob very slowly to the new setting. The controller is referenced to cabin air by an inlet port. This port is covered with a screen on models prior to serial number P3370149. Models after have a replaceable paper filter part number 85D87-1. Keeping this screen clean and replacing the filter when needed is important because there is always airflow through the controller and connecting line to the outflow valve. Blocking the air to the controller can cause the outflow valve not to close or act sluggish and not capture the altitude setting properly.

The air from the controller flows through a line routed down the left side of the aircraft and into a chamber inside the outflow valve. This air acts against a diaphragm with outside ambient air on the other side of the diaphragm. The difference in pressures, close, open or keep the valve in a balanced open position to match the setting of the controller. This is a loop system and relies only on the incoming air from the cabin to work. There is another segment to the outflow valve. Should the differential pressure exceed 3.35 psi a differential poppet valve will open letting cabin air out stopping any further pressure increase.

The safety valve is for protection in case there is a malfunction with the outflow valve. Both valves function the same way with the differences being the differential setting and from where the valve receives its input pneumatic signal. The differential setting on the safety valve is 3.5 psi. and prevents the pressure in the cabin from exceeding design limits should the outflow valve not open at its setting of 3.35 psi. The safety valve has an additional function of preventing the cabin from being pressurized through an on/off switch. Air flowing to the input chamber must first flow through a solenoid valve that can be energized to the closed position by the switch marked Pressure, mounted on the instrument panel next to the altitude selector. In the on position the power is removed from the solenoid and the safety valve will function normally limiting the pressure to valve setting. In the off position electrical power is applied to the solenoid to close the valve. With no air to act on the diaphragm, the valve remains in the open position preventing the cabin from being pressurized.

How efficient the system is working can be seen in the cabin altitude and differential pressure gauge. The small needle is the differential indicator and is redlined at 3.5. After the aircraft has established a rate of climb and passes through the altitude selected on the altitude controller, the controller then captures that altitude and cabin should stay at the selected setting. As the aircraft continues to climb, the small needle keeps increasing until the maximum differential obtainable has been achieved. At this point the cabin altitude will start increasing. If the indicator shows less than 3.35 when the cabin begins to climb, then there is a problem somewhere in the system.

If the controller captures the altitude and tries to hold it and both valves are fully closed when the cabin altitude begins to climb, then the problem is probably leaks in the pressure vessel. The valves can be visually checked for proper operation on a test flight. They are not prone to problems and usually only require cleaning the lip seals with alcohol if dirty. Due to the age of the valves there have been reports of cracks in the rubber diaphragms, which render the valves inoperative. The controller is not field repairable and will have to be sent out for repair if not functioning correctly. The controller and valves are available from Cessna on an exchange basis or can be repaired by Precision Electronics, Inc. in Atlanta, GA. They are a certified repair station and can be reached at 404/767-4667, fax 404/765-1722.

The most common problems with this system are, not getting all the flow available from the turbochargers to the cabin, and air leaks in the cabin itself. Either engine should be able to make the cabin meet maximum pressure differential. The air flows through a sonic venturi, which basically meters how much air will go to the cabin, so the engines will always be able to produce rated power. If there is a problem with an engine not being able to make critical altitude, this should be addressed before condemning the pressurization system. The aircraft can be tested on the ground if the maintenance shop has a pressure cart. This is a fairly expensive piece of test equipment and most shops do not have one. In the interim, one or even better two, shop vacs can be used to check for leaks in the hoses and cabin pressure vessel. The cabin cannot be tested to the maximum differential with this method, but if there are some leaks they will usually show up. The outflow and safety valves must be blocked off because they are in their normal full open position. By removing the plastic cover panels, the two valves are exposed. With a piece of cardboard cut to the size of the box section, where the valves are mounted and duct taped in place, the valves are blocked off. Use sufficient care not to damage the valves or plumbing. Connect the blower side of the shop vacs hoses to the hoses removed from the sonic venturi at the front and rear engines. A standard altimeter is used as a test gauge and set to a reference point, 1,000 ft, and placed on the instrument panel visible through the window. Open the gear doors, pull the hydraulic power circuit breaker, make sure the vent windows are closed and close and latch the cabin door. Turn on the vacuum cleaners and note the change in the altimeter setting. It should show about a 30 to 50 foot decrease in altitude. With a spray bottle of soapy water, wet all the areas in the front and rear firewalls and gear wells and look for bubbles. The access panels at the base of the windshield and the cabin door seal are prime places for leaks, as are the belly drain seals. Leaks in any of the inner connect hoses and duct work going to the cabin are very important because this cuts down on the available air to pressurize the cabin. Make sure there is no air coming from the cabin heater exhaust, as this would indicate a bad combustion tube and a potential for carbon monoxide in the cabin. Spray all the skin seams and mark any places that leak. Don't forget the air vents on the leading edges of the wings. There should not be much leakage past the vent valves. You may have to duct tape the cabin door shut for other leaks to show up.

Now comes the fun part, trying to seal the leaks. Hoses and obvious leaks can be easily repaired. Skin seams and leaks at the firewall can be a problem because of limited access to get at these areas. I have found sealing a leak from the inside is the best way, but not always practical. The product to use is the two part fuel tank sealant and goes by the name of PRC or Pro-Seal and is the same stuff that was used to seal the cabin when the aircraft was built. What you will find is that as the major leaks are sealed, more of the minor ones begin to show up. Keep track of your progress by checking the test altimeter that will indicate a lower setting as the sealing process takes place. There may be some areas that are not economically feasible to repair, and if enough of the other leaks are cured, can be lived with. The seals on control cables are ones I would leave till last. The cost of the seals and the difficulty involved in replacing them isn't worth the effort. The door seal is usually a major source of leakage and the inflatable seal is the best way to solve that problem. With the cabin tightened up and the aircraft put back together make another test flight and that little needle should be right up there where it is suppose to be.