probably tell you it isn't practical to air-condition small aircraft. We tend to be most concerned about protecting the pilot from extreme cold, forgetting that excessive heat is also a problem.

Studies conducted by both the U.S. Air Force and the U.S. Army show that an airplane with a stable, comfortable cabin temperature is a safer flying environment. With 30-minute waits on the ground at some of the larger airports, and outside air temperatures of 80–90 degrees Fahrenheit (F), it's no wonder that the inside of an airplane can exceed 100 degrees. How safe can a pilot be after sitting in a 100-degree cabin for 30 minutes prior to takeoff? Certainly, few business executives are going to sit in that kind of heat.

There are penalties to be paid for air-conditioning, to be sure. There is an increase in aircraft empty weight, due to the compressor and other required equipment. This translates into fewer bags, reduced fuel, or fewer passengers. Just the operation of the system causes a reduction in available engine horsepower. The Cessna 210N operating handbook states that there is a one-knot TAS cruise reduction when air-conditioning is installed on the aircraft, and an additional one to two-knot TAS cruise reduction when the compressor actually is operating!

Two types of heat affect airplanes: aerodynamic and sun. Aerodynamic, also known as adiabatic skin temperature, is the result of free-stream kinetic energy being converted to thermal energy when the free stream air is slowed to zero at the surface of the airplane. The faster the airplane moves through the air, the greater the heat buildup, skin temperature being a function of free-stream temperature and Mach number. For instance, at Mach 2.0, the fuselage temperature would be approximately 260 degrees F; at Mach 5.0, it would be about 1550. This obviously is a problem for large aircraft, not singles or light twins. For the slower aircraft, the basic problem is the sun and little or no ventilation to carry off cabin heat. The automotive air-conditioner fits nicely into this type of airplane.

System Overview

Fundamentally, air-conditioning is simple physics; the rapid expansion of fluid causes a drop in temperature. There are two basic types of air-conditioning units; air cycle machines (ACM) and vapor cycle systems. Large aircraft ACMs bleed compressed air from the turbine engine and allow it to expand, causing cooling. With the vapor-cycle system used in light aircraft, a pressurized liquid refrigerant evaporates, causing a temperature reduction. This liquid refrigerant, called Freon, usually is F-21 (dichloromono-fluoroethane) or F-12 (dichlorodifluoromethane). The two, which are not interchangeable, are chosen because they are nonflammable, nontoxic, and do not cause irritation.

The system is divided into two parts as shown in Figure 11-3. They are a high-pressure side and a low-pressure side. The high side begins at the compressor discharge of high-pressure refrigerant vapor. Driven by the engine through a belt and pulley system, a clutch disconnects the compressor when cooling is not required. The low-pressure, low-temperature refrigerant vapor enters the compressor, and its pressure and temperature are raised by compression, turning it into high-pressure liquid. Then the refrigerant passes through copper coils surrounded by cooling fins to maximize refrigerant heat transfer to outside air. The condenser hangs under the fuselage in most aircraft and retracts into it