2. Turbine Engine Fuels

The aircraft gas turbine is designed to operate on a distillate fuel, commonly called jet fuel. Jet fuels are also composed of hydrocarbons with a little more carbon and usually a higher sulphur content than gasoline. Inhibitors may be added to reduce corrosion and oxidation. Anti-icing additives are also being blended to prevent fuel icing.

a. Volatility

One of the most important characteristics of a jet fuel is its volatility. It must, of necessity, be a compromise between several opposing factors. A highly volatile fuel is desirable to aid in starting in cold weather and to make aerial restarts easier and surer. Low volatility is desirable to reduce the possibility of vapor lock and to reduce fuel losses by evaporation.

At normal temperatures, gasoline in a closed container or tank can give off so much vapor that the fuel/air mixture may be too rich to burn. Under the same conditions, the vapor given off by Jet B fuel can be in the inflammable or explosive range. Jet A fuel has such a low volatility that at normal temperatures it gives off very little vapor and does not form flammable or explosive fuel/air mixtures. Figure 6-3 shows the vaporization of aviation fuels at atmospheric temperatures.

b. Fuel Types

Because jet fuels are not dyed, there is no on-sight identification for them. They range in color from a colorless liquid to a straw-colored (amber) liquid, depending on age or the crude petroleum source.

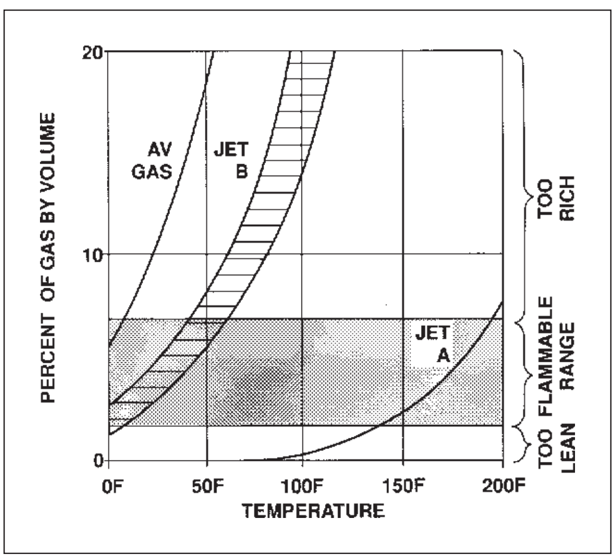

Figure 6-3 Vaporization of aviation fuels at atmospheric temperatures.

There are currently two types of turbine fuel in use — JET A and JET A-1 which are kerosene types, and JET B which is a blend of gasoline and kerosene fractions.

Jet A-1 specifies a freeze point of –47°C (052.6F) and Jet A a freeze point of –40°C (–40F).

Jet B, similar to JP-4, is normally used by the military, particularly the Air Force. This fuel has an allowable freeze point of –50°C (–58F).

c. Problems With Water In Turbine Fuel

Water occurs in aviation fuel in two forms, namely (1) "dissolved" and (2) "free."

All aviation fuels will dissolve water in varying amounts depending upon the fuel composition and temperature. This can be likened to humidity in the air. Any water in excess of that which will dissolve is called free water. Lowering the fuel temperature will cause dissolved water to come out of solution as free water somewhat like fog forms when humid air is cooled.

When the water precipitates out it may collect on the fuel filter, and freeze. This coating of ice on the filter element may shut off the flow of fuel to the engine. To warn against fuel ice, high-flying jet aircraft measure the temperature of the fuel in one of the tanks. If the fuel temperature is low, it can be heated before it flows through the filter.

The fuel filters are equipped with a differential pressure sensor across the filter element. This sensor will turn on an ice warning light on the instrument panel if the filter ices up and the pressure across the element rises to the present value.

To further minimize the ice problem, most jet fuel is treated with an anti-icing additive that mixes with the water in the fuel and lowers its freezing point. This acts so that the water will not freeze, but will remain in its liquid state.

The other problem with water in turbine engine fuel is that it may serve as a home for microscopic-size animal and plant life. Microbial growths, or contamination with bacteria, or "bugs," has become a critical problem in some turbine fuel systems and some aircraft. Because microbes thrive in water, a simple and effective method to prevent or retard their growth is to eliminate the water.

C. Aircraft Fuel Systems

The aircraft fuel system stores fuel and delivers the proper amount of clean fuel at the right pressure to meet the demands of the engine. A well-designed fuel system ensures positive and reliable fuel flow through all phases of flight. This must include changes in altitude, violent maneuvers and sudden acceleration and deceleration. Furthermore, the system must be reasonably free from tendency to vapor lock. Such indicators as fuel pressure gauges, warning signals, and tank quantity gauges are provided to give continuous indications of how the system is functioning.

We will examine here the fuel system used in several different types of aircraft. They will range from the simple to the complex, and represent the variety offered by todays civilian fleet.

1. Small Single-Engine Aircraft Fuel Systems

Single-engine aircraft may utilize any of several types of fuel systems, depending upon the fuel metering unit (carburetor or fuel injector) used, and whether the aircraft is a high-wing or low-wing design.

a. Gravity-feed Systems

The most simple aircraft fuel system is that found on the small high-wing single-engine training-type airplanes. This type of system is illustrated in figure 6-4. These systems normally use two fuel tanks, one in either wing. The two tank outlets are connected to the selector valve that can draw from either tank individually, or both tanks can feed the engine at the same time. A fourth position on the selector valve turns off all fuel to the engine. Since both tanks can feed the engine at the same time, the space above the fuel in both tanks must be interconnected, and this space vented outside of the airplane. The vent line normally terminates on the underside of the wing where the possibility of fuel siphoning is minimized.

After the fuel leaves the selector valve, it passes through the main strainer and on to the carburetor inlet. Fuel for the primer is taken from the main strainer.

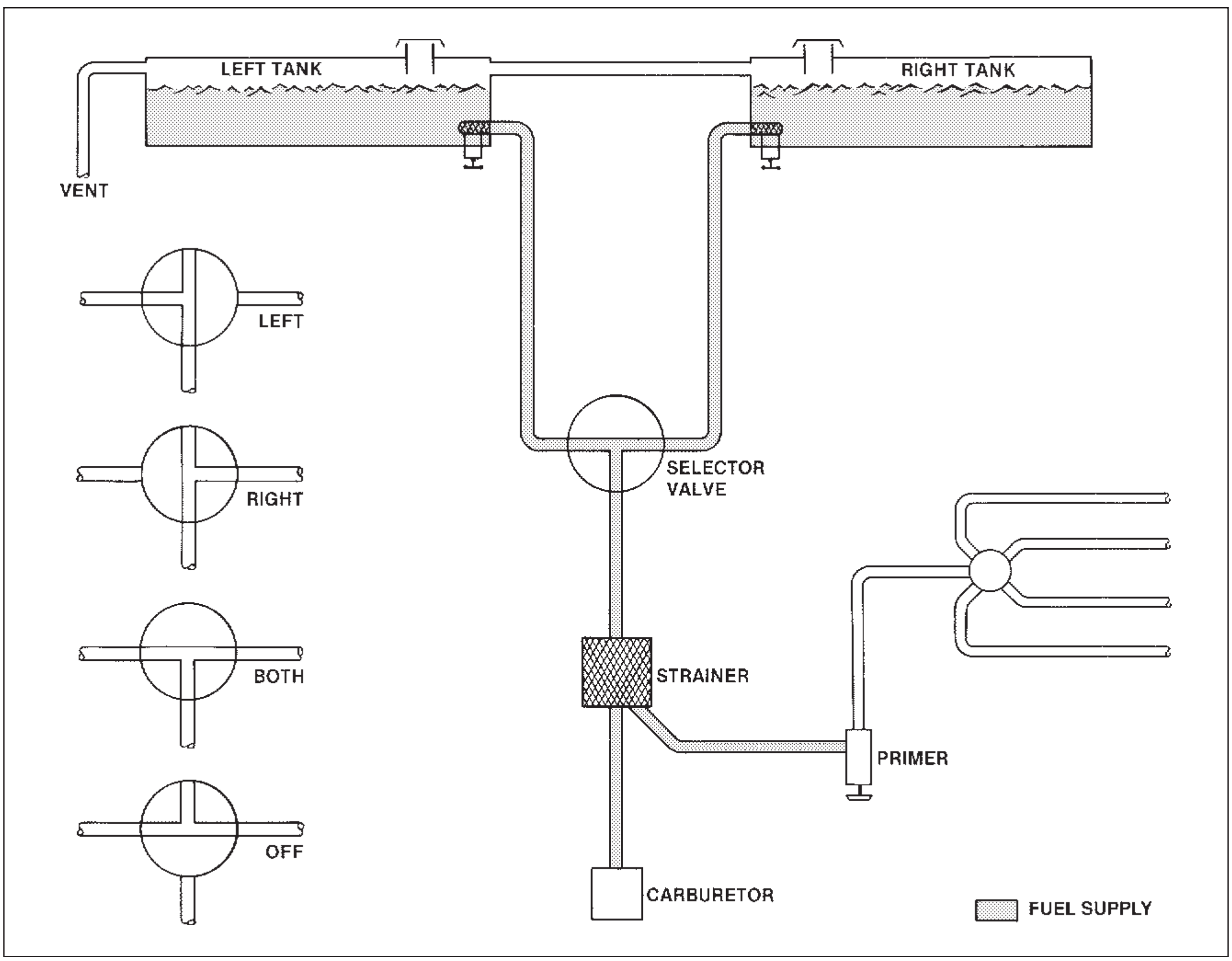

Figure 6-4 Typical gravity-feed fuel system for a small single-engine, high-wing airplane.

b. Pump-feed Systems

Low-wing airplanes cannot use gravity to feed the fuel to the carburetor, and these airplanes use a fuel system similar to that in figure 6-5. The selector valve used in these systems can normally select either tank individually, or shut off all flow to the engine. But they do NOT have a Both position, because the pump would pull air from an empty tank rather than fuel from a full tank. After leaving the fuel selector valve, the fuel flows through the main strainer and into the electric fuel pump. You will notice that the engine-driven pump is in parallel with the electric pump, so the fuel can be moved by either pump, and there is no need for a bypass feature to allow one pump to force fuel through the other. In order to assure that both pumps are functioning, note the fuel pressure produced by the electric pump before starting the engine, and then, with the engine running, turn the electric pump off and note the pressure that is produced by the engine driven pump.

The electric pump is used to supply fuel pressure for starting the engine and as a backup in case the engine-driven pump should fail and to assure fuel flow when switching from one tank to the other.

c. High-wing Airplane Using A Fuel Injection System

The fuel injection system requires an engine driven fuel pump, and the system in figure 6-6 uses a Teledyne-Continental system that returns part of the fuel from the pump back to the fuel tank. This fuel contains any vapors that cloud block the system, and by purging all of these vapors from the pump and returning them to the tank they cannot cause any problems in the engine.

Fuel flows by gravity from the wing tanks through two feed lines, one at the front and one at the rear of the inboard end of each tank, into two small accumulator (reservoir) tanks, and from the bottom of these tanks to the selector valve.

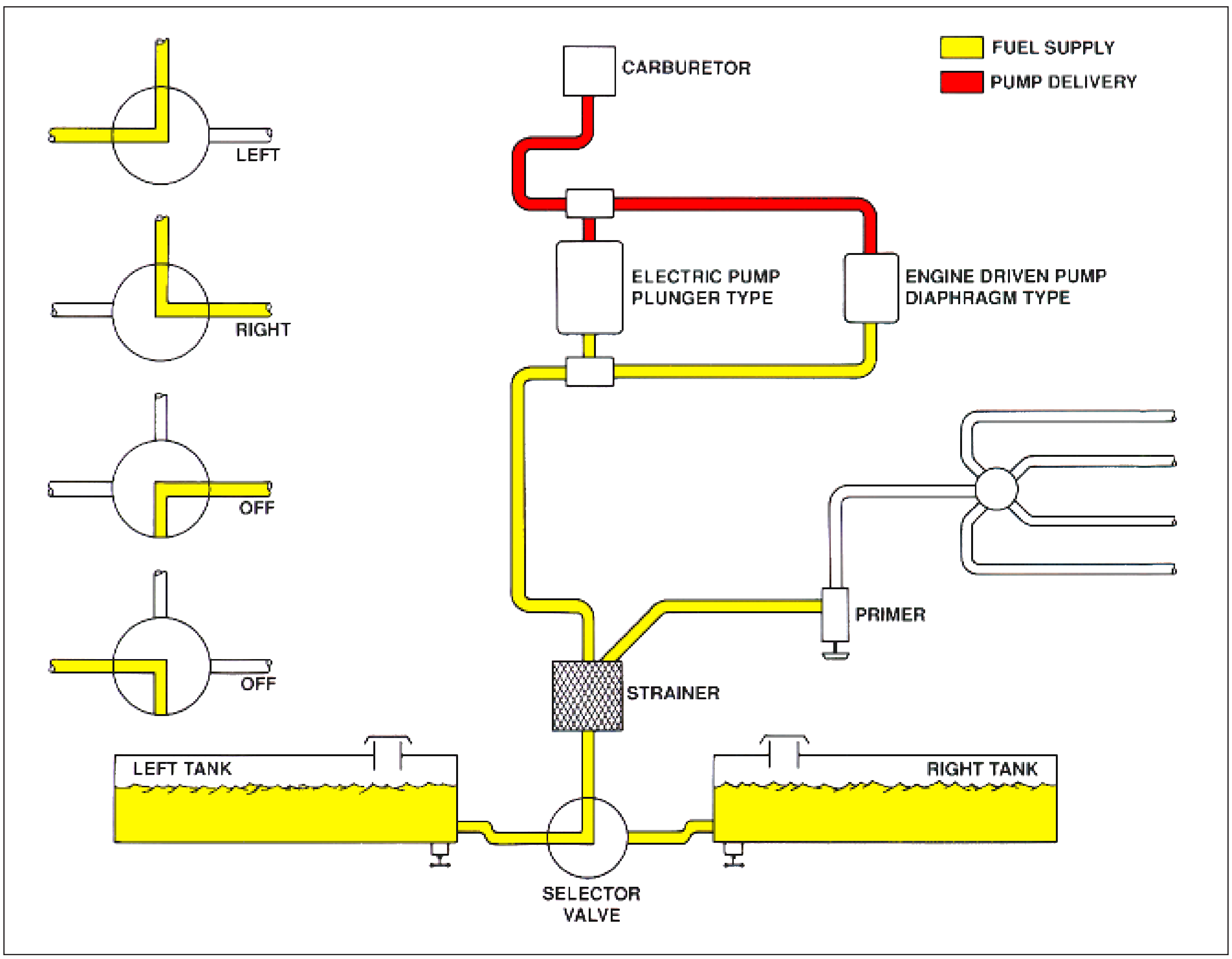

Figure 6-5 Typical pump-feed fuel system for a small single-engine, low-wing airplane.

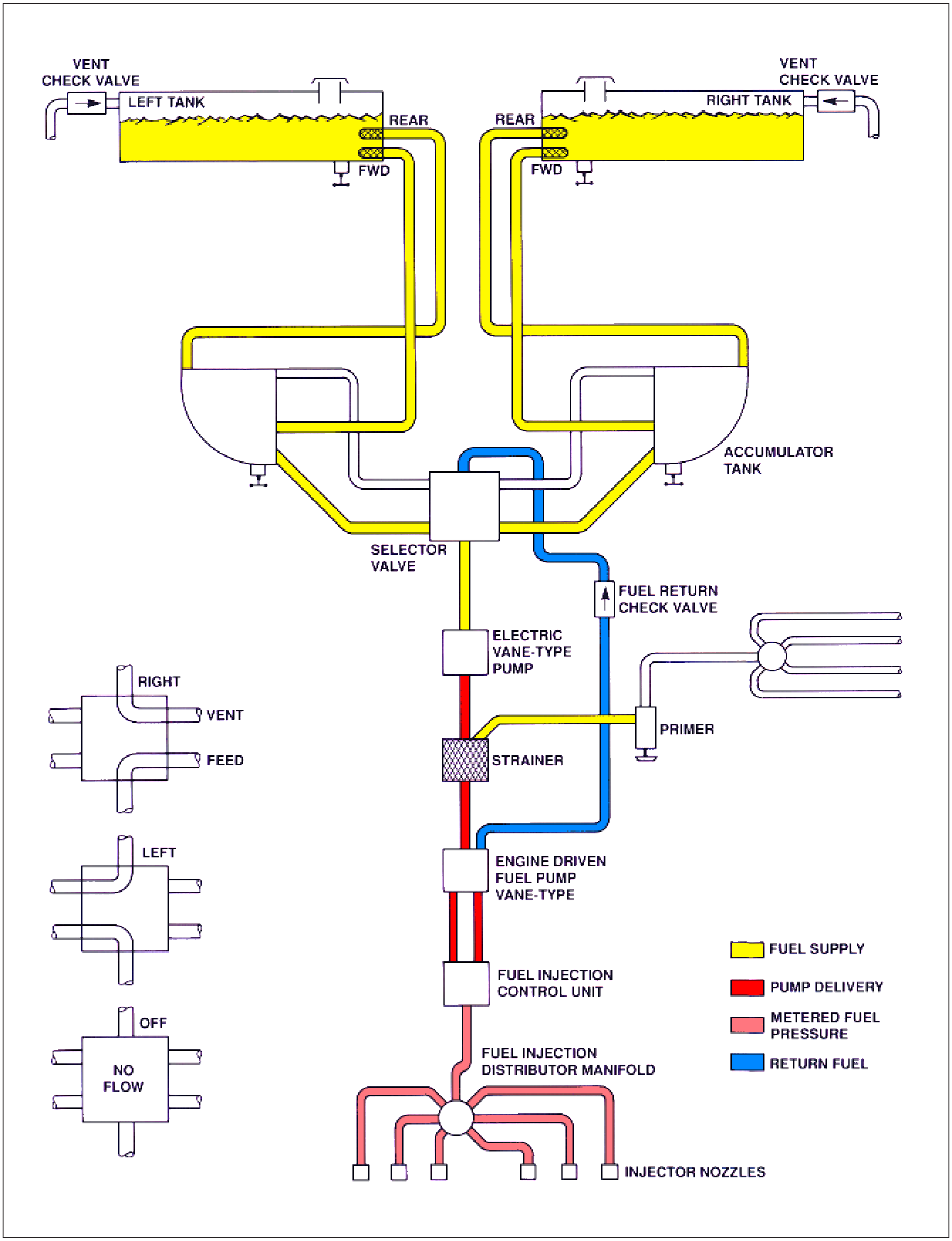

Figure 6-6 Typical fuel system for a high-performance single-engine airplane using a Teledyne-Continental fuel injection system.