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# Lear Romec Fuel Pumps

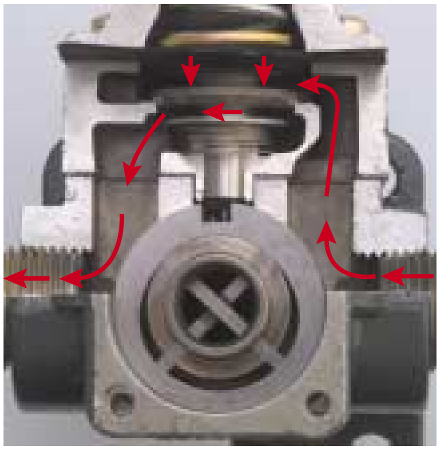
## *Rock solid simplicity (with a few rough edges)*

*By Randy Knuteson*

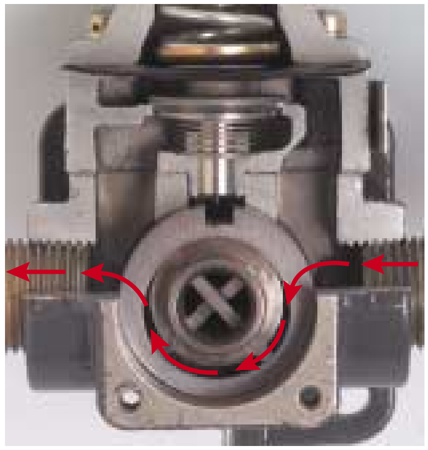
Nome, AK. The pilot was about a mile out and on final approach when he first noticed flames blazing from the left engine nacelle of his Piper Navajo. Immediately, as if by instinct, he shut off the flow of fuel to that engine. An uneventful landing was followed by a successful, yet frantic, attempt to extinguish the remaining fire fed by residual fuel.

Two months passed. Sparta, TN, another pilot, another Navajo, another fire. Fortunately, the pilot had noticed excessive fuel consumption and had diverted to the nearest airfield. Upon landing and rollout, he realized the left engine compartment was trailing flames. The plane sustained substantial damage. The pilot was unscathed; his preemptive action possibly saved his life and the lives of his five passengers.

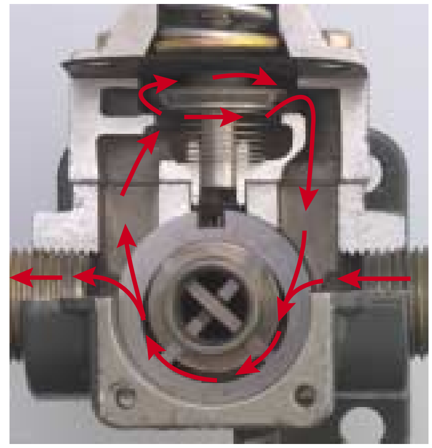
In both cases, investigators' attentions were drawn to the engine-driven fuel pump. Closer scrutiny revealed that fuel had sprayed from the parting surfaces where the relief valve housing mates to the pump body, bathing the rear section of the engine compartment with 100LL. Lycoming closely examined new pumps back at the factory. An analysis of



*Bypass Valve: Used in priming, takeoff, climbing, landing, or in the unlikely event of pump failure.*



*Relief Valve: Shown fully closed. All pressure and flow is being fed directly to the Fuel Servo or Carburetor.*



*Relief Valve: Partially open and regulating flow to the Servo. Opens and closes in order to assure constant pressure throughout mid and high ranges.*

seven similar pumps revealed that four of the seven also leaked in the same gasket area.

## Chronology of a crisis

Were these isolated incidences? A perusal of applicable Service Bulletins would lead you to believe otherwise. As far back as 1976, Lycoming had issued a Service Bulletin (#406) addressing the importance of inspecting Titan and Lear Romec fuel pumps for potential leaks caused by insufficient tightening of the cover screws. It was further discovered that these cover screws could possibly loosen due to the gasket material either taking a set or shrinking with time.

Lear Romec attempted to redress this problem by substituting a rubber material for their asbestos/paper-based gasket. The goal was two-fold; to choose a material that would not be as susceptible to shrinkage while eliminating the perceived risks associated with an asbestos type gasket. Unfortunately, what appeared to be a workable solution only turned out to worsen an already bad situation. The rubber gaskets also took a set, and seeped fuel. Furthermore, these rubber gaskets suffered from their tendency to deform and extrude out from the parting surfaces when re-torqued, occasionally spraying fuel across hot exhaust surfaces.

Continued field reports of leakage prompted the manufacturer to release Service Bulletins 101SB012 in 1985, bulletins 101SB017 and 101SB018 in 1987, culminating with 101SB020 in 1997. All the aforementioned bulletins dealt with re-torquing the relief valve housing screws at scheduled intervals in an attempt to prevent the onset of any fuel seepage. Textron Lycoming issued Mandatory SB 529 in December of 1997. Airworthiness Directive 98-18-12 (a reprinting of SB 529), mandating these repetitive torque checks, was implemented the following year.

The process of inspecting relief valve cover screws and pumps for fuel leaks at 50-hour intervals brought an interesting anomaly to light. Mechanics soon discovered that fuel pumps having the composite gasket manufactured by Kelly Aerospace Power Systems consistently required no further tightening. Many became tired of wrestling with pumps buried deep within the engine and were anxious for some form of relief.

## Solution? A modified pump

More recently, Crane has opted to redesign the entire valve housing of their Romec pump in an attempt to eliminate the troublesome gasket. Their new design incorporates packing type seals commonly seen in industrial type hydraulic pumps. Recesses machined into the relief valve housing serve to capture the seals internally. This third attempt to address the ongoing issue of fuel leakage appears to have solved the

## A glance back

In the early 1900s, mechanical pumps were commonly used in steam engines. Rotary Machine & Engineering Company (ROMEC) was started back in 1918 in an effort to satisfy these and other industry demands. Coinciding with these needs were the requirements within the aviation arena for a "positive displacement" engine-driven fuel pump. The aftermath of World War I brought with it an increased interest in the possibilities associated with the fuel injecting and turbocharging of aircraft engines. Aircraft would no longer rely solely on gravity to perform the function of feeding fuel to the engine.

Engine-driven fuel pumps provided a means of discharging fuel under pressure in a volume exceeding engine demands. Because of this, Romec pumps were used extensively throughout the '30s and '40s by both the Air Corps and the Navy, allowing these aircraft to climb to higher altitudes.

Pesco, Titan, and Thompson pumps were also used to fuel a steadily growing fleet of aircraft. All four companies used similar technology in their respective pumps. The basic principle of operation remained the same – an eccentric sliding-vane type of pump. As the rotor is turned the vanes carry fuel from the inlet to the outlet of the pump. They are capable of pumping fuel in either direction with equal efficiency if the pumps direction of rotation is reversed. Like most of aircraft technology, these pumps have remained relatively unchanged over the years, primarily due to their elegant simplicity and proven track record.

problem. Modifying these pumps eliminates the need for repetitive torque inspections. Modification kits for the Romec Pumps may be purchased from Crane Manufacturing (see Lycoming SB 539). The cost of these kits range from $285-315 depending upon which model of pump you are modifying. Crane has replaced the gasket with a ladder-shaped packing and also designed a circular packing for the opposite side of the housing where the diaphragm is positioned. Pumps are to be converted by authorized repair stations.

## Pressures to perform

FAR23.955(c) states that a pump-fed fuel system must be capable of supplying 125 percent of the takeoff fuel consumption requirements of the engine. Since the pump is mechanically driven from the accessory housing by a direct-drive type coupling, any change in engine speed directly impacts pump speed. Thus, fuel pressure becomes proportionate to engine rpm.

Altitude and ambient air temperatures also play an important role and can limit the amount of fuel reaching the cylinders. It is precisely for these and other reasons that the pump must deliver fuel in excess of engine requirements. So, how does the pump compensate for this over-abundance of fuel when it's not needed? A re-circulation path is provided within the pump body itself — a provision that ensures proper pressures at all operating speeds (see diagrams of fuel flows above). The relief valve and seat become a variable orifice, a simple, but effective means of accurately tailoring pump output pressures. The relief valve is in parallel with the rotor and vanes (the pumping mechanism). Adjusting the spring tension on the relief valve controls discharge pressure generated by the pump. As pump output increases beyond what the engine requires, the relief valve opens and regulates the re-circulation of fuel through the pump. Surplus fuel is routed back to the intake side of the pump.

*Pumps incorporating new valve housings manufactured by Crane/Romec are no longer subject to Lycoming SB 529. These relief valve housings rely on the improved sealing characteristics to eliminate fuel leakage and the need for repetitive torquing.*

The precise metering of fuel is accomplished downstream of the pump within a Fuel Injection Servo. The servo, in turn, feeds fuel to a flow divider atop the crankcase or divider blocks positioned beneath each bank of cylinders. Fuel in equal volume is then fed via injection nozzles to the individual cylinders where it becomes mixed with induction air.

A diaphragm in the relief valve housing is essential for two reasons: 1) It provides venting to turbo discharge pressure or to the atmosphere; and by its balancing action, 2) it helps to maintain a constant output pressure regardless of variations in pressure on the suction side of the pump.

The relief valve must be vented to either atmospheric or upper deck pressure (pressure between the turbo and throttle plate) to assure that fuel pressure is maintained and fed at a constant pressure to the fuel servo or carburetor. Failure to reference the relief valve to turbo pressure would result in decreased fuel pressures at higher altitudes. In a normally aspirated installation, the vent is referenced to atmosphere and must remain unobstructed to prevent fluctuations in fuel pressures. In a turbocharged application, this vent fitting is orificed (restricted to .014-.017). If the diaphragm fails, the restricted fitting prevents massive amounts of fuel from entering the upper deck air reference lines to the injection nozzles. Such a leak would cause a rich mixture creating a roughness in engine performance and a corresponding loss of power at any power setting. No indication of this additional fuel consumption would be indicated on the fuel flow gauge. Should such a symptom occur, simply remove the hose feeding this fitting and look for evidence of fuel in the line. Another problem in relation to the reference line and fitting occurs if either becomes blocked or leaks. Turbo pressure to the relief valve would be reduced, result-

*Textron Lycoming and Crane have issued numerous bulletins emphasizing the importance using orificed reference fittings. The type of fitting and orientation are determined by engine and airframe application. Orificed fittings are readily identified by an "R" stamped on the fitting. Lycoming Service Bulletins 487, 494, and 497 specify which fittings to use.*

*Do not depress the drive-coupling when handling or installing Lear Romec pumps. Depressing the coupling could allow contaminants to get between the disc and plate seal damaging the seal faces, and ultimately resulting in fuel leakage from the fitting at the base of the pump.*

*Contaminants trapped between the valve face and seating area can dramatically reduce pump output. Loss of pressure is more pronounced at idle speeds.*

ing in a reduction in pump output pressure during climbs to altitude.

In the unlikely occurrence of pump failure, a bypass valve within the pump body allows the fuel to flow around the pump vanes under boost pressure from the electrically- driven auxiliary pump. This bypass valve also provides a conduit for fuel when the boost pump is engaged for starting the engine. This check valve feature is designed to sense output pressures from both the injection pump and the boost pump. Once the engine starts and the pump pressure rises above that of boost pressure, the valve is forced closed.

## Contamination

Debris lodged between the valve and seat of the relief valve assembly is the single-most cause of pump failure. The smallest speck of contamination can effectively reduce fuel output pressures to nil. Sediment in the form of rust, scale, lint, sealant, aluminum compounds, have all been known to cause pumps to lose their pressure. It is strongly recommended that fuel lines be flushed prior to installing them to the pump. Furthermore, installation of pump fittings can introduce unwanted Teflon® paste, tape, or material pulled from the fitting or housing itself. Be certain to clean the fittings and pump threads thoroughly before installing the fittings to the pump. Avoid using a vise to hold the pump when installing or repositioning fittings, as this can permanently damage the assembly. If possible, mount the pump to the engine prior to making any fitting changes.

On occasion, fuel-borne contaminants can actually be purged from the relief valve seat. The procedure is simple. First, remove the safety wire that secures the 9/16-in. jamb-nut to the valve housing and turn it one-half turn to loosen it.

Next, using a straight-bladed screwdriver, turn the relief valve adjusting screw counter-clockwise until it no longer turns. The screw has an internal stop that prevents it from falling out. It's important that you count the amount of turns required to fully release tension on the relief valve spring. Now, with the throttle in the wide-open position and the mixture at full rich, engage the boost pump for a few moments. Before attempting to restart the engine, be certain to return the adjustment screw to its original setting and safety-wire the nut. About 30 percent of the time this effectively flushes the contaminant from the seat. The odds aren't great, but it's worth trying before removing the pump and sending it out to be repaired.

## Vapor locking

Low or pulsating fuel flows can also be attributed to vapor locking. Vapor locking is the partial or complete interruption of fuel flow due to the formation of vapor within the fuel system. This phenomenon most commonly occurs after a flight when the engine has become heat soaked and outside air temperatures are warm. But, it is also known to happen in flight and may cause engine roughness or power loss accompanied by fluctuations in fuel flow meter indications.

Excessive heat transfer from the engine to the fuel lines will naturally cause a vaporization of fuel within the line. Lines in close proximity to cylinders or exhaust heat sources are prime candidates for the creation of a vapor lock situation and should always be fire-sleeved. The problem of vapor locking is more pronounced at higher altitude airfields. At higher altitudes, low atmospheric pressure on the fuel results in a lowering of the boiling point of fuel and increases the likelihood of fuel vaporization. Careful consideration should be given to the routing of fuel lines and the radius of turns within the lines. Tight bends or kinks in the fuel lines can cause air to become trapped in the radius of the bend. Furthermore, it also encourages agitation or turbulence in the fuel flowing through the line, again contributing to the formation of vapor. The onset of vapor lock is readily apparent in a plane equipped with both an analogue gauge and a Shadin- or Hoskins-style gauge. The needle on the analogue gauge begins to drop off while the digital flow gauge begins to spool up. The reason for the disparity is that the digital flow is measuring the movement of vapor racing through the line.

Consult the *Pilots Operating Handbook* for the best course of action to correct vapor lock. Generally speaking, there are two options: 1) allow the airplane to cool, returning the vapor to its liquid state, or 2) turn the boost pump on, forcing the vapor through the system. Textron Lycoming recommends that the fuel boost pump be used "whenever there is any possibility of excessive vapor formation," or when "a temporary cessation of fuel flow would introduce undesirable hazards." However, if the boost pump is employed for ground operation, always be certain to check the integrity of the engine-driven pump before takeoff by turning the boost pump off momentarily then back on again for takeoff. If the pump operates satisfactorily while on the ground, it's safe to say that it will perform well in the air. AMT

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*For more help or information on Fuel Pumps, contact Kelly Aerospace Power Systems at (334) 286-8551 or contact Lear Romec at (440) 323-3211.*