

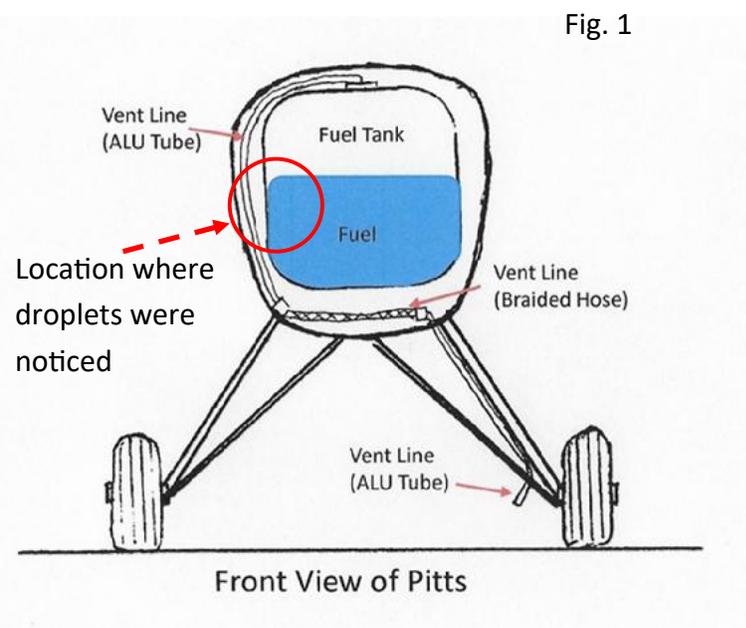
## Fuel Tank Vent Line Leak – Sharing another Experience

By Hugo Ritzenhaler

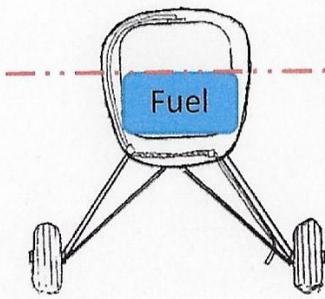
Going through the maintenance records of my first Pitts, an open cockpit S1S, which I had flown from 1981 through 1996, I came across an anomaly that occurred during the spring of 1993. During practice flights, every so often, I felt droplets of liquid hitting my hand or even my face. I noticed it, when flying negative g's over the top of a Humpty (pull-push-pull) or during the first quarter of a down half outside loop. Initially, I thought it may be water inside cockpit that made its way out from wherever it may have been trapped. Flying an open cockpit Pitts, I was unable to identify the liquid by smell. Over time the droplets hitting my skin became more frequent as I practiced the Advanced Known sequence for the Michigan Open competition that year. Over the following practice flights I made sure that the aircraft was totally dry, in and out, to eliminate the possibility of water being trapped anywhere inside the cockpit. Still, I felt the droplets on my skin that made me start a thorough systematic root cause analysis. Part of the analysis was taking a close look at the fuel system components inside the cockpit, such as tank and fuel lines.



If those droplets were fuel, there had to be a leak somewhere in the cockpit close to the pilot seat. Furthermore, it had to be a function of the attitude of the aircraft. Since this Pitts did not have a header tank below the main tank, there were no other fuel carrying tubes and fitting, except for the vent line, that was located near the pilot seat. With the assistance of Doug Dodge, Acro Specialties, in Bay City, we took a look at the fuel tank vent line. Fig. 1 shows a cross section of the front of the Pitts. The vent line, an ALU tube, is routed from the top of the tank down the side to a fitting at the bottom of the cockpit. From there, a braided flexible tube connects to another ALU tube that is routed down the landing gear leg.



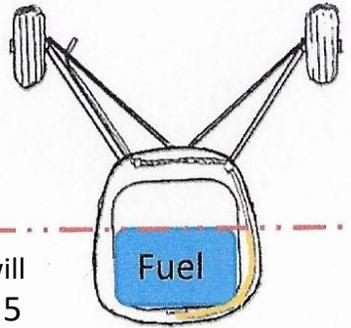
Since subject leak was depending upon the attitude of the aircraft while in flight, it was suspected that any fuel entering the vent line when the aircraft was in a certain attitude, could be causing the spray. Fig. 2 upright flight, no fuel can enter the vent line. Fig. 3 knife-edge to the right, if tank is more than half full, fuel will enter the vent tube. Fig. 4 knife-edge to the left, fuel will only enter the vent tube if tank is almost full. Fig. 5 inverted flight, fuel will only enter to the level of the fuel in the tank. Fig. 6 push-over flight at greater than  $-2$  g, fuel will enter the vent tube. Hence, flight attitudes in Fig. 3 and 6 were the most likely candidates for fuel to be ejected.



## Up-Right Flight

No Spray

Fig. 2 Fuel in tank will not enter the vent line



## Inverted Flight

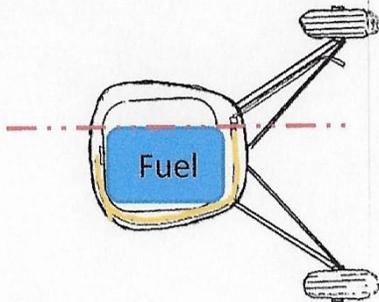
No Spray

Fuel Level in Tank

Fuel in Vent Line

Fuel in tank will enter the vent line, but will remain in the ALU tubing

Fig. 5

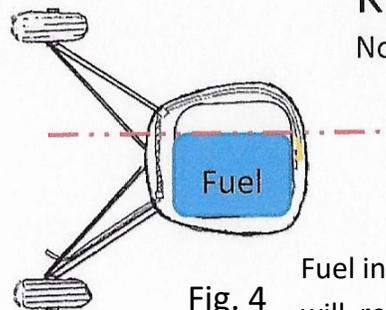


## Knife-Edge Right Flight

Spray

Fig. 3

Fuel in tank will enter the vent line, but will also enter the braided flex hose



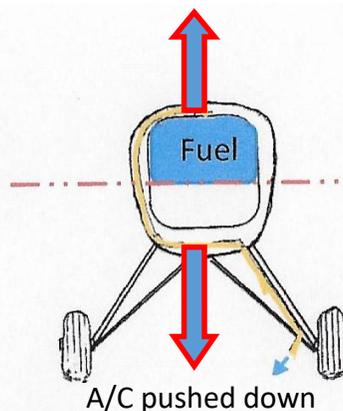
## Knife-Edge Left Flight

No Spray

Fig. 4

Fuel in tank will enter the vent line, but will remain in the ALU tubing as long as tank is not completely filled

Fuel pushed up



## Push-Over > -2g

Spray

Fig. 6

Fuel in tank will enter the vent line, but will also enter the braided flex hose

A/C pushed down

During the root cause analysis it was important to evaluate the g-force acting on any fuel having entered the vent line. In case of Fig. 3, one would not expect any appreciable g-force during a slow roll. An inverted turn would produce negative g's.

However, since most of the sprays that I encountered were at the top of a pull-push-pull Humpty (Fig. 6), it was this scenario to be closer looked at. Any fuel having entered the braided hose portion of vent line would see a force up toward the pilot when subjected to negative g's. A damaged flex hose would cause a spray upwards. At this point, the flex hose was removed and checked for a leak. Our assumption proved to be correct, there was a leak close to the right side of the cockpit.

That was the location the spray was noticed during the outside figures.

The braided flex hose was replaced with a fuel resistant clear plastic tube, which fixed this leak for good.

