# **About That Hydraulic Lock**

By Craig Payne

For this article, “Hydraulic Lock” means a cylinder’s combustion chamber contains fluid, which stops further movement of the piston on its journey to Top Dead Center on the compression stroke. This is an event occasionally seen during manual clearing of the cylinders by pulling through the propeller or on startup.

Liquids, gasoline or oil , do not compress like a fuel vapor-air mixture does. When forced against that “lock” by firing of another cylinder during the start, or by someone pulling the propeller; the buildup of stress results in the strain of something bending, likely a piston rod. Even with a bend slightly out of true, damage is done. The rod may last the life of the engine, another 150 hours or maybe it will fail on the next power stroke, depends on the deformation when metal grains crystalize and are subjected to further stress that results in failure. Larger rod deformation results in more immediate, and dramatic failure.

**What** causes this condition? Blame gravity. Gravity pulls fluids down into the lower cylinders where it can pool, within the combustion chamber, or on the intake tube elbow. This happens with engines where cylinders are inverted, Radials, and engines like the Gypsy series or Czech inverted engines.

**Who** does this happen to? What prompted this article was a cry for help from a newbie that had just hydraulic locked #5 with a bad result. Lack of knowledge and awareness. A friend had 1900 hours of CJ time over 25 years. No stranger to radial engines he has 1000 hours in the B-24 bomber, 200 hours in the B-17 and B-25, 800 hours in the DC-3, and PIC time in the inverted V-8 German Storch. What happened was he did not take extra care after installation of high compression pistons in his M-14P. This unnamed friend is also a good artist and cartoonist.

**Prevention:** Follow Pilot Flight Manual procedures. Always. Most Yaks and CJ’s are fitted with a simple after-market central point intake drain that routes fluids away from the Induction Elbows of cylinders 4, 5 and 6. Open this drain when pulling through until fluids are drained. If the aircraft has been sitting for more than a week without starting, removal of front spark plugs from these cylinders may also be required if resistance is felt.

My pre-start procedure also includes pulling through after priming with fuel, followed by opening the drain again to watch fuel flow out. This means getting out the cockpit a second time before start. The Chinese manual says to go through the Pre-start procedure if the engine fails to start after 3 tries. The M-14P Operator’s Manual only allows two attempts before requiring removal of front spark plugs from 4, 5, and 6 and pulling through. Fine, if you have a ground crew of trained mechanics but common sense goes a long way.

**On Pulling Through**: Mags OFF first! I have watched big beefy pilots’ man-handling the prop and flipping it through at a good rate. They tempt fate, slow is better as fluids drain better from the lower cylinders as valves open slowly. Concerning the number of Blades, each cylinder fires in 2 crank rotations or 720°. For these geared engines, count five 180° Blades to be sure. That will cycle the crank through more than 2-2/3 times. If you feel resistance with the prop, reverse direction to try and open those lower valves, and wait for them to drain before proceeding the pull. Sometimes, stopping and pulling a spark plug is required.

**Formation Clinic Note:** Lead must allow plenty of pre-flight time between end of brief and start time. Wingmen should use that time to prep for start, not get on the cellphone.

**Aggravating Factors**

* Flooded engine, drain intakes and let set for several minutes.
* Sitting for several days without starting.
* High compression pistons, combustion chamber volume is smaller.
* M-14P engines have a .658:1 prop gear ratio and a higher compression ratio than Huosai’s, which use .787: 1 ratio and lower compression. This makes the M-14P’s more susceptible.
* Worn oil control piston rings which allow more oil into the lower cylinders.
* Cold temperatures slow draining of oil due to viscosity. Always warm the engine, oil cooler, and propeller gearcase before starting.
* Position of the pistons in the lower cylinders after shutdown. Pistons near their TDC position allow more crankcase drainage into the cylinder.

**After-market Mods**

* Valve cover scavenging pumps may sound a reassuring hum, but they only clear what is in the valve cover.
* Single-point drains allow induction elbow draining without opening the cowling. A very good, labor saving mod. I feel all our radials should have them.
* Oil Tank shut-off valves do a good job of turning off the tank but they work best when the lower cylinder pistons are near TDC. Shut-off valves also introduce the possibility of oil starvation when they fail and that failure could well be on initial climb.
* Propeller reduction gearcase windows allow setting #1 cylinder at TDC on M-14P Series II engines. This positions the pistons in the lower cylinders at the bottom of their stroke which helps diminish drain down from the crankcase.
* After-market pistons with modern design rings reduce oil consumption and leak less when sitting.

**Best practices – Take the time to do it right, use the checklist.**

* Proper pre-start pull-through and draining. Do everything required to get a quick start without excessive priming during engine cranking.
* Shut-down by following the book, RPMs up to scavenge the engine and reduction in RPM while checking CHT and Oil temps. Do a quick mag check at idle before shutdown.
* Pre-heat when cold. Always do what it takes to get a quick start, even if it means taking a several minute wait before attempting again.
* Kick-backs are bad for multiple reasons, proper spark timing, clean distributor cap, carb adjustment, good start valve, and start coil action help get good starts.