Tips from Comanche *Flyer* magazines Feb 1973 – Sep 2012

CHAPTER TWO

ENGINE

(EXHAUST SYSTEM, OIL ISSUES, CARBURETION, AIR DOOR, FUEL INJECTION)

Table of Contents

Iridium Spark Plugs

These plugs seemed expensive three years ago when I bought my set. The original cost was three times the cost of the standard, massive electrode type. But according to Champion, the iridiums will go 2,000 hours or 7 times as long as the standard plugs. When figured over the long run, the "expensive" iridium plugs cost half for the life of the engine compared to the "inexpensive" plugs. As the cost of the plugs increase with the economy, this calculation will have to be refigured, but this is still a good example of how the cheap way may be the most expensive. So far, I have 700 hours on my set of iridium plugs in three years and they show minimal wear. In addition to the cost advantage, the iridium plugs "scavenge" much better thereby making them less prone to fouling. They must be rotated every 100 hours (top front to bottom rear) as per the Champion recommendation literature or they will wear unevenly and won't go the distance. They are easy to clean with a small wire brush and a scribe to carefully pick out any lead or carbon deposits. Never sand blast them; just re−gap and reinstall. Be careful when cleaning. If you drop them, it can get expensive.

Oil Analysis

With every other oil change, I send in a sample of the oil to be analyzed. Every report showed the oil was high in wear metals − metals that normally wear such as aluminum from the pistons, copper from bearings or wrist pin plugs or iron from rings. Sand was also present. Our plane sits out in the open at Chino Airport, so I didn't think that the report was out of line.

A new oil analysis company sent me a chance to have my oil checked at a very reasonable price, so I sent a sample in. Within three days they sent me a report stating that wear metals were very high and I should change oil and send another sample after five hours flying time. I changed the oil and then flew five more hours and sent the sample to another company that I had been dealing with to double check the new company. I got a report right away saying that my oil looked like it had 25 hours on it − not 5.

There had to be something wrong, so I borrowed a borescope so I could check the engine. A borescope is a device that you place in the sparkplug hole of the cylinder that lets you see the inside of the cylinder. The number 3 cylinder showed some very small scratches in the cylinder wall. I pulled the cylinder off the engine and the top compression ring fell out in sixteen pieces. I pulled the other two cylinders on that side and found the same condition. This engine had 700 hours since a major overhaul was performed.

The plane had just come out of its annual inspection and had passed with flying colors. A compression check is part of that inspection. The compression check was better than the year before.

Because the oil analysis check showed something was wrong, we caught the problem before it got too bad. To be on the safe side I replaced all six pistons and rings along with the wrist pin plugs. The new parts were expensive, but because we found the problem soon, I figured I saved around $1,500 in parts alone by discovering the scored cylinders before they had been scratched so badly that they too would have to be replaced.

It now costs around $12 to have your oil analyzed. That is pretty cheap price to pay for peace of mind and a long engine life.

Engine Roughness

Check for:

1. Fuel injectors for obstructions.
2. Intake pipes for fuel leaks and intake seals for leaks.
3. If problem occurs on ground run−up or even on takeoff, you can try this: Check the operation on each mag. If the problem is the same on both mags. this will eliminate the mags. as the culprit.
4. The problem can still be in your valves.
   This can be checked at fairly low cost. When the engine is cold, remove the valve springs one cylinder at a time. Move the valves back and forth and try to rotate them. If you find one or more which is a snug fit, you will probably

have found your trouble maker(s). Alternatively, you may be able to isolate the cylinder by removing the cowling and the exhaust system. Run the engine. If the problem is an exhaust valve, the sticking valve will show up immediately.

If your mechanic happens to be better than average, he can push the valve out into the cylinder and bring it up into view in the spark plug hole so that the carbon deposits can be cleaned off. It is then replaced with the use of mechanical fingers and a small (Snap−On) magnet to help lift the valve up into the valve guide. The complete job should not take more than 4 to 5 hours.

Engine Hot Starts (Fuel Injected Engines)

Procedures for Lycoming vs. Continental Engines
Every once in a while we get a letter that professes to solve a very vexing problem for the Comanche public. The fix is guaranteed to cure the problem − it will because the author has first−hand knowledge. He has done it. And every now and then we get to investigating (big magazines like to call it "researching") one of these fixes and we find out that although the fix works it works for the wrong reason. Here is an example.

The following procedure was sent to me as a sure fire way to start hot fuel−injected Comanches.
1. Mixture control to full lean or cut−off.
2. Throttle to full open.
3. Electric auxiliary fuel pump on.
4. Now sit back and wait for approximately 20 seconds.
5. Start engine.

A little detective work prompted by the statement of step 1 and the explanation that went with the procedure led me to the startling fact that this procedure was meant to be used with Teledyne continental engines. The explanation said that with the mixture control in full lean (or idle cut−off) cool fuel from the fuel tank would be pumped through the hot lines and then back to the tank thereby purging the hot lines of any vapor lock. Now it stands to reason that anyone who has looked at the fuel servo and flow divider on a Lycoming engine can not find a return fuel line to the gas tank. What's the difference? We know that in the idle cut−off condition in our Lycoming engines we are not able to pump any fuel to the engine. Did you ever try to prime your Comanche engine by turning on the boost pump and find that you had failed to push the mixture control to rich? No fuel flows. No priming takes place.

In the Lycoming engine's fuel servo, the fuel pressure is regulated according to the mixture control setting, the throttle setting and the air flow. No fuel flows in the lines if the mixture is in idle cut−off.

In the Continental engine's fuel system, the servo regulates the amount of fuel sent to the cylinders at the flow divider (spider) and returns any excess flow to one particular tank. Thus, in planes so equipped, the return tank must be the one from which the fuel is drawn first so that the return fuel won't be pumped into a full tank and thus be forced overboard. The Lycoming system does not require this kind of fuel management.

Now we can see why the hot−start procedure works the way it is described in the Continental description. Fuel actually circulates in the Continental system and indeed would cool the gasoline lines thereby purging them.

Why did the Continental system work for our correspondent who owned a Lycoming? It might have been that the pressure built up in the fuel system did purge the lines when the mixture control was opened to start the engine after the "20 second" wait. However, the recommended procedure from Lycoming is given, among other places, in Lycoming's Key Reprints' book

*Lycoming owners may obtain a book of interesting facts called "Key Reprints" by writing AVCO Lycoming, Williamspsort, PA 17701.
HOT STARTS, immediately after shut down or shortly after.
1. Master on.
2. Magnetos on.
3. Fuel Boost on.
4. Open throttle and mixture controls simultaneously for one second.

5. Fuel boost off.
6. Open throttle (since the mixture control is already closed, you will now be in the flooded start position).
7. Engage starter. Cranking time here will be longer than normal, about 4 to 6 seconds.

The execution of item 4 will result in a flooded condition. We recommend this procedure for two reasons:
1. After a hot engine shut down, the nacelle temperatures actually increase, especially so if parked in the hot sun, for a period of time. The fuel in the injection system will actually boil. The end result is vapor in the system. By brief priming, solid fuel is pumped into the system.
2. Since the cooling period, after a hot start, is a continuously varying thing, one would be hard pressed to know whether to prime or not and just how much. So from experience we have found a successful hot start can be made every time by the outlined procedure. It eliminates the embarrassment of getting into the aircraft, not knowing the heat condition, and having to make several start attempts. We know where we stand; we have slightly flooded the engine and we know these engines clear themselves out very well using the standard flooded start procedure. So says Lycoming.

We say: No matter whose procedure you use, if it works for you, GREAT!

Engine Hot Start (400)

To HOT−START a Comanche 400: With throttle closed, mixture in idle cutoff, purge the fuel line 6−10 seconds. Mixture rich, throttle open an inch or so, prime very briefly. Mixture full lean, throttle half to full open, crank. As firing commences, close throttle to half inch or so. Turn on the boost pump, and ease the mixture in to full rich. Keep the starter turning until the engine is running, or you may lose it. If you do, start over. To forestall the funny retorts, yes it would help to have three or four hands. The reason for the boost pump after initial firing is to keep the bubbles (vapor lock) from cutting off sufficient fuel flow thru the injector lines.

The Comanche 400 article in the November 1977 Flyer by Dick Cox was very good. Our hot−start procedures are similar. One can believe that no two IO−720−AIA engines start exactly the same. I have owned three Bellanca 260's in the past. All had Continental IO−470F engines. Each one started a bit differently. Get to know your engine.

Don't waste your money converting to 24v systems, unless you just like gadgetry and have money which is bothering you. Much better to buy a new battery every two or three years.

Engine Cold Weather Starts

Q. How do you recommend starting a fuel injected engine in cold weather?

A. It is simpler to start an injected engine than a carbureted one, and they start more easily, too.This is because the injection system puts more raw gas into the cylinders. It is very difficult to flood a real cold engine. The procedure I recommended for starting is as follows:
1. Mixture full rich, throttle open, fuel pump on.
2. Get a good indication on the fuel flow meter.
3. Load the engine up good.
4. Mixture cutoff and half throttle, then start. Several things are important here:
    1. Make sure the oil is not too heavy.
    2. Be sure the engine is loaded with raw gas.
    3. If the engine does not start readily, the plugs will probably ice up. Then the engine will not start.The cure for this is to pull the plugs, warm and dry them, or just let the engine sit for a long while.

Q. Sometimes after starting my engine in cold weather, there is a popping noise, sounding like abunch of firecrackers going off. What causes this and what should I do about it?

A. The noise is caused by backfiring. Backfiring is the firing of a lean gas−air mixture in the exhaust system. When you turn over the freshly primed engine, some raw gas may go into the muffler and begin to fire there. Sometimes it helps to turn on the electric fuel pump to help keep the mixture rich, but other than that, there isn't much you can do about it.
It is possible that a muffler can be damaged by such backfiring, so after this happens, it would be a good idea to inspect the muffler.

ED: Please, also refer to the Lycoming Key Reprints at
http://www.lycoming.com/support/tips-advice/key-reprints/

Exhaust Gaskets

I had the problem of losing nuts and studs that held the exhaust manifold in place.
At the suggestion of my mechanic, we changed the exhaust gaskets to an all metal Garlock #77611 gasket . This cured my problem.

Exhaust Stack Cracks

Q. I have had trouble with cracked exhaust stacks on my Comanche 180. Is the 180 especially bad about this, and what can be done about it?

A. The 180 is no worse than any other Comanche in this respect. There is nothing I know that can keep stacks from cracking, but they can be repaired. Use a heliarc welder, but observe some cautions: Don't weld the muffler where the stack enters, as this can make an area of stress concentration. Then a crack along the weld is likely and you will have a carbon monoxide problem.

If a stack continues to crack in the area of a weld, then there is either bad material in the stack or there is too much buildup of the weld, causing an area of stress concentration. Either way, the stack should then be replaced.

CHT

Q. I have a 1958 250. I installed a cylinder head temperature gauge with the thermocouple on the lower plug of cylinder #5. On cold days, the gauge reads just below redline during normal 65% cruise. Occasionally, during climb, it will hit redline and sometimes exceed it. On warm days at normal cruise, the gauge often reads above redline, even at low power settings and low altitudes. During climb, it is always above redline. However, even on the warmest days on an extended climb, the oil temp. never goes higher than slightly past the midpoint of the gauge. Do I have a cooling problem or just a bad CHT gauge? This has been going on for over 300 hours.

A. It is my thought that you have a CHT gauge problem as you have all those engine hours with no troubles. It has to be kept in mind that all components of the CHT system must be matched to each other − that is the gauge, the wire, wire length (wire must not be shortened) and probe or gasket under spark plug.

At Penn Air, we found the following method to be a quick and inexpensive way to check the system:
1. Remove spark plug, leaving thermocouple connected to wire and to CHT gauge.
2. In a small metal container (a 1 qt. saucepan will do), put enough engine oil to about 1 1/2" − 2"deep.
3. Use a small hot plate which can be set up near the engine compartment so that wire with thermo couple can reach.
4. Use a good candy thermometer − place it and the thermocouple in oil. Heat to the 300−400 degree range.
5. With battery switch on, CHT gauge should be the same temperature as shown on the candy thermometer.

Air Oil Separator

A member recently installed a Beryl D'Shannon Aviation Air Oil Separator on a PA24−260. Belly oil is completely eliminated. Installation was straight forward without any problems.

ED: The Beryl D'Shannon oil separator is approved for the 180, 260 and 260 (http://www.beryldshannon.com).
For the Twin you may consider the M-20 Separator (http://www.m-20turbos.com). These are approved for all Single and Twin Comanches.

400 Magnetos

I will say a word about magnetos on the Comanche 400. I have owned mine almost two years; it has the 700 series original mags. The mags are serviced regularly which means clean and inspect points etc. at least every 300 hours, which I would do with any mags.. Being a bit paranoid about my airplane, I have never had a hot−start abort with my Comanche 400. I can draw some conclusions re those 400's which give trouble:

1. The mags are poorly maintained.
2. If this is not the trouble, then the problem is fuel oriented and has nothing to do with the electrical system (you DO need a good battery in ANY airplane, you know).
3. Fuel−injected engines seem to flood all by themselves when hot, as you know if you have flown any such power plant. The IO−720−AIA is more prone to this than most.
4.

Engine Cold Weather Start

I have been using your method of hot−starting my 400 and have been having good success.
It is a little late in the season to tell you how to cold start the 400, but I have had good success down to 10 degrees with my method.

Set up normal starting procedures. Master switch on; mixture full in; throttle in one inch; prop full in; fuel pump on until steady on gauge; fuel pump off. Leave mixture in. Crank engine until it coughs once or twice, then while still cranking pull mixture out. When engine takes, release switch and play mixture and throttle until you maintain 12 to 15 inches. If engine doesn't take after 6 or 8 full revolutions, start with fuel pump again.

This method works well on any cold start even in temperatures up to 40 degrees and cuts down the cranking time.

400 Magnetos

The article on starting prompts me to mention that the only problems I've had with my 400 starting have been due to the Vibrator in the shower of sparks system. I have had to buy a new one every year for the past six years. The last time I shipped three used ones back to Bendix and I just got a letter back saying they had been re−conditioned and were being returned at no charge. It was interesting to find out that they are guaranteed for one year or three hundred hours. I would like to know if the 1200 series mags still use the vibrator system. I hope not. For those unfamiliar with the old system, here are a few items of interest;

When the starter switch is turned to the start position both mags are turned off. If they were to fire at that speed, (cranking), the engine would kick back severely as there is no retard system on these mags. With the switch in the start position, 12 volts is supplied to the vibrator which does the same thing as a Model−T Ford and current is fed to a second and separate set of points in the left mag which are retarded 25 degrees to top dead center. As long as the starter switch is on, this is the ignition system that makes the engine run, through the left upper and right lower spark plugs. When the switch is released, the system returns to normal. As for starting in cold weather, my 400 starts better than any piston engine I've ever seen.

I once started it at −15 with no pre−heat, but this was after flooding it thoroughly the night before. This dilutes the oil in the cylinders and makes for easier cranking the next day but I strongly doubt that it's a procedure endorsed by Lycoming, although there have been many engines built with an oil dilution system such as some Cessna 210's.

There must be close to 100 ways of starting 400's, but as long as they work, hang on to them. When mine is hot, I simply flood it and start it as a flooded engine. The catch here is that it takes several seconds of cranking and just before it starts, it sounds as if the battery has gone flat, but that isn't the case. Must be due to partial firing in the cylinders. When it does start, you must let it turn up to about 1,500 RPM to get cool fuel through the lines before it vapor locks again.

Exhaust Slip Joints

When my 1961 180 was being annualled, the mechanic determined that the crossover pipes on the exhaust system were fused where they touched and as a result, rusting was started. In addition, there was some corrosion caused by fretting in the vicinity of the expansion joint.

After measuring the damaged section, we cut two pieces of 300 series stainless sheet to the dimensions shown in items 1 and 2. Your measurements will depend upon the type fix you are trying to make. I had the two pieces rolled so they would fit inside one another to make a double walled tube. The slots in the two pieces were oriented 180 apart to preclude any gas leak.

Incidently, this method is an ideal one since you can easily fit the pieces before you permanently attach them to the stack.

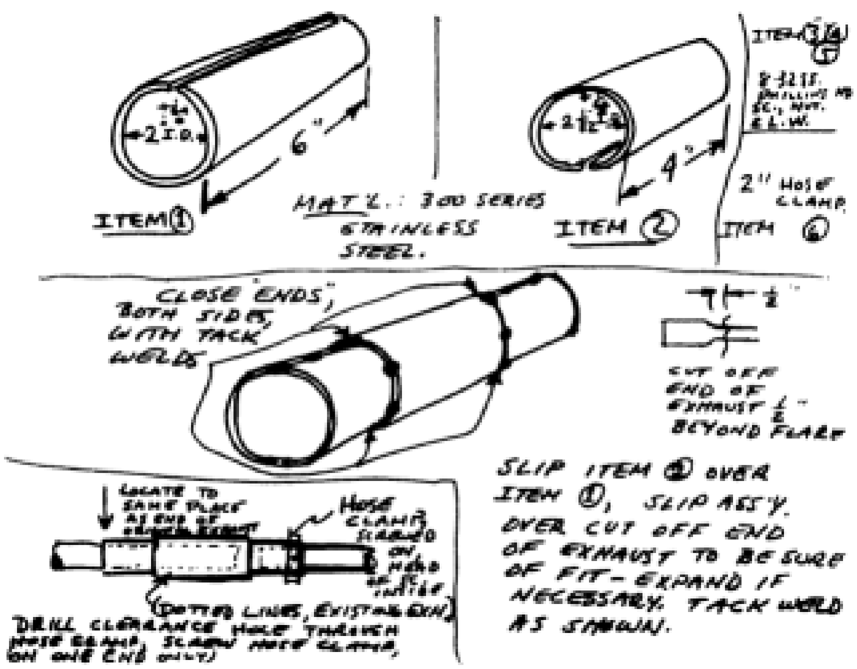
The pieces were tack welded since gas leaks were impossible.
A stainless steel hose clamp was fixed over one end of the inner, larger sleeve. A hole was drilled through the clamp, inner sleeve and exhaust tube.

A stainless steel screw of proper size was fitted to a long screwdriver with some 'gunk' to and carefully worked from the inside out. I did it this way since I thought that I could better determine if it was starting to loosen. I could also mash the threads to further insure integrity. This fix worked so well on the one pipe that this year, we did it to the other pipe.

I used 300 series only because the pipe wall thickness was that size. I suspect that a thinner sheet would be acceptable.

The fix is very professional looking and the stainless is still nice and bright − a sharp contrast to the exhaust system.

Those back Comanche Flyer issues helped jog my memory and made it possible to get a good, economical fix installed very quickly.



Oil Cooler Llines

One "flaw" our Comanche had was that the solid stainless steel oil lines from the rear of the engine to the oil cooler would frequently work loose from vibration. Mostly this was an expense and a nuisance, resulting in occasional minor repair bills and oil streaks on the cowl. But one day over the mountains a gasket failed and she lost 8 quarts of oil in ten minutes.

We've had those oil lines replaced with metal covered TEFLON military type hoses to hopefully prevent any future excitement, and we strongly recommend this modification. It requires FAA approval, but our FBO had no problem in securing this.

Exhaust Gaskets

Try "Garlock" − type gaskets. They are heavy steel type, and excellent with most, serviceable, cylinders. Check and clean cylinder faces. If pitted, or badly eroded, may I suggest some furnace cement, in a thin coat on the cylinder, or the Garlock to help fill in. Check the pipe flanges for bowing, which is the biggest cause of problems. They must be perfectly flat.
In an emergency the furnace cement, or when available two of the thin copper "blowout proofs" sandwiching the Garlock, get me by till I can get new Garlocks.

Twin Induction Pipe Missing Check Valve

I had some recent expensive troubles which I would like to share in hopes of saving someone else from the same problems.

To set the stage:

1. R/H engine came up to over 2,100 faithful turbocharged hours and was duly completely overhauled along with turbos and props and everything else that would come off. It ran fine after except for an unexplained lower boost pressure.
2. L/H engine apparently assembled with parts of half the longevity of the R/H engine) overhauled the same way 100 hours later − so now both are essentially new.
3. L/H engine now has contracted the low turbo boost malady and shows 4 ½ inches more manifold pressure at idle and without turbos at power settings below about 65%.
4. It is concluded after extensive induction system examination that the problem lies in fuel servo mismatch at lower power settings and the aircraft is returned to service for about 100 hours.
5. At 100 hours SMOH LE and 200 hours SMOH RE have serious power loss and spectrographic oil analyses indicate worn out valve guides confirmed by a teardown followed by a rebuild of all 8 jugs with original Lycoming parts − (other parts having been used in the overhauls were suspected of being sub−standard quality / material specifications).
6. Upon firing up the now top overhauled engines the same mysterious 4½ inch manifold pressure spread is still there.
7. Upon further examination the induction pipe check valves threaded into the bottom of the induction pipes in the engine oil sump were found to have been removed at some time prior to my acquisition of the aircraft. Both check balls had been removed from these valves on the left side and one of those on the right had been similarly emasculated.
8. It is theorized that prior to overhaul both sides were sludged up and closed off. After overhaul this sludge was washed out allowing excess air both into and out of the induction system. This meant:
   a) The mixture would always be excessively lean even though recommended leaning procedures were slavishly followed and checked against hourly fuel burn with both manual methods and an SDI Hoskins flow meter.
   b) Turbo boost pressure would be lost through the now open check valve openings.
9. The moral to this story is that $28 worth of check valves can result in 10 times that much in engine overhaul costs if someone has modified them by defeating their function in such a way that they display little or no sign of it and if your mechanic doesn't check them periodically to make sure they are working properly.

Exhaust Manifold Modification

Any time a cylinder has been replaced or an engine overhauled, take your exhaust manifolds to a machine shop and have them ground true. Then when they are placed on a sheet of glass flange down, nowhere can a piece of cellophane from a cigarette pack slide under the edge of a flange. Now when it is bolted on the engine, any gasket, blow proof or not, cannot leak.

Carburetor Air Box Repair

The 180 Air Box: If this is the carb. air box, I had mine repaired by having it heliarc welded. There are not many who can do this, but it is possible. Some extra metal was added at stress points, and the quick detach filter fastenings were eliminated as a source of cracks. I'm convinced a worked−over box is better than a new one and cheaper in the long run. A Wag−Aero vane kit was also installed − no problems in 600 hours.

Alternate Air Door Manual Control (260)

There is a manually controlled heated alternate air door available. Piper drawing No. 27186 covers this installation.

Oil Temperature Gauge High Reading

I had high readings on the oil temperature probes.
The probes were corroded. The problem was solved by replacement of the oil temperature probes.

High Oil Temperature (Twin)

My right engine oil temperature always ran too high − everything else normal − CHT, pressure all perfect. We did everything from flushing oil radiator to checking the gauge. Finally we changed the hoses to the oil radiator. Even though there was no apparent buildup on the inside of the hoses or any apparent difference in the inside diameter of the new hoses vs. the old hoses, something was different and it solved the problem.

Engine Crankshaft Prop Oil Tube (180)

I am doing a major overhaul on my O−360−AlA and have found a problem with the crankshaft. In the front part of the crankshaft there is a small tube which meters the oil to the prop. This tube has come loose and worn a groove in the front bearing shell. I am in the process of finding someone to repair it.

Of note is that the tube is not listed in the parts book and is not available as a replacement part. Lycoming says this is a rare occurrence. Suggest that if anyone is overhauling their engine that they check the tube.

Stuck Engine Valve

When I started the engine it missed badly and a mag check would not clear it up. Probably a fouled plug, I thought. But two plugs on one cylinder? Before I could nail down which cylinder it was with my 6 − probe EGT, the engine smoothed out and ran fine.

I was still a little uneasy about the consistency of the miss so, after doing a very thorough pre−takeoff check, I decided to fly around the patch a couple of times to really check it out.

After landing, and while being gassed up, I spotted oil dripping from the engine. I had an uneasy feeling that something bad was happening. I had to clear the gas area so I decided to check it thoroughly at the park area.

While taxiing back the engine started missing again and I was able to tell from the EGT readings that number four was cold.

How could oil be dripping from a closed cylinder, I was thinking as I opened the cowl. A close inspection of number four cylinder showed it was where the oil was coming from. The exhaust pushrod housing tube was no longer seated in the case but was displaced forward out of its hole − thence the oil leak.

After removing the tappet cover I could see the housing tube was also pushed into the rocker arm holding the valve open. A little jiggling of the tube and valve closed and the compression was back.

I concluded that I had a stuck valve which had stuck shut during starting causing the pushrod to bend and deflect sideways. Apparently, after the valve guide heated up the valve unstuck and the engine ran smoothly although with less power, since the exhaust valve was not opening all the way. Later, while taxiing, the pushrod housing wedged into a position where it held the valve open.

The moral of this story is, that if your engine misses after startup then smooths out, don't takeoff on a long trip.

Different Engine Oil Levels (Twin)

It appears in determining that equal amounts of oil in each engine of a Twin Comanche will indicate about one quart lower in the right engine, and wing dihedral is part of the answer. The engines on the twin are identical, the oil filler tube is located on the right side (looking forward). In the case of the left engine the engine is tilted toward the oil filler tube, but the right engine is tilted away from the oil filler tube hence the difference between what is put in vs. what is indicated on the dip stick on the right engine.

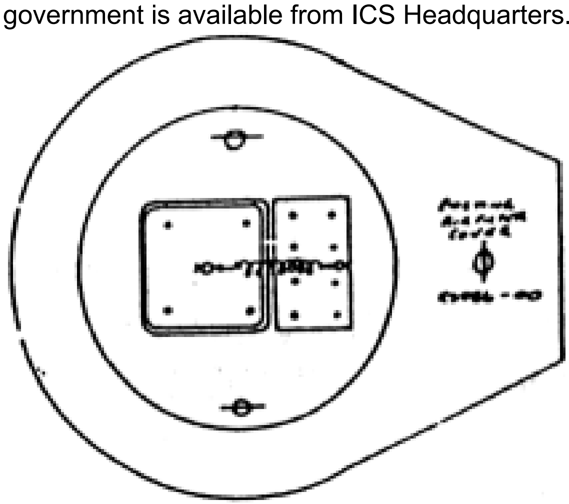
I was told once that the oil dip sticks for the two engines were different part numbers (not true) and were calibrated to indicate correctly (also not true).

Line personnel are notorious for wanting to add a quart or more to the right engine on a twin. My usual rule of thumb for the right engine is if the oil dip stick indicates 5 or above "leave it be".

Alternate Air Door Modification (non-Turbo Twin)

A member has developed a modification for removing the alternate air door from the engine high vibration area to the air filter cover where it is also more readily available for pre−flight inspection in the PA−30 Twin Comanche.

The following drawing indicates the new location. A copy of the complete drawing as approved by the Australian government is available from ICS Headquarters.



Exhaust Stack Removal (250)

If you want to change the exhaust gaskets on the right side of the engine, you're probably dreading removing all those nuts and bolts from the carburator heat muff so you can remove it to get at the clamp inside the heat muff that "pins" the exhaust stack to the muffler. Well, don't do it!

Remove the clamp on the left side (stack to muffler), then remove the bolt that holds the muffler to the engine, disconnect the carb. heat scat duct, and now the whole muffler / right stack combination (with heat muff in place) will be free to rotate downward for gasket replacement.

Exhaust Gaskets

I've been experimenting a little with exhaust gaskets and would like to pass on my experience to the rest of you. The real problem here is that the exhaust will erode the aluminum of our cylinder heads and eventually only expensive welding and resurfacing following cylinder removal from the engine will correct the problem. Various factors affect how well our exhaust gaskets seals − the alignment of the exhaust stack to the cylinders, the flatness and trueness of the surfaces themselves, the different expansion rates of the steel exhaust stacks relative to the aluminum, etc. The following has been my experience:

1. Use of the expensive, spiral wound no−blow exhaust gaskets. These appear to work well if allsurfaces are machined true and don't warp out of alignment. They don't have much depth to "crush" and thus require good alignment and flat surfaces. But most exhaust stacks don't have slip joints on each riser and thus the flanges are in a fixed position relative to each other. The flange height must be the same all across the stack, and to this end large belt sanders are used to attempt to "true up" the stack. This now reduces the thickness of the flange and on two stud cylinders a bowing effect can occur on the flange between the studs when torquing down the stack.
   Additionally, most engine shops machine each cylinder exhaust port smooth, but make no attempt to machine the height and the ports relative to each other. Thus, when finally bolted on the case, the exhaust port height relative to even a perfect exhaust stack is "stair stepped/staggered." With these normal, in the field conditions, the no−blow spiral wound gaskets can eventually leak. Following a top overhaul on 72P, I found a slight leak some years later and eventually we found one cylinder machined about 1/16 to 1/32 more than the others on that side and thus, without a slip joint on the riser from the stack, I had one flange that was always under tension to try to seal on the gasket. The result: a leak.

2. Copper / asbestos exhaust gaskets. These crush more than the spiral wound and will make up for some of the variables I have mentioned. But of course they are not blow−proof. Additionally, they are becoming as scarce as hens' teeth due to the asbestos. Replacements are made without asbestos, and I've seen a service life as short as 10 hours with these; what a pain. Again, the fit of the stack to the head, stack height, etc, determine the life of these gaskets.

3. Solid copper no−blow exhaust gaskets. I started experimenting with these when #1 and #2 didn't work for me as well as I thought they should. These have a cross section like the letter "U".

The theory is that the projection will crush as the flange is torqued to the stack. Normally, they are used in pairs (two stacked on top of the other) but the "stacking" follows various theories.

- Theory #1: Stack with one projection fitting inside the other.
- Corollary #1: Mount with projections toward exhaust flange.
- Corollary #2: Mount with projections toward cylinder head.
- Theory #2: Stack with "valleys" opposing each other.
- Theory #3: Stack with projections opposing each other.
- Theory #4: Use more than two where needed to account for stack/cylinder height differences.

As you can well imagine, one can spend a lot of time testing these theories. A call to Lycoming found the following recommendation: Stack two together as in Theory #1 and apply as in Corollary #1. I mentioned the use of three of them and he said try it and call him back.

So I put two on the left side of 72P and three on the right. Additionally, almost everyone now recommends using a little high temp silicone smeared to each side of the gasket, be it spiral wound, copper / asbestos, or solid copper. Also, one wants to keep the studs well lubricated for continued re−torquing as the gaskets take a "set." Anti−seize works well here and a little Teflon lube helps also. You don't want the exhaust nut to seize on the stud or you lose the ability for continued torquing which will be necessary.

Well, so far after over 50 hours of use there are no leaks on either side of 72P. Make a short 1/4" drive, 1/2" socket with a 3" & 6” extension part of your luggage compartment "kit." After initially installing the gaskets, snug up the stacks before each flight. Don't use a lot of torque with only a 3" handle on your ratchet, turn for a good solid feel in the wrist − not a big push on the very end of the handle. You will find that the gaskets will continue to compress as the number of flights increases and soon will reach a point where further adjustment seems to terminate. Sometimes during this process, the nut may only turn 2−3 degrees, but that's enough. Those big clamshell doors on our cowlings make the process only a minor portion of our pre−flight. Both Lycoming and Airborne make these solid copper gaskets, but I found that the Airborne matched the exhaust openings better than the Lycoming. Well, I hope this helps someone.

Engine Roughness (PA-39 Turbo)

On the turbo models, there is an O-ring which seals the reference air fixtures at the injector nozzles. In my particular case, someone had used standard aircraft O-rings and they had flattened with the passage of years and were allowing air to leak past these O-rings. I discovered that the proper O−rings are manufactured by Bendix and are light blue in color. After replacing these O−rings at $2 a piece, my problem was immediately solved and has remained so to this day.

I would suggest that if other owners of turbo charged twin Comanches are experiencing engine roughness or erratic fuel flow, that this might be their first area of investigation.

Twin Engine Roughness (PA-39)

A recent Flyer article addressed a problem of intermittent engine roughness in a PA−39. I was plagued by the identical problem for two years. On a trans−Atlantic flight in 1985 in my Miller Twin Comanche, I departed Narsarsuaq, Greenland three times. I returned twice because of engine roughness. After the second return, I was told by the appropriate Danish official that the government would ground the aircraft if I returned once more for the same reason.

By this point in time, I could un−cowl the engine, remove the injectors, disassemble the fuel dividers, pull the fuel screens, do the flow tests, etc., etc., with my eyes closed. I rarely found anything wrong − now and then a frog hair in one of the injectors (or was it failing eyesight?). Every FBO who had been exposed to my problem had found "nothing" as well.

The third departure from Greenland went perfectly. I flew around Europe for about three months and had a couple of recurrences. Each time I "fixed" the fuel system. I stopped at Biggin Hill (England) for a time prior to the return trans−oceanic flight and plaintively asked the local Piper dealer if he had an answer and a solution to my problem.

His response was roughly this: "All Twin Coms and Aztecs have this problem. The fuel screen O-ring seats against a flat surface and because of dissimilar metals, that flat surface becomes pitted or grooved and tiny, tiny particles go right by the fuel screen." In ten minutes he had that Bendix part out of both engines and SHOWED me the PROBLEM. One of his mechanics took these parts and lapped them flat on a surface lapping plate.

I have never had a rough engine since. I would be embarrassed to tell you how much money I had spent over a two year period trying to locate that SOB difficulty.

Engine Overhaul Options

Let me say that Continental's overhaul and re−manufactured engine policies are different than Lycoming. This article is written in general and may not pertain exactly to the type of engine that you have. There are three basic overhaul options that we will address in this article:

A. Factory re−manufactured,

B. Factory overhaul, and
C. Third party overhaul (engine shop, etc).

A. Factory re−mans are the only engines that come with a zero time log book from the factory whenthey are shipped. In the case of a re−man, the clock on the engine starts over at zero when the factory ships the engine to you or your installation center. If you receive anything other than a new zero time log book, you don't have a factory remanufactured engine
Factory re−man's are overhauled to new limits. Generally, they have new cylinders and valves. In the case of Continental's IO− 520−1313, BA or C's, they come with a new case in most instances. Just because it is a factory re−man, doesn't mean that the crankshaft and other assemblies are at standard tolerances. The factory reserves the right to grind assemblies to under tolerances as long as the + & − specifications are within new limits. Most people are not aware of the fact that these engines may contain remachined items.

B. Factory overhauled engines are engines that are overhauled, not remanufactured by the manufacturer under a contract with a large aviation parts supplier. The engines will probably have chrome cylinders and are overhauled to what is called service limits rather than new limits. Service limits are very close to new limits in most cases. In the case of factory overhauled engines, you will receive a new log book showing the total engine time carried forward. In most cases, these factory overhauled engines are several thousand dollars less expensive than the factory re−mans.

C. Third party overhauled engines are engines that have been overhauled at a local engine shop. In this case, it is very hard to tell just what you will receive in these engines, since every shop is different. Generally with this approach, you will get your engine back. There are many good overhaul shops. If you choose to go this way, you should investigate the shop to satisfy yourself that you are getting what you want in an overhaul.
Again, as in the case of the factory overhauled engine, you will not get a zero time log book and probably not even a new log book. In most cases, a third party overhaul will cost you about the same as a factory overhauled engine.

ED: Please check the Lycoming Website http://www.lycoming.textron.com for this subject. “Factory overhauled” engines are now called “zero-time rebuilt”.

Oil Analysis

There are essentially two types of reciprocating oils available; straight mineral and ashless dispersant. Straight mineral oils are products of petroleum without special purpose additives. Ashless dispersant types are a blend of mineral oils and non−petroleum additives added to perform specific tasks.

Straight mineral oils leave deposits and because of deposits, the ashless dispersant oils were created. "Ashless" means the anti−sludge additive will not leave deposits in the combustion chambers. "Dispersant" means that impurities entering the system will be held in suspension in the oil. In turn, these impurities will leave the engine when the oil is changed.

Analysis of used engine oil is becoming a day−to−day preventive maintenance tool. Developed by the railroads and later picked up by the military, it is today one of the finest maintenance and troubleshooting tools available for oil−wetted mechanical systems.

Your engine begins to wear out the moment it is started. Oil analysis will indicate unusual wear patterns and often detect beginning failure before excessive damage is caused or costly repairs are needed. These incipient, or beginning failures, cause an abnormally high wear metal content in the oil. The problem may be obvious or it may fall into a group of suspect areas. Some typical failures that can often be detected are: crankshaft scoring, cylinder scoring, rod bearings, pistons, rings, valve guides and external contamination in the form of dirt or sand.

Analysis requires that a sample be taken about 25 to 50 hours after an oil change. This sample will establish a base and, thereafter, wear metal levels will be compared to this base. Samples taken on a routine basis are analyzed. Any increase in one or more metals may indicate unusual wear is taking place.

Permanent analysis sheets are furnished for each customer's engine, noting results and comments concerning the status of the engine. In the event that an analysis appears out of line to the point where it is the opinion of the laboratory that it would be dangerous to fly the aircraft, the owner is notified immediately by telephone.

The secret of low−cost, high−time engines is to make minor repairs when indicated by oil analysis and before ugly sounds tell you the engine is in need of serious, costly repair.

Engine Oil

When it comes to the use of synthetic oils, I have to say that I have received very little feedback from the membership about their experience with its use. I do know that at my seminars, there are a few who say they have gone to synthetic and are very pleased with its performance. They do not seem to agree which one is better, I have noticed.

Lycoming SL #147 covers the use of Anderoil, and it is my understanding that Mobil has, or soon will be accepted. I have not found any specific reference to Amzoll, but it must meet the requirements of Lycoming SL #203, copy enclosed, which means it meets MIl−L−6082 or MIl−L−22851. You are completely correct when you say these oils have a workable wide temperature range.

I know of no additive which will help a bad battery, so it just has to be replaced. You say you have been lucky with yours, but it is more apt to be a case of a good battery to start, and the charging system on your 260C must be set at the proper voltage level and it is being properly serviced with distilled water. These are the items which make for a long battery life.

Avco Lycoming Specification Number 301 F approves for use lubricating oils which conform to both MIL−L−6082 straight mineral type and MIL−L−22851 ashless dispersant type lubrication for aircraft engines. Any brand name lubricating oil in accordance with these specifications is acceptable for use in Avco Lycoming reciprocating aircraft engines.

NOTE: Proof of such conformity is the responsibility of the lubricating oil manufacturer.
The purpose of this service letter is to remind all of our customers that Avco Lycoming does not recommend engine lubricating oil by the brand name. Obtaining FAA approval for oils and/or additives is the responsibility of the oil supplier. Avco Lycoming is in no way involved in this approval.

(Avco Lycoming Service Letter No. L203)

Engine Cold Weather Start

I discovered something that might be helpful to someone else operating in cold weather conditions. I have had my Comanche (the first aircraft I have owned) for twenty months now. When the first winter hit over a year ago, I was about to go flying on a clear cold day. After starting the engine and waiting a few moments for it to warm up, I released the brakes to taxi to the run−up area, when the engine quit. After restarting, the engine quit again after about 20 seconds. This had never happened before, so the engine really had my attention. However, nothing appeared to be wrong and I figured that the engine was still too cold to run properly. I restarted it again and sat there for a few moments pondering the situation. The RPM was at 1,200 and then started dropping as the engine ran rougher and threatened to die again. Normally, you would try pumping the throttle or the primer to keep it running in these conditions.

Cars have a heat riser with a shroud around the exhaust manifold to help the engine run better when it is cold. Basically, it is nothing more than an automatic carb. heat control that provides warm air to help vaporize the fuel. If it works on a car, why not on an aircraft? So I pulled the carb. heat on to see what would happen. The RPM jumped to about 1,500 and the engine ran a lot smoother. Interesting. I pushed it back in, the engine ran rougher and the RPM dropped. With the carb. heat back on, I continued to the run−up area with no more problems. When I could push the carb. heat off without an appreciable change in RPM, I figured the engine was warm enough to do the run−up checks.

Since that day, I have used carb. heat after start−up in winter and it has worked every time. Not only does the warm air help the fuel vaporize, but since it is less dense, it also serves to enrich the mixture, exactly what you need when it gets really cold. The ground here is usually snow covered in winter, so I don't have to worry about dust. However, if you try this technique, remember that the air filter is bypassed when carb. heat is on.

Engine Oil Pressure Loss

After experiencing a sudden drop in oil pressure on one engine of my PA−30, the engine was shut down. (Luckily, this was roll out after touch down.) The shop on the field disconnected the line and put a gauge on line. I was told to go ahead and run the engine and have line blown out as soon as possible. After several diagnoses and repeatedly blowing line out, replacing the oil pressure gauge, and 3 shops, it finally occurred to me to call a professional.

One of the diagnoses was to replace the engine, as it had 2,000 hours. I was told to screw out a plug near the filter and check for a foreign object behind a ball bearing. We did this with a mirror and light, and behind the bearing was a small piece of metal holding the valve open, creating the low oil pressure.

My next question was, where did the wire come from. We thought it was probably a piece of tie wire, but again, back to the professional, as I sent this to him with a note that he had solved the problem. Again, he came to the rescue and diagnosed this as a piece of spring steel and that it probably came from a small coil spring on a thermostat for the oil. This was removed (with great difficulty) and replaced with a new oil thermostat. Problem solved.

Thanks again to the ICS for providing us with such expertise.

Quick Oil Drains for PA30

I wanted to install Oil Quick Drains on my Twin Comanche, N311S, and even purchased a pair of Curtis CCA 1700 drains. However, as other ICS members have noted, there may not be enough clearance to install them without modification. Pete Burgher had an STC for constructing inspection plates with 1/4 inch relief, and some pilots have even drilled an adequate sized hole in the inspection plates so as to provide clearance.

In my case, I found that my left cowl had adequate clearance, but my right one did not. The standard oil drain plug is a 9/16 inch square head plug (male end) with a threaded end that goes into the oil sump (Lycoming STD−551). The traditional way to remove these plugs is to use a 9/16 inch open−ended wrench, which seemed to require removing the lower cowl every time I tried it, in order to gain adequate leverage. Well, it turns out that Snap−on sells a double square 9/16 inch socket to fit a 1/2 inch drive ratchet that fits perfectly on the male plug end. The part number is SW−418, and they cost $9.50 each at the present time. It works great! There is now no need to remove the cowl. Simply take off the inspection plate, snip the safety wire, apply the socket with a 3 inch extension and ratchet and the plug is easily removed.

Oil changes seem to take just about the same amount of time, whether or not you use the quick drain. Although the quick drain can be rapidly opened or closed, the oil takes longer to drain through the small orifice than when the entire plug is removed. It is necessary to use safety wire when using the standard plug, but this only takes a minute or two, and frankly, I feel more confident with the drain plug wired in place. Also, the standard plug doesn't depend on O-rings which require occasional replacement.

Engine Roughness (250)

After about 30 minutes of flight, the engine started vibrating moderately. I noticed the cylinder head temperature gauge was pegged on the low end. I also knew the probe was on cylinder number 5, so we knew which cylinder had given up. We discovered the bottom spark plug could not be removed. The top plug was removed and we could see that the plug electrodes had been severely deformed. Looking in the plug hole, we could see several marks on the top of the piston.

When the intake runner was removed, a small ball of metal fell out. Upon investigation, this ball of metal could be unfolded and flattened out. It was stainless steel and was discolored like an exhaust system piece. The ball of metal had ruined both plugs' electrodes and ceramics, causing that cylinder not to fire.

When the right side of the exhaust system was dismantled to locate the source of the metal, I found a large crack and hole in the carburetor heat shroud. My shroud had been weld−repaired many times, and was missing a few of the bolts holding the halves together because of the placement of the welds.

There are two tabs welded onto the exhaust stack leading to the muffler. These tabs hold the carburetor heat shroud firm and prevent unnecessary vibration. The tabs are also in the area of my shroud that was missing fasteners. Both of these tabs were broken off, and one was found loose in the carburetor heat shroud. The other was the piece that went into the cylinder.
Apparently, the exhaust system piece was sucked into the intake system when I tried carb. heat during the run−up. It must have either laid flat or bounced around until something caused it to be sucked into the cylinder.

Slow Throttle Response – Alternate Air Door Hinge Broken

The right engine on my Twin Comanche began to be slow to achieve maximum RPM on takeoff as compared to my left engine. It wasn't very noticeable on gradual throttle application, nevertheless, manifold pressure and RPM would equal the other engine after several hundred feet of runway. The most likely suspect seemed to be the prop governor. This was overhauled, with the result of some improvement but not quite normal operation.

The next problem occurred during climb out when I got caught in some turbulence. Again the right engine lost power which was restored by throttle movement. We took the entire cowl off this time and discovered that the alternate airdoor hinge had broken allowing the door to rattle around in front of the air inlet of the fuel controller servo, occasionally blocking it.

I replaced the door and spring with a new one from Webco, and amazingly enough, the right engine finally kept up with the left one on take−off. Apparently, altered induction air flow was causing the problem all along.

Fuel Surging in 260C

Maurice Taylor / Technical Director

Over the past few months, Cliff Freiwald (ICS #10826) owner of a 260C, has been experiencing a fuel surge problem. At altitude, in straight and level flight, the following series of events would take place: engine roughness, a 1 to 1 1/2 GPH increase in fuel flow, and a 250 reduction of EGT on each of the six cylinders. Although this happened at all power settings, it was especially pronounced at the lower settings, lower RPM, and higher altitudes. He also experienced a sudden increase of better than one GPH in fuel flow, and the engine would at times lean to one fuel flow and then, after a short time, exhibit an indication of fuel starvation so that he would have to provide a richer mixture.

Initially we felt this was being caused by air introduced into the fuel lines so a thorough inspection of the fuel system was performed. The line from the servo to the flow divider was replaced with a section of clear plastic tubing and the fuel was observed during an extensive ground run−up. No air bubbles were noted so that idea was not the answer.

Having eliminated this as a source of the problem, attention was turned to a close examination of the air induction system as this might be upsetting the fuel servo. It took several tries to isolate the problem. It was finally discovered when the alternate air assembly was checked. The alternate air door on the 260C is held closed by a relatively low tension spring at one end and a magnet at the other. When the assembly was removed, we found that the magnet had moved so that only one corner was contacting the flange which holds the door shut. The door seal, which was not contacting the ridge all the way around had noticeable indentations where it was in touch with the ridge that is part of the housing.

After cleaning and reattaching the magnet so it would have maximum contact and manipulating the door so it would seal properly, the fuel surging seems to be gone. Piper sent us the engineering drawings of the air door assembly (see following), so that the drawing could be compared with the assembly itself. It was noted that the bracket which holds the magnet was not positioned according to the specification. This resulted in the magnet not contacting the entire length of the flange − only about 2/3 of the flange. The Piper drawing shows a Stanley magnet and we are trying to find a replacement because of the excessive wear on the present one. The housing is not made of a very strong metal and it has deteriorated at both attach points where the magnet is attached to the case.

I suggest that owners of the 260C and the twins become familiar with their alternate air systems and inspect them at regular intervals. This way you can be sure they are performing properly. While they are simple enough in design, they can have a profound affect on how the engine performs.

It was a pleasure working this problem out with Cliff as he is very meticulous about the condition and maintenance of his aircraft.

Two New Bracket Induction Air Filters

One of these air filters is for the turbo charged PA−30 and the other is for the PA24−260C. This latter we need to give Dr. Walter Woods (ICS #04211) credit for. The list I have at present is :

	Filter	Element
Pa30/39	BA105	BA10
PA30/39 turbo	BA121	BA27
PA24−260C	BA4510	BA4505

After the initial installation, you need only change the element. Brackett has filters readily available for the other models.

Valve Sticking and Plug Fouling

Roy Sneesby, ICS #00570

Fouled Plugs and Sticking Valves can be an annoyance whenever this problem occurs in your engine.

Here are some of my observances and hints on modifying or eliminating the problem.
Proper engine handling and maintenance will go a long way in eliminating this problem. In this day and age of reduced utilization most engines need more attention, such as cylinder removal and inspection of valves, guides and rings. Much has been documented as to the cause of these problems. I cannot stress highly enough maintaining clean lubrication, which is attained by regular oil and filter changes. Take advantage of investigating the advertised after market oil filters which will remove much smaller particles than the original strainer and filter assembly does.

A stuck valve usually occurs when the engine is cold and first started, the engine begins to run roughly and will not smooth out. The engine now requires mechanical attention to rectify the problem. High temperatures in the exhaust valve guide oxidizes the oil and forms carbon deposits in the guide and on the valve stem which reduces the stem to guide clearance.
The most frequent reason for high valve temperatures is valve to seat leakage. All of the combustion gas must pass by the valve face as it exhausts. The large surface of the valve absorbs heat which has to be conducted away through the valve seat and guide. Poor seat contact and carbon deposits on the stem and guide interfere with this thermal conductivity. High valve temperature and normal expansion now cause the valve to stick. This hot valve with the lubricating oil on it now turns to carbon again, putting another layer on it.

Five percent of a Lycoming valve guide protrudes from the cylinder head. This extended portion cannot transfer heat directly to the head and fins. Consequently the guide bore increases in size, this allows more exhaust gasses to enter the guide causing more carbon, acid and lead deposits and increasing the corrosive environment. Corrosion increases the size of the valve stem. When the engine stops and cools, the end of the guide shrinks to normal. The guide now has grabbed onto the stem and is now seized.

The engine should never be flown with a known valve problem, as serious unseen problems and damage can occur.

Valves which do not seat properly cause warping of the face and continue flexing and eventual failure. Either the head or part thereof will break off. If a part of the valve breaks off and it cannot be found, do not assume that it has been expelled out of the exhaust. It can, due to valve overlap enter the intake system and be sucked into another cylinder or remain in the intake to create havoc at a later date. Remove the intake system and check. If the engine has been started with a stuck valve several damaging things can happen. The push rod and tube can bend and dislodge the tube seals allowing the oil leak to eventually empty the crankcase. Because the push rod socket now cocks sideways and chips parts from the top of the follower. The tremendous valve train loads incurred whilst trying to force the valve open can damage the contact surfaces of the cam follower and the camshaft lobe. This exceeds the metals elastic limit which can cause pitting of the surface and eventual failure.

Other consequences are that the rocker arm can break or the cylinder bosses which hold the rocker shaft can crack and break off. Also the exhaust valve rotator cap can fall off allowing the rocker arm to operate on the valve spring retainer cap which can dislodge the valve retainer keys, creating further damaging consequences.

If an exhaust valve sticks in the closed position it can happen that the intake push rod in the cam cylinder can also bend or break the rocker boss. Thus happens because the exhaust gasses can no longer exit the cylinder. As the piston comes up the resulting compression will not allow the intake valve to open even if it is operating normally.

Engines which had deteriorating piston rings allowing excessive oil to enter the combustion chamber also contribute to valve sticking problems. Excess oil in the combustion chamber also contributes to valve sticking problems. Excess oil in the combustion chamber causes an increase in carbon deposits and also reduces the octane rating of the fuel. This can result in the onset of detonation and incomplete fuel burning, causing excess ash and other deposits to remain further aggravating the valve problems.

Poor sealing piston rings allow more combustion gasses to enter the crankcase which overheats the oil and causes more contaminants to form in the lubricating oil. Thus continuing the cycle.

Long periods of idling and long descents with closed throttle with the resultant higher manifold pressure causes more oil to enter the combustion chamber and be drawn down the valve guides. This is caused by the unequal pressures above and below the pistons (refer previous articles on engine pumping).

Spark plug fouling occurs due to low combustion chamber temperatures. The desirable temperature at the electrode tip to avoid fouling is 900 F − 1,300 F.

Closed throttle and low idle cause carbon and lead deposits to collect around the plug core. These deposits are conductive and if occurring in sufficient quantities cause the plug to misfire. Spark plug temperatures below 800 F allow the molten lead and carbon deposits to float around the plug core. With an increase in plug temperature the bromide scavengers in the fuel react with the lead to form lead bromide. Lead bromide now has a lower melting point and is thus expelled from the cylinder.

When applying power for take off always apply it slowly and progressively. Sudden application of full power causes the spark plug core to increase in temperature very rapidly. This sudden increase in temperature may cause the lead bromide deposits to form oxysulphate which melts at 1650 F. You now have a fouled spark plug which no amount of running will clear. It has to be removed and mechanically cleaned. Your aircraft should be taxied with the mixture leaned.

Some of the causes of valve sticking and plug fouling start on the downwind and landing legs of the circuit where more often than not we have been taught during the cockpit check to go to full rich mixture. This has the effect of lowering the combustion chamber temperature resulting in the afore mentioned deposits to accumulate.

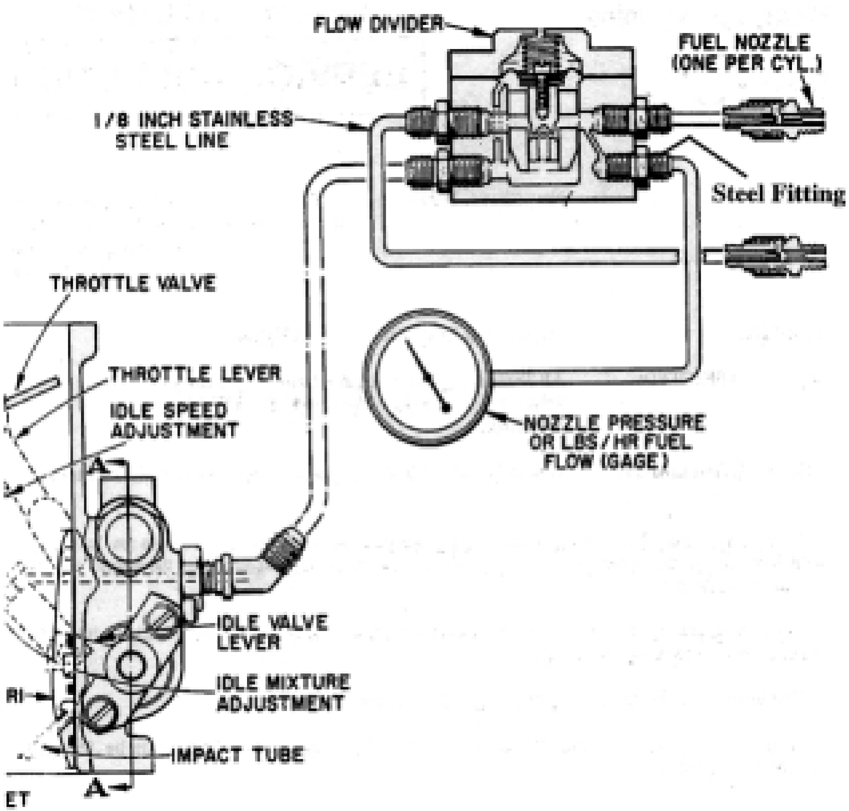
Proper attention to leaning at this stage will help to eliminate or alleviate the fouling and sticking problems.

Rough Engine on PA30

As I have said so many times, I have learned so much from our members and this is another case in point.
Dr. Neil Hayward of Capetown, South Africa, has had a near constant problem with the #3 injector nozzle plugging up on one engine of his PA−30. As there is a 70 micron screen in the servo unit, he had made sure that the hose from the servo unit to the flow divider was good. It was a puzzle where the particles were coming from and each time, it was the #3 cylinder. I was not able to come up with any reason for this.

He and his mechanic found the answer to the problem. The fittings coming out of the flow divider are all brass except the one going to the fuel flow gauge and this is steel. It is also a restrictor. See the drawing. They found this fitting was badly rusted on the inside and happens to be next to the fitting going to the #3 cylinder. It is obvious that the rust particles breaking loose from the fitting found their way to the #3 nozzle. I have sent him two treated (chrome plated) fittings which should not rust.

In the fuel injected singles and twins, besides this restrictor fitting, a stainless steel wire is inside the portion of the fuel flow gauge line from the flow divider to the engine baffling. This must not be removed as it is an additional restrictor.
I thank Dr. Hayward for this information as it should be very helpful to the members.



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TEXTRON LYCOMNIG SB 815.
A mandatory Lycoming S/B #518 affects all of our aircraft. My understanding is that the 180 and the twin use #75944 bypass valve and the 250, 260 and 400 use #53E 19600 bypass valve. Please have your mechanic check these and if yours has one of these valves, comply with this bulletin.
DATE: November 4,1994 Service Bulletin No. 518

TEXTRON Lycoming

Reciprocating Engine Division/
Subsidiary of Textron Inc.
652 Oliver Street
Williamsport, PA 17701 U.S.A.

MANDATORY SERVICE BULLETIN

(Supersedes Service Instruction No. 1423)
Engineering Aspects are FAA Approved

SUBJECT:
Inspection of Thermostatic Bypass Valves

MODELS AFFECTED:
All Textron Lycoming engines employing thermostatic bypass valves P/N 53EI9600, P/N 75944, P/N LW−13230 and P/N 53E19980.

TIME OF COMPLIANCE:
Within the next 25 hours of operation and then annually thereafter.

Textron Lycoming has received reports that a number of thermostatic bypass valves are in service with loose crimp nuts. It has been shown that the nut can work free and drop into the engine causing severe engine damage.

All thermostatic bypass valves must be inspected within the next 25 hours of operation with subsequent inspection each year thereafter.

The thermostatic bypass inspection consists of two steps:

Step 1 is the dimensional inspection of the crimp nut. The crimp depth on the nut must be .161 − 167 as shown in Figure 1.

Step 2 is the physical inspection of the crimp nut to ensure it is seated and solid on the shaft.
Separate the seat and retaining nut by holding the valve assembly in one hand and compressing the valve spring with the forefinger and thumb. (See Figure 2.) With the seat and nut separated, grasp the crimp nut with the other hand and attempt to move it. The crimp nut must not move.
If the thermostatic bypass valve does not meet either step of the inspection, it must be replaced immediately.

Make appropriate log book entries for each inspection.

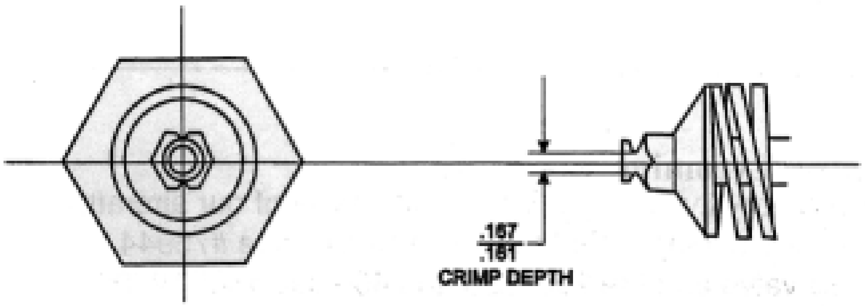


Figure 1.

Figure 2.

Cleaning Solvent

Gun Barrel Cleaning Solvent (such as Hoppe's #9) has a few good uses around the airplane. As it is a lead solvent it will dissolve the lead deposits that make separating exhaust system slip joints a knuckleskinning experience. Available at any sporting goods or gun shop for a low price, make sure you get a brand of cleaner that specifically says it will remove lead fouling. Get the aerosol spray can only as it allows you to direct a stream of solvent into the joint from a distance. This solvent can also be used to super clean the lead fouling deep in the recesses of your spark plugs. A shot of the lead solvent around the valve stem bases might not be a bad idea when the exhaust is off. Thanks to Ron Newberg of Canada Aero Engines, Orillia.

What's all this Sparkling Metal Stuff in my Oil?

Larry Clark, ICS #10059 A&P, I.A.

What happens to that little bottle of oil that you collect from your engine during the oil change? The following information was obtained from Aviation Oil Analysis (AOA) who has a lab located here in Phoenix. They have over 20 years of experience in spectrographic oil analysis. In this article, I hope to also answer the age old questions; "Why should I take an oil sample?" and "What does a sample tell me?"

First, when that little bottle of oil arrives at the lab, it gets numbered and correlated to a report sheet that links the oil sample to your aircraft tail number. AOA maintains a data base of previous oil samples from that aircraft, in order to provide historical trend information, or changes in the element levels as compared to past samples. AOA receives hundreds of those little bottles each day, and not just from piston engines, but also turbine engines, helicopter gear boxes and even aircraft hydraulic systems. They also analyze oil, fuel and coolant samples from trucks, cars and heavy equipment.

One sample by itself may not tell you too much, unless the individual element levels are very high. AOA can compare a single sample from one engine to their data base of samples from similar engines with the same hours. But the best way to compare your sample is with previous samples from the same engine. I would never buy an airplane without seeing a report from at least one oil sample, and preferably a history of oil samples over hundreds of hours. When you consider the cost of the airplane you are about to buy versus the price of an oil sample kit, it is foolish not to take a sample and have it looked at by a laboratory.

Back to the lab where the oil sample is placed into an atomic absorption spectrophotometer for the first run. On piston engines they check for 7 elements: aluminum, iron, copper, nickel, chrome, silver and silicon. Each element is searched for individually so that the test is more accurate. Lead is something they don't look for since we bum leaded fuels. Water is another item that they skip (unless you have a water cooled engine in your Comanche). Boron and sodium are coolant elements and have no bearing on reciprocating engines either. Phosphorus, zinc, calcium and barium are oil additives, and due to the relatively low oil change intervals on most aircraft engines, the additive levels are rarely depleted. Titanium, molybdenum, cadmium and barium are only trace elements in alloys and testing to find them would only increase the analysis cost and provide information with very little value.

Ph or Total Acid Number (TAN) and viscosity are indicators of the oil condition. Testing for these is only done if the operator is approved for extended times between oil changes. If you are following the engine manufacturer's recommended oil change cycle (hours and/or 4 months, see Lycoming SB 480) you should not need this extra test information. Fresh oil is relatively inexpensive when you consider how much cleaner, better and possibly longer your engine will run with regular oil changes.

Now that we know what is in the oil sample, what's next? A technician will look at the element levels, and if one or more are out of the ordinary, they will consult with the lab's chief chemist to try and determine what is going on with this sample or your engine. This could result in a telephone call to you to discuss the test results and consider what action should be taken. It could involve running the engine for a shorter oil change cycle and taking another sample. In some cases it may involve your mechanic and the possibility of additional inspections of your engine, including internal examination of some specific parts. This is where the real value of regular oil analysis pays off; it is much cheaper, and safer, to replace worn parts on the ground, rather than wait for the internal engine destruction (a.k.a. LOUD BANG) that can occur when a part fails in flight.

If all appears to be within normal levels for your oil sample, you can expect a written report which will be mailed within 24 hours. The report will list the Parts Per Million or PPM of the various elements. Remember, PPM is very small traces, much smaller than anything you can see with the naked eye when looking at an oil screen or an oil filter after it has been cut open. The PPM size elements are suspended in the oil and circulate within the oil system right through a filter or screen.

This is why it is important to drain your oil when the engine is warm, while the particles are suspended in the oil. Also, take your oil sample midstream, or during the middle time period of the draining. The readings may be higher at the beginning and end of the flow.

Large amounts of iron can come from broken rings. Also large amounts of chrome if you are flying with chrome cylinders could mean a broken piston ring. In most oil samples iron will be the predominant element since it is used in gears, bearings, shafts and pump gears. Large amounts of silicon can mean that your air cleaner element needs to be cleaned or changed. Silicon is dirt. Maybe it's normal, if you are flying from a dusty airport or you used too much of the silicone lubricant on the oil filter gas kit. Aluminum is used in pistons and piston pin plugs. Large amounts of aluminum could mean piston wear, and perhaps oil pump problems if you have aluminum oil pump gears. Copper is the result of bearing or bushing wear. Silver is also an indicator of bearing wear and is also used in oil cooler repairs. Nickel is an alloying element present in materials used for gears, shafts and bearings.

And AOA can also analyze metal particles found in your filter or screen, to tell you what they are and where they may have come from inside your engine. Cut open your paper filter element, and using a cleaning solvent, rinse the metal particles into a clean container. Send the container to AOA and they will provide you the results of their testing. The size and shape of any metal particles are important to determining where they may have come from. (Some people don't get concerned unless the "particles" are large enough to have part numbers.)

In summary, a regular oil analysis program is very important to knowing the health of your engine. It is not an answer to everything. Regular compression checks and other maintenance procedures will also help ensure that you get all the hours that your engine has in it. For the cost, an oil analysis kit is one of the best values in aviation safety. I have been using oil analysis on everything that I have owned or flown, and recommend it very highly.

Engine Maintenance S/B #388B Valve Wobble Check

From the Desk of MAURICE TAYLOR

Lycoming service bulletin #388A was called the Mid−Life inspection due every 1,000 hours. Then in May 1992 they issued service bulletin #388B requiring this inspection every 400 hours. This inspection determines the valve stem to valve guide clearance. If it's too small the valve is apt to become stuck in the guide. If it is too loose then the valve will not be properly cooled and is apt to fail such as the head breaking off. This is not a big time consuming job as neither the cylinders nor valves need to be removed. The rocker arm and springs are removed while on the engine. A special fixture (#ST 7 1) and measuring instruments are needed. Most shops should have the equipment and know what to do.

ED: Please refer also to AD 2005-0023 and Lycoming Service Bulletin 388C, Nov22, 2004.

Overheating Problem II

Tony Stamiello Jr., ICS #03662

The October 1996 Comanche Flyer, Volume 23, No. 10, contained an article about overheating written by John T. Williams ICS #05337. The article states that "My Comanche has always had a tendency to overheat as evidenced by oil temperature at or near red−line on climbout. It is an insidious problem that is difficult to detect, and it becomes progressively worse as the years go by."

My Comanche PA24−250 has been in the family since early 1960, so I know every sound she makes and what every instrument traditionally indicates. During 1995, 1 chose to do a Top Overhaul (TOP), because I had some non−repairable exhaust gas leaks where the manifold pipes and the block meet. For at least a couple of years prior to this time, I had also noticed the oil temperature gauge was indicating warmer temperatures, especially during long climb−outs. I kept an eye on this condition, but considered it normal because the areas I was flying in at the time were much warmer climates or at higher elevations than the Pacific Northwest coast area where I generally fly.

After TOP I did some local flying and noticed that the engine oil was indicating warmer than the normal temperature range that I had remembered. I had not used the plane for about six months so was slightly unsure about the oil temperature indications. After taking some trips to other climates that were warmer and higher, it was obvious something was not right.

I discussed the problem with our local FBO person, John Twiss of Twiss Air Service, who is very good with Comanches, and we took a flight. All indications were, of course, normal. It did not occur to me that one contributing factor to the normal temperature indication was that it was cold outside. Later in the summer, when my FBO guy was out of the country, I went pleasure cruising, and my oil temperature was again headed for the red zone. I returned to base, parked my baby, scratched my head, thinking I had nobody to help me solve my problem. I went home with my head hanging, contemplating about looking through all those stacks of old Comanche Flyers for help, opened the mail box, spotted the new issue Volume 23, discarded the junk mail, bills and such, opened the book to page 23 and found the article OVERHEATING PROBLEMS by John T. Williams.

When my FBO guy returned from his sojourn out of country, I showed him the article, to which he responded that it was possible; he also listed some other probabilities. I decided to call our Guru, Maurice Taylor, and get his input about John T. Williams' suggestions. Maurice Taylor returned my call post haste and asked me several questions, and then said he wanted to ponder a bit and would get back to me.

We discussed the replacement of a thermal control valve. I believe it’s called a (ver−i−therm). Maurice called me back within an hour and said the solution seemed reasonable, but since the part costs 200 plus bucks, he suggested I test the old part before I called Wells Fargo. Mr. Taylor told me that the part (ver−i−therm) must expand from room temperature, about seventy (70) degrees, .053 inch or 1/2 inch at 180 degrees.

John Twiss and I removed the old part and put it into a glass coffee pot on a stove, and used an electronic turkey probe for a thermometer. The part expanded only about one quarter (1/4") of an inch; we tested it four different times. You could say I was somewhat delighted, (less $200 that is) that we were reasonably sure about a cure. I would suspect that since it was opening partially, this might account for the engine running only warmer, but not overheating. However, whenever the engine started to run hotter, I always took precautions to keep the engine cool, so I never really new if the Comanche oil gauge would red−line.

All indications are that my Comanche is back to normal, making all its usual sounds, and indicating all its normal indications. So thanks to John T. Williams, Maurice Taylor, and my FBO guy John Twiss, for listening.

400 Hot Starting − No Problem now

Gil Dahl, N400SW ICS #00744

The 400 Comanche, with the original 700 Bendix magnetos had to be the worst engine in the general aviation fleet to hot start. The 700 mags needed to be removed and adjusted at every oil change, but few owners did. The 400 earned a reputation early on: pick a good lunch stop because you might have to eat dinner there too. This is the main reason Piper only produced them for two years. Piper tried a fuel purge system, dumping hot fuel overboard. Lycoming offered a 24−volt starting system, and later Bendix developed the 1200 Series mags. These helped but still didn't solve the problem. I had passengers tell me after a flight that they were worried the whole trip about the mechanical condition of my Comanche since I had so much trouble getting it started.

About 15 years ago I converted the right mag to "Shower of Sparks" and installed a second Bendix starting vibrator and a 5amp, 12 volt battery on the firewall. This system is isolated from the normal aircraft system and is triggered by a switch on the panel when making a hot start. This made a big improvement, but I was still not comfortable making a hot start.

I have finally solved the problem. I replaced the old Bendix vibrators with the new Slick START magneto boosters built by Unison Industries. These are solid state, sealed boosters that supplies a lot more energy to the mag than the old Bendix vibrators. Now a hot start on just one mag is as good as I used to get from two mags, but when I trigger the second; it starts as well as any fuel injected engine. I no longer worry about a hot start. Unison Industries does not have a STC for this conversion on the 400, but I had no trouble getting one time approval from the FAA via a form 337.

I owned a 250 Comanche for seven years and hot starts were never a problem, but I sometimes had trouble starting when it was very cold. Since the 250 only had one impulse coupling, which puts out only a momentary spark for each compression stroke, everything had to be just right to fire that cylinder. The Slick START puts out a hot spark for a longer period of time, which will help starting.

Unison produces two different units, SS 1002 for Bendix mags which I used, and SS 1001 for their own Slick magnetos. They tell me the SSI001 puts out about three times more energy than the SS 1002,.

According to the instructions that came with the installation kit (which included everything needed to install the Slick START), Unison Industries has an STC for the 180, 250, 260 and twin Comanches with impulse coupling or "Shower of Sparks." If you are having any trouble starting your Comanche, hot or cold, I would recommend installing a Slick START unit, and on the 400 two Slick STARTS are the answer.

Exhaust Support for the 180

Bill Creech, ICS #03423

Some time ago, a friend of mine and fellow 180 driver by name of Ward Whipple, had a potentially serious exhaust failure. His only symptom was that when he checked his carburetor heat prior to takeoff, his engine nearly stopped. There was nothing obviously wrong on casual inspection. Only when he removed the exhaust muff on the right side of the engine, did he discover the problem. His exhaust pipe was broken just aft of the number three cylinder! This type problem has long been prevalent on the 250 and has resulted in the publication of SL 412A, dated May 6, 1964. This letter requires the installation of a muffler support between the rear of the engine and the muffler.

I've flown my 180 over two thousand hours without exhaust problems and Ward's was the first time I'd heard of this on a 180. A query to Maurice on the subject revealed that in fact, he was aware of a number of such incidents on the 180 but was unable to shed any light on the subject of why the service letter only applied to the 250.

For the first time, I really compared the muffler geometry on my 180 to a 250 and low and behold, the moment arm is longer (muffler to engine) on my 180 than it is on the 250. This would indicate, at least on the face of it, that the problem should be greater on the 180 than the 250. With this in mind, we set out to fabricate a muffler support for both Ward's and my airplane.

With the help and guidance of our local sheet metal, engine, aircraft, welding, and Jack of all trades guru, Dean Moon, we fabricated exhaust supports for our birds. One of the first problems was to find a place to attach the brackets to the engine. On the 250, it's no problem, but on the 180 we have the propeller governor on the rear of the engine, which severely limits the available attach points. After much measuring and cogitating about the problem, we decided on two separate brackets from the engine. The upper one is attached to the upper mounting stud of the right magneto. The lower one is attached to the left rear mounting stud for the carburetor. The muffler clamp is made of 4130 .050 steel strap and is twenty inches long (circumference) by one and three eighthswide. The photo shows the location of the two bracket ears where the support arms attach. Both of the support arms are also made of 4130 tube, three eighths by .049 wall thickness. The nominal length of the upper bracket is fourteen inches and the lower one is eighteen and five eighths. I emphasize nominal, because it will vary a bit from aircraft to aircraft, so measure on your bird before you finalize this dimension. Left to right spacing of the muffler bracket will affect the amount of clearance between the upper arm and the oil filter, so check this carefully.

One of the big surprises came when we had our local resident IA check with the Feds on the kind of approval needed. I fully expected that he'd want a form 337, but glory be, he said just make a log entry.

This bracket really gives a solid feel to the assembly, and though I've only flown mine a couple of times, there's an added "warm feeling" knowing my exhaust is firmly in place. Thank you Ward for helping make our 180 fleet safer.

From the Tool Box of Maurice Taylor

ENGINE MOUNT INSPECTIONS: All of our aircraft have engine mounts made of 4130 steel that will rust. At annual time inspect per item 43 on single engine and item 42 on the twins on the inspection report. On many of our singles, the mufflers are now hollow. If this is the case on your aircraft, be sure that your IA has C/W PIPER S/L 431 to help keep the extra heat away from the engine mount. If this has been done, then be sure that if something like a fire sleeve was used that it is removed at each annual to check for corrosion.

If you have a turbo model of a single or twin, this problem of too much heat on the engine mount legs must be watched closely. Utilize any kind of baffling to help in keeping the very high temperature away from the engine mount as much as possible

Oil Drain Plug Leak (Nov 2002)

Mike Rohrer ICS #13392

Has this ever happened to you? You finished putting the last quart of oil in your engine just in time to see oil dripping out of your drain plug? Try this. Start your engine. Let the oil circulate. Shut it off and then take your shop vacuum, slip the end over the dip stick tube and turn it on, or have someone hold it just a fraction of an inch above the opening. Doing this will not suck out any oil. With the vacuum on, remove the drain plug, clean out the piece of whatever that is stuck, and re-install. Works every time, and no mess.

The Rope Trick (Nov 2002)

Mike Rohrer ICS #13392

Here is one more. To repair a stuck valve without removing the cylinder, remove both spark plugs. Insert about 4 - 5 feet of nylon rope (any rope will work) into the cylinder through the spark plug hole. Turn the propeller until the piston pushes the rope up against the valves. This will hold the valve up while you remove the keepers on the valve stem. When this is complete, turn the propeller to put the piston on the bottom of the stroke. Remove the rope, push the valve into the cylinder and then ream the guide. With a flashlight and mechanical fingers put the valve back into the hole. You have just saved a few hours. I can do this procedure in about 1 hour or less. I have had a lot of practice with a local Cessna 150 that does not get leaned enough while taxing.

Exhaust Port Cracks (Dec 2002)

Mike Rohrer ICS #13392

I covered this before, but feel it is important to bring up again. I remove the exhaust to help with the inspection of cracks in the exhaust port / fin area. At Oshkosh, I brought a cylinder for `show and tell' that had a crack in the exhaust fin area. This is usually found in cylinders that were overhauled and have approximately 600 to 800 hours on them. It can be found by looking with a very bright flashlight and looking up into the fin area between the spark plug (lower) and exhaust pipe. It can be verified by spraying dye penetrant into the exhaust port and waiting about 15 minutes. If you see dye coming into the fin area, it's a crack. Recently, a PA28-180 landed with a very bad miss, and we found that the #3 cylinder head had a crack almost completely around the circumference, which radiated from the crack in the fin area. It had just a little over 100 hours since the crack was first detected.

Cruise OPS - Is 'OVER SQUARE' Really a Bad Thing? (Mar 2003)

Johnathan Socolof ICS #14267

I don't know where it started, and I cannot find any reference to support it, but I hear it all the time. In fact, the mere mention of anything to the contrary is sure to invoke the wrath of fellow pilots, flight instructors, and old-timers alike. It must be one of those things that just is because we are simply taught to operate this way.

I am talking about the idea of never operating our engines at power settings with a manifold pressure in inches higher than the RPM in hundreds or "over-square", lest we wish to create internal pressures that will overstress and damage our engines.

So where did this notion come from? No one seems to know for sure, although it is surprising that in the face of all the documentation to the contrary, this misinformation continues to exist. In fact, I could find no supporting documentation for this type of operation from any authoritative source. It may be a holdover from the radial engine days or the admonitions of countless CFIs to "reduce manifold pressure before RPM, increase RPM before manifold pressure". Although valid and correct, this instruction was never meant to imply "never run your engine over-square". Modern engine design, along with improved metals and lubricants, permit changes in the operation of our flat, opposed cylinder power plants. Pilots who still believe that square power settings are necessary should be urged to read and understand the information in the Pilot's Operating Handbook. While there are limits, those settings listed in the POH have been flight tested and approved by the airframe and engine manufacturers.

We wouldn't drive our car on a highway in 3rd gear, so why are we trained to operate our aero engines this way? Let's suppose we are driving our car onto a highway. As we accelerate onto the highway, we use our low gears (high RPM) to increase our speed until we reach our cruise speed (maybe 60 MPH). During this process, we instinctively shift through the gears to reduce RPM, noise and fuel consumption. Once at cruise, we find ourselves in a high gear, low RPM mode. Our cruise speed doesn't change and our engine is not working nearly as hard as it was during the acceleration. Of course, we could cruise along in 3rd gear and would still be operating in the green, but it would be noisy and uncomfortable, and we just wouldn't do it. So, why don't we apply this reasoning to managing the engine in our aircraft.

But "over-square" operation will damage our engines. Who said it would? Both Piper and Lycoming say no. According to their own printed material, not only is it okay to operate most engines at high MP and low RPM, for cruise operation it may be the best way to operate them. When asked, Lycoming refers pilots to the cruise power charts in the Pilot's Operating Handbook. "Whatever the combinations of RPM and MP listed in the charts - they have been flight tested and approved by the airframe and power-plant engineers". Just look at your power charts and you will see a lot of settings where MP in inches exceeds RPM in hundreds. As a result, "if the POH lists 2,200 RPM and 26 inches of MP as an approved power setting, pilots should not be apprehensive about using that setting if it meets their needs".

Since every airframe and engine combination has their own idiosyncrasies, it only seems logical that we should explore the various power setting combinations in the POH to determine those settings that provide the best results of speed, fuel consumption and noise for our particular aircraft. So what combination of RPM and MP would be best to use at cruise?

Lycoming recommends the pilot try the various combinations over a five-minute period when flying in smooth air and use the RPM and MP that give the least vibration and the lowest noise level. Piper (Comanche Owners Handbook) recommends, "For minimum fuel consumption and maximum efficiency, the best power settings during cruising flight are with minimum RPM and the necessary Manifold Pressure to obtain a given percent of power, consistent with any POH limitation. Engine smoothness and noise level should be major factors in determining the best RPM." So let us discuss some of the reasons why high MP and low RPM operation may be the best way to operate our engines in cruise.

But first, I am not an engineer and this is not meant to be a technical discussion. I am a Comanche owner looking to maximize the efficiency and performance of my aircraft. This discussion is limited to normally aspirated, non-turbocharged piston engines and applies to cruise operations only. I would never suggest the use of low RPM during takeoff or climb, or low RPM settings not approved in the POH.

Piston engines are remarkably consistent in their efficiency. In other words, efficiency does not change much with air temperature or RPM. The only significant factor affecting the efficiency of the piston engine is throttle setting. When the throttle is retarded (making the manifold pressure lower than surrounding air pressure), the engine loses efficiency (Ray Preston Aerodynamics Text).

Any given amount of power can be produced by any number of manifold pressure and RPM combinations. For example the following MP x RPM combinations all produce equal amounts of power:
22 MP x 2400 RPM
23 MP x 2300 RPM
24 MP x 2200 RPM

Therefore, the engine will be more efficient if the pilot chooses the higher MP and lower RPM combination. This, of course, assumes that the pilot leans the mixture to the maximum economy setting, as specified in the Pilot's Operating Handbook. We choose this option for the same reason we choose fifth gear in our car.

Of course, any power setting will have an optimum altitude for our engine. This will be the altitude(s) at which full throttle produces the desired amount of power with the mixture set for maximum economy. Once you climb past this altitude, the altitude at which you run out of throttle, you have no choice but to increase RPM to maintain cruise power.

The higher RPM you use, the more often the pistons go up and down in the cylinders and the more fuel is consumed (each intake stroke draws fuel for combustion), and the more metal on metal contact friction is generated, consequently resulting in more engine wear. We can therefore infer that a lower RPM would result in less fuel consumed, less wear, and engines that last longer. Lower RPM also means more thorough combustion, by allowing more time for the fuel / air mixture to burn and gasses to expand within each cylinder, resulting in lower EGT and cleaner plugs.

Lets look at the math. "Cruising at 2,100 RPM instead of 2,350 RPM over 1,000 hours may save as much as 15 million crank rotations, seven million cam rotations and 75 million piston reciprocations. In addition, at 2,350 RPM, our engine may lose as much as 35 HP due to internal friction. By reducing RPM to 2,100, that figure may drop to 25 HP, which means we are delivering as much as ten more HP to the propeller at the same fuel flow." (Mike Busch, AVweb July 1995)

In addition to engine efficiency, we must also look at the efficiency of the propeller at converting the power into thrust. Propellers tend to operate more efficiently at lower RPM. The higher the RPM setting, the closer the propeller tips are to the speed of sound and all the compressibility and associated high drag effects. At 2,700 RPM, the tips may be traveling close to Mach 1, and the resultant sonic shock wave steals a good deal of power that would otherwise be converted into thrust. So, obviously, the slower the prop turns, less energy is wasted making noise and is available as thrust. Also, as we previously discussed, lower RPM allows us to deliver more HP to the propeller that would otherwise be wasted.

Piper and Lycoming have applied their vast experience and engineering in writing the POH for your aircraft. They have thoroughly tested their products and provided in the operations procedures those techniques and settings designed to maximize performance, safety and efficiency. Although there are no secret techniques that will give better than book performance numbers, if you're not getting book numbers when you fly, try the different setting in the POH. There might be a few extra knots waiting for you at your favorite power setting?

Engine Overhaul Terminology and Standards (Jan 2004)

Mahlon Russell

TBO time draws near and you need to decide on a course of action. You call around, talk to your maintenance facility, and find that you are totally confused because you don't understand or know the definitions of many of the terms used by the people that you have been talking to.

New limits, Service limits, Remanufactured, Rebuilt, New, Used, Overhauled, Like new, OEM, Aftermarket, what does it all mean?

Lets look at and define the terms that are approved to be used by the FAA.

A **New Engine** that has been manufactured from all new parts and tested by an FAA-approved manufacturer. The engine will have no operating history except for test cell time when received. No FAA approved manufacturer can approve another entity to manufacture or assemble a **New Engine**.

New Limits are the FAA-approved fits and tolerances that a new engine is manufactured to. This may be accomplished using standard or approved undersized and oversized tolerances. **Service Limits** are the FAA approved allowable wear fits and tolerances that a new limit part may deteriorate to and still be a useable component. This may also be accomplished using standard and approved undersized and oversized tolerances.

An **Overhauled Engine** is an engine that has been disassembled, cleaned, inspected and repaired as necessary and tested using FAA approved procedures. The engine may be **Overhauled** to **New Limits** or **Service Limits** and still be considered a FAA-approved **Overhaul**.

The engine's previous operating history is maintained and it is returned to you with zero time since major **Overhaul** and a total time since new that is the same as before the **Overhaul**. A **Rebuilt Engine** is an engine that has been **Overhauled** using new and used parts to **New Limits** by the manufacturer or an entity approved by the manufacturer. At the current time neither Teledyne Continental nor Textron Lycoming approve any other entity to **Rebuild** engines for them. The engine's previous operating history is eradicated and it comes to you with zero hours total time in service, even though the engine may have had used components installed that have many hours of previous operating history. Textron Lycoming uses the term "remanufactured" in their advertising and commercial media to describe their factory-rebuilt engines. Although this term has no official definition in the eyes of the FAA, when used by the Textron Lycoming and only when used by Textron Lycoming the term Remanufactured should be considered the same as the term **Rebuilt**.

When an engine is **Overhauled** or **Rebuilt**, the new parts that are used during the repair process can come from a variety of sources. An **O.E.M.** part is a new part that is manufactured by the original engine manufacturer to stringent FAA standards. An **Aftermarket** part is a new part that is manufactured by someone other than the original engine manufacturer that meets or exceeds the same stringent FAA guidelines as a new **O.E.M.** part. Any other terms used to describe the work performed during a engine overhaul are defined by the person or entity using them. They have no official meaning and often times are very misleading. Terms like "overhauled to factory specs or tolerances," "rebuilt equivalent," "overhauled to like new condition" and "remanufactured to factory fits and limits" and any other terminology that isn't defined above needs to be investigated as to what those terms actually mean. You will probably find that advertisements and log entries that use undefined terminology are not really delivering what you think you are getting.

There are specific requirements by the FAA for the use of the terms **Overhauled** and **Rebuilt** in an engine's maintenance records. If these requirements are not met, it is illegal to use the terms. Any terms other than those listed have no meaning in the eyes of the FAA and should not be accepted by you in your engine logbooks.

Now that we understand all the terms, let's put it all in a nutshell.

Only the manufacturer can currently produce a new or rebuilt engine.

Both new and rebuilt engines are made to new limits. A new engine will have all new O.E.M. parts. A rebuilt engine can be produced using a combination of used and new O.E.M. parts. An overhauled engine can be done to new limits or to service limits or a combination of the two using used parts and new O.E.M or new aftermarket parts. An overhauled engine comes to you with its previous operating history intact and zero hours since major overhaul. A new or rebuilt engine comes to you with no previous operating history and zero hours time in service, even though, in the case of a rebuilt engine, some of the parts used may have a previous operating history.

Understanding these terms and the regulations that apply to them may make the decisions that you have to make, at TBO time, a little easier.

Mahlon is a graduate of Parks College of Aeronautical Technology with 29 years of experience in the repair and major overhaul of general aviation piston engines. He has been employed at Mattituck Airbase for 26 years, with 10 years as Service Manager and 12 years as Production Manager.

Suggestions for Proper Engine Break-In (Feb 2004)

Mahlon Russell

Whenever an engine's piston rings are replaced – whether in part or in entirety – it is necessary to break in the engine. Piston rings are replaced at a complete engine overhaul or repair, top overhaul or single cylinder overhaul or repair.

When we refer to engine or cylinder break-in, we are talking about the physical mating of the engine's piston rings to its corresponding cylinder wall. That is, we want to physically wear the new piston rings into the cylinder wall until a compatible seal between the two is achieved.

Proper engine break-in will produce an engine that achieves maximum power output with the least amount of oil consumption due to the fact that the piston rings have seated properly to the cylinder wall.

When the piston rings are broken in or seated, they do not allow combustion gases to escape the combustion chamber past the piston rings into the crankcase section of the engine.

This lack of "blow-by" keeps your engine running cleaner and cooler by preventing hot combustion gases and by-products from entering the crankcase section of the engine.

Excessive "blow-by" will cause the crankcase section of the engine to become pressurized and contaminated with combustion gases, which in turn will force normal oil vapors out of the engine's breather, causing the engine to consume excessive amounts of oil.

In addition to sealing combustion gases in the combustion chamber, piston rings must also manage the amount of oil present on the cylinder walls for lubrication. If the rings do not seat properly, they cannot perform this function and will allow excessive amounts of oil to accumulate on the cylinder wall surfaces. This oil is burned each and every time the cylinder fires. The burning of this oil, coupled with "blow-by"-induced engine breathing, are reasons that an engine that hasn't been broken in will consume more than its share of oil.

When a cylinder is overhauled or repaired, the surface of its walls are honed with abrasive stones to produce a rough surface that will help wear the piston rings in. This roughing up of the surface is known as "cross-hatching." A cylinder wall that has been properly "cross hatched" has a series of minute peaks and valleys cut into its surface. The face or portion of the piston ring that interfaces with the cross-hatched cylinder wall is tapered to allow only a small portion of the ring to contact the honed cylinder wall. When the engine is operated, the tapered portion of the face of the piston ring rubs against the coarse surface of the cylinder wall causing wear on both objects. At the point where the top of the peaks produced by the honing operation become smooth and the tapered portion of the piston ring wears flat break in has occurred.

When the engine is operating, a force known as Break Mean Effective Pressure or B.M.E.P. is generated within the combustion chamber. B.M.E.P. is the resultant force produced from the controlled burning of the fuel air mixture that the engine runs on. The higher the power setting the engine is running at, the higher the B.M.E.P. is and conversely as the power setting is lowered the B.M.E.P. becomes less.

B.M.E.P. is an important part of the break-in process. When the engine is running, B.M.E.P. is present in the cylinder behind the piston rings and its force pushes the piston ring outward against the coarse-honed cylinder wall. The higher the B.M.E.P., the harder the piston ring is pushed against the wall. The surface temperature at the piston ring face and cylinder wall interface will be greater with high B.M.E.P. than with low B.M.E.P. This is because we are pushing the ring harder against the rough cylinder wall surface causing high amounts of friction and thus heat.

The primary deterrent of break in is this heat. Allowing too much heat to build up at the ring to cylinder wall interface will cause the lubricating oil that is present to break down and glaze the cylinder wall surface. This glaze will prevent any further seating of the piston rings. If glazing is allowed to happen, break-in will never occur. We must achieve a happy medium where we are pushing on the ring hard enough to wear it in but not hard enough to generate enough heat to cause glazing. If glazing should occur, the only remedy is to remove the effected cylinder, re-hone it and replace the piston rings and start the whole process over again.

Understanding what happens in the engine during break-in allows us to comprehend the ideas behind how we should operate the engine after piston rings have been changed. The normal prescribed flight procedure after ring replacement is to keep ground running to a minimum, takeoff at full power and reduce to climb power at the first available safe altitude, all while keeping the climb angle flat and the climb airspeed higher to promote the best cooling possible. At cruise altitude we should use 65 to 75 percent power and run the engine richer then normal. At all times we are to remember that heat is the greatest enemy of engine break-in, we should try to maintain all engine temperatures in the green, well away from the top of the green arc or red line. This means step climbing the aircraft if necessary, operating with the cowl flaps open or in trail position during cruise flight and being generous with the fuel allocation for the engine.

We should not run the engine above 75 percent power in cruise flight because the B.M.E.P is too great and the likelihood of glazing increases. As you can see, keeping the engine as cool as is practical and at a conducive power setting is the best combination for successful engine break in.
After an engine is overhauled or has a major repair, it is run in a test cell to ensure operating characteristics and to begin the break-in process. However this process may take as long as 100 hours of operation to complete. You, the pilot, are in control of engine break in for 98 percent of the time that it takes to occur. This is a serious responsibility when you consider the expense and aggravation of having to remove, re-hone and re-ring cylinders that have glazed and not broken in.

Hopefully, understanding what engine break in is, as well as what is happening in the engine while the rings are seating and how our flight procedures effect the break in process, will help us to achieve the quickest and most efficient break n after piston rings are replaced.

Engine Sudden Stoppage (Mar 2004)

Mahlon Russell

What is a prop strike? Is it a sudden engine stoppage regardless of the cause? Is it an occasion when a prop blade strikes a foreign object and the engine continues to run? Is it hitting a rock or other loose object with a prop blade while operating on a runway or taxiway? Is it when something or someone impacts a prop blade when the engine isn't running?

The only pertinent FAA definition that I have been able to find is in Advisory Circular 43.13-1A. It defines a sudden engine stoppage as: stopping an engine in one revolution or less for any reason, be it from propeller impact or from an engine failure of some sort. Both major engine manufacturers have service literature that explains the desired course of action after accidental propeller damage and, in the case of Teledyne Continental, defines what their interpretation of a propeller strike is.

TCM's Service Bulletin 96-11, in a nutshell, says that if a propeller must be removed from the aircraft to be repaired following a propeller blade impact of any sort or if the engine physically lost RPM's from the incident, then the engine has experienced a propeller strike and it should be removed from service and completely disassembled and thoroughly inspected for damage from the incident.

Textron Lycoming, in their Service Bulletin 533, takes the approach that the safest procedure is to take the engine apart for inspection following any incident involving propeller blade damage. However, they have the caveat that the inspecting mechanic may override that position and return the engine to service without disassembly and inspection if he feels that it is the prudent and responsible thing to do.

Textron Lycoming has also published Service Bulletin 475B which requires, in the event that the engine has experienced a propeller strike, inspection and possible rework of the accessory gear train as well as the rear of the engine's crankshaft.

Compliance with this service bulletin is mandatory in the eyes of the FAA by AD note 91-14-22, if and only if, the engine has experienced a sudden engine stoppage not a propeller strike. It should be noted that to comply with AD note 91-14-22, the engine does not need to be completely disassembled and that access to the accessory gear train can be accomplished, in most cases, with the engine still installed in the aircraft.

What this all boils down to is that in the case of any accidental damage to a propeller installed on a aircraft operating under Part 91 of the FARs, it is up to the inspecting technician to determine if the engine should continue in service without total disassembly and inspection. A Textron Lycoming engine, that is being operated on a Part 91 aircraft, that had a sudden engine stoppage, not a propeller strike, must comply with A.D. note 91-14-22 and Service Bulletin 475B at a minimum.

Teledyne Continental-powered aircraft operating under Part 135 of the FARs, that have to comply with all manufacturers service bulletins, would have to comply with Service Bulletin 96-11 requiring total disassembly and inspection after any incident that required removal of the propeller for repairs or if the engine physically lost RPM's during the incident. An aircraft, operating under the same regulations, that is powered by a Textron Lycoming engine, would have to comply with Service Bulletin 475B after a propeller strike of any kind and would also have to comply with AD note 91-14-22 if the propeller strike was deemed a sudden engine stoppage. On these Textron Lycoming powered aircraft, it is the responsibility of the inspecting technician to determine if the engine should be removed from service for disassembly and inspection.

These are the legal requirements as I see them. There may be other additional requirements mandated by insurance policies or engine manufacturer's and or overhauler's warranties. Either may require additional inspection requirements but neither may negate the inspections required by the FAR's. Never allow an insurance adjuster to dictate the inspection requirements after an incident. Always rely on the inspecting technician, applicable service data and the FAR's to dictate how thorough an inspection is necessary to continue the engine in service.

After the extent of the inspection has been determined, it is important, as with any major repairs that are accomplished on your aircraft, to find out exactly what is included in the estimate to repair your engine following a prop strike. Are the minimum legal requirements being met? Is the engine being completely disassembled and inspected? What other services or inspections are being performed at the same time as the inspection? If the engine is being disassembled does the estimate include testing after reassembly? Are any of the engine's accessories inspected and if so to what extent?

Are there any hidden costs? After finding out the answer to these questions, it's time to discuss with your insurance company what they will pay for and what they won't, before it's a big surprise after the inspection has been completed.

Many insurance companies will not pay for any inspection requirements unless damage from the incident is found during that inspection. Others will pay for all costs for the inspection and for any parts needed due to the incident. Still others will only pay for the labor to do the job and will not pay for any parts.

Finding out what needs to be done and whether that agrees with what you feel should be done, who's going to do it and who is going to pay for it, should help make the experience of a prop strike as painless as possible.

Good Engine Operating Habits (Apr 2004)

Mahlon Russell

There are several good habits that we, as pilots, can develop during pre-flight and engine operation to enhance our safety, as well as elongate our engine's life. The following items are not cumbersome to do and really take very little time or effort to perform.

Logging Fuel and Oil Consumption
By making a notation every time oil is added to the engine or engines we will develop a database that can be useful to maintenance personnel, as well as ourselves, to determine general engine health. By being able to average our oil consumption over many hours of operation, and knowing what that average is, makes it easy for us to see changes that might be important.

If you know that over the last 100 hours of operation you used an average of one quart of oil every seven hours and you find that over the last 10 hours of operation you used three quarts of oil, it is easy to see a problem developing and when it started. Without logging the oil consumption you most likely wouldn't know you had a problem until the engines usage became extreme and there was a possible safety issue.

Likewise, logging and averaging fuel usage may alert us to changes that could cause potential engine problems. Changes in our average fuel consumption, at the same power settings, can alert us to discrepancies in our fuel flow indicating equipment, exhaust gas/turbine inlet indicating equipment or our fuel metering systems. Catching these problems early can save thousands in cylinder repairs.

Keep RPM to a Minimum at Start Up
After engine start-up we should run the engine at the slowest RPM that the engine will continue to run at. If it will stay running at 700 RPM then that is the RPM we should be running at not 1,400 RPM. Allowing the engine to run at a high RPM right after start without letting it warm up can cause premature wear to many internal engine surfaces that are splash lubricated. Some of these splash lubricated components, most notably the camshaft and tappets, are especially susceptible to damage right after start with cold oil and high RPM operation. Keeping the RPM to a minimum will limit the amount of interaction of these components before enough oil has splashed around inside the engine to provide sufficient splash lubrication.

Keep Propeller Cycling to a Minimum
It is absolutely necessary to cycle a constant speed propeller before flight. Not only does this operation exchange cold thick oil in the propeller with warm thinned oil from the engine, it also ensures that the propeller and propeller governor are functioning properly. The amount and frequency of this operation is what is at issue.

When we purposely deep cycle our propellers, that is cycle them down more than 400 RPM, we cause more vibration and chatter on the engines counterweight system than we do if we only cycle the prop down only 300 RPM. This increased amount of vibration and chatter can cause increased wear on the engine's counterweight bushings and pins. The fit of these pins and bushings is what allows the counterweight system to absorb a very specific frequency of harmonic vibrations within the engine. If the fit between these components is compromised we are said to have "detuned" the counterweight system and thus we have severely limited the counterweight system's ability to absorb its intended frequency of vibrations.

These vibrations, when not absorbed, can cause many vibration -elated maintenance problems. Anything from catastrophic engine or propeller failure to minor cracking of engine baffles and cowlings is a possible result of detuned counterweights.

By keeping the frequency and RPM that we cycle the propeller to a minimum, we can maintain the counterweight systems ability to absorb it's intended frequency of vibrations and limit any problems related to detrimental harmonic engine vibrations while still testing the propeller and propeller governor properly.

Proper Engine Warm-Up
Before initializing a full-power application, we should ensure that the engine is properly warmed up. We should have at least 220 degrees Fahrenheit CHT and an oil temp of 110 degrees Fahrenheit on a normally aspirated engine and 130 degrees Fahrenheit on turbocharged engines. When an engine is running, it relies on the temperature of certain components to maintain proper clearances between them. The hotter a particular component becomes, the more it expands and thus the larger it gets.

If we operate an engine without attaining proper even temperatures, we have some components that aren't big enough and some that are too big. When this happens we can experience excessive wear on the internal components involved.

Assuring proper minimum temperatures, will assure proper tolerances, keeping wear to a minimum.

In addition to the wear factors, turbocharged engines rely on warm engine oil to properly control the turbo system. Applying full power to an automatic control turbocharger system with improperly warmed up oil can cause the system to react sluggishly to control impulses being supplied by the turbo controllers. This can easily allow an over-boost condition to exist. Overboosting of an engine not only can cause excessive premature wear but if severe enough it could cause complete engine failure. Properly warmed up oil will also help ensure that all splash lubricated internal components are receiving the proper amount of lubrication.

Proper Engine Cool Down before Shut Down

Proper shut-down procedures are important to all engines but are especially important to turbocharged engines.

We should allow a cool down run at 1000 RPM for at least five minutes on a normally aspirated engine and 10 minutes on a turbocharged engine. These cool down runs allow internal components to cool and shrink evenly at a acceptable rate eliminating any hot spot within the engine that may have developed during let down and landing. On turbocharged engines these runs allow the turbo itself to cool dramatically from operating temperatures. Shutting the engine down with cylinder heads and turbocharger at too high an operating temperature will cause the oil that is left on internal parts of these components to be cooked and turned into carbon. Carbon build up in cylinder components can cause stuck valves and rings causing high oil consumption. Carbon build up inside of a turbocharger lubrication section will cause seal failure, high oil consumption and eventual turbocharger failure.

These simple procedures can provide a multitude of benefits to us and our engines, if they are followed regularly. Of course to gain the benefits we must modify our procedures where necessary and use them. In doing so we will be operating our aircraft in a safer, more economical and knowledgeable way.

Backfiring at High Altitude (Jun 2004)

Q I was going to a motorcycle race in Utah (KPUC). On the way there, we went up to 13,500 and the plane, a 1964 250, started back-firing. So no big deal leaned it out using the EGT. But it keeps doing it about five times every minute. Pull the mixture out to where the engine started running a little rough. I pushed the mixture in just a little tiny bit. It kept doing it. Once we got down around 12-11,000 feet, it ran fine. On the way home, we went to 14,500 because of weather. I very impressed 1,000 feet per min climb up to 9-10,000 feet and 500 up to 14,500. I pass 12.5 and it does it again. The whole way home a little back-firing. What causes this?

A Undoubtedly, the ignition system. Could be dirty spark plugs, bad points, or another magneto component such as the condenser or rotor that is failing. More than likely though, it is a crack in the distributor block. It also could be that you have one magneto that has completely failed. The backfiring is unburnt fuel entering the exhaust pipes and exploding. Leaning the mixture aggressively causes the fuel to burn completely in the cylinders.

Q I just bought a turbo Twin Comanche. I love the airplane and it is a joy to fly, but I am constantly having a problem getting the engines started when I stop for gas. I have heard there are some "hot start" techniques. Could you share some of them with me?

A The problem is caused by fuel vaporizing in the fuel system after shutdown. There are lots of techniques for hot starting. Here is an approved method that works reliably, according to advice from our expert in Australia. The concept is to get the engine to a known state – flooded, and then do a "flooded start." Here is the procedure:

- Magnetos ON
- Throttles FULL FORWARD
- Mixtures FULL FORWARD
- Fuel Pumps ON until you get positive fuel flow, then:
    - Fuel Pumps OFF - Retard Mixtures to IDLE CUT OFF.
    - Leave throttles fully forward.

Crank the engine and when it fires, move the mixture control smoothly forward and retard the throttle to a normal setting. There is no rush to retard the throttle, but it needs to be done before the engine accelerates to unacceptably high rpm.
If the engine stumbles after starting, or starts to die, turn the electric fuel pump back on briefly to clear the last of the vapor from the mechanical fuel pump. Switch it off once things settle down, and to confirm the mechanical fuel pump is supplying the engine. Of course, as usual, switch the fuel pumps back on for takeoff.

Troubleshooting a Starter (Dec 2003)

Mike Rohrer ICS #13393

I want to share with everyone a way of troubleshooting a starter or cranking problem, and another problem that could have been solved and money saved if this knowledge was known. Let me explain.

A good customer and friend of mine called to say he had a problem with his 250 Comanche. He normally brings it to me but he is a long distance away and it seemed to be a very simple problem a local technician could handle. The problem was that when he took off and put the gear up, his GPS and storm scope would either reset or blink. At one time the gear would not go down - no power.

The technician said that the fuel selector was leaking onto his gear motor and it shorted out. That's a pretty good one. Anyway, the tech had the gear motor assembly overhauled. The reason that the owner called me was that wanted me to call his tech and explain how to re-seal the fuel selector valve. Sure, not a problem. I called and asked what he was planning to do. He wanted to fix the leaking selector valve and didn't know how to remove the valve and wanted to know if he had to drain the fuel tanks.

I told him if he wanted to stop the leak, all he had to do was remove the cap that screws on over the valve and look under the cap. There he would find the O-ring, no need to de-fuel or remove the valve. And by the way, this valve should be removed once a year cleaned and lubed properly. It takes a Special kind of lube that will not wash off when in contact with fuel.

The owner called me again several days later and said that the airplane did the same thing again. He was on his way to Arizona and had stopped en route. This time, when the battery switch was turned on, nothing came on. This was too easy. I told him that it was not a gear motor problem but a high resistance problem in his electrical system.

First, I told him to look at his battery cables. I told him to turn on the battery switch and go to the battery cable and try to turn one of the ends. Guess what? The power came on. I instructed him to remove the cables one at a time and to be sure to remove the negative one first. We didn't want any welding going on when he tries to remove the positive end when the negative was still hooked up. Well, too late, already did a little welding. This worked and he was on his way. I told him that the cables were probably aluminum and would need to be changed down the road, preferably with copper cables.

It was a short time later, a week I believe, and he called and said that it did it again. This time he was on his way back home, and now he was stuck in Abilene, Texas. I told him to teil the tech to replace both negative and positive cables to the battery and that would solve the problem. Believe it or not, I was in Tampa during the International Comanche Society Convention when he called again. This time he said the tech told him the cables checked out fine with a Voltmeter and the cable from the relay to the bus was bad, to include the relay and the master switch circuit breaker (GB), at a cost of more than $1,000.

My friend said, "Don't touch it!" and rented a car so he and his wife could get back to Cape Girardeau, Mo. I was furious. What master switch CB? First of all, does anyone know how to use a Voltmeter? Of course, you will have the proper volts at the terminals and cables. It's not the volts that was the problem but the current. If he had understood how to use the meter and how to measure a load, my poor friend would have been on his way in a short time. When I returned from the Convention, I put some tools together with a couple of cables and went to the rescue.

No kidding, I was not on the ground 20 minutes and I had the cables installed and was ready to go. I called him at work and let him know that his beautiful airplane was once again well. Needless to say, he was very upset. He had spent more than $1,000 on a new gear motor assembly, not to mention labor, a rental car and a long ride home all because of a lack of troubleshooting skills and just down-to-earth common sense.

Slow Starters (Apr 2004)

Mike Rohrer ICS #13392

Last thing is something that we found when we were troubleshooting a slow starter. This is just an example of what looks new or in good condition – but isn't. Troubleshooting is very easy when you understand the system, but this was too simple. We removed the cowling and proceeded to look at the starter wire. I noticed a little corrosion on the terminal end. While I was removing the terminal end, it broke off. The wire broke in half. The old aluminium wire had broken down and was turning to powder. This airplane had only 1,200 hours on it but was almost 40 years old. Time to replace the cables.

A sure sign that it's time to replace the starter cable.

To Start or Not to Start (Feb 2008)

Todd Underwood, ICS #16461

In the early 1990s I purchased my second Comanche, a 1959 PA-24-180 from an airline pilot in Boulder City, Nev. Although she was beautiful in my eyes, she needed some TLC (the airplane, that is). Not being an expert on the maintenance side of things, I sold shares to a few knowledgeable pilots, one of whom was an engineer at the Piper factory in Lock Haven during the years the Comanches were built. With his help and an A&P IA Twin Comanche owner, that just happened to have a hangar a few doors down from ours, I was able to learn a lot about the mechanics, restoration and modifications of Comanches.

Over the course of a year, we made quite a few modifications and improvements including new glass, headliner, interior, gear motor and transmission, instrument upgrades and much more. But one annoying problem just never seemed to go away – the airplane was always hard to start, and it wasn't engine problems. It didn't matter if we had a new battery or not, it was like pulling teeth to get the propeller turning when trying to start the engine. Typically, the starter would be engaged and the propeller would just maybe get over one compression stroke and stop, so we would have to rock the prop back and forth with the starter to get it over the next stroke and hope the engine started. Hot starts were all but impossible and the battery would run down in a matter of minutes.

So, we pulled the starter (a 1930's Delco, typical of early OEM) and took it to a local shop and had it overhauled with new brushes; we reinstalled it on the airplane. Now we were able to get the prop to go past two or three compression strokes before having to rock the prop. This was workable, although barely, and at the time we didn't know what else could be done to improve the woeful starting. Unfortunately it didn't last long, a few months later the plane was back to not even getting over one compression stroke when trying to start it. One cold winter day I had to fly a bunch of Geology students from Arizona State University to Page, Ariz. for the day and when we returned to the airport and got in the plane, it just would not crank over. Nothing exudes more confidence in your passengers then when your plane won't start! That was the last straw for me.

Eventually I did make it back home and decided to go through the entire starting system, seeing as how new batteries and starters were not doing the trick. Our friendly A&P IA suggested we join the Comanche Society because we would then get the Comanche Flyer magazine and access to a wealth of knowledge from other Comanche owners. We did, and in the Flyer was an advertisement for Bogert Aviation's battery box and copper cable modifications, and an advertisement for the fairly new Sky-Tec flyweight starters.

Bogert's advertisement claimed that their battery box modification would improve starting performance and prolong the life of the battery and starter and that their "Low Loss" copper cable kits would deliver the amperage from the battery, that we so badly needed, all the way to the starter rather than having all that "juice" being lost to heat in the factory aluminum cables that we had. Sky-Tec's advertisement claimed their flyweight starter had twice the spin of the OEM starter and weighed 10 pounds less, which on a 180 is a significant useful load increase. So we decided we had nothing to lose and took the plunge on the battery box mod, the "Low Loss" copper cable kit and the new Sky-Tech flyweight starter.

To say we were happy when we finally pulled that OEM Delco starter off for good, is an understatement. I still have that behemoth sitting on the shelf to remind me of how hard it can be to start an unmodified Comanche! Replacing the starter was the easiest thing, as it is simply a bolt-on replacement. The Sky-Tec was also FAA-PMA and STC'd for the Comanche, so the paper work was a breeze. Since the battery on the 180 is located in the back, the battery box modification and cable replacement was a little bit more difficult as we had to pull the seats, floor panels, and the rear bulkhead, but the whole process only took a few hours. Replacing the long positive cable went smoothly, as it was just a matter of routing it under the floor and through the firewall following the exact path of the old aluminum cable.

The battery box modification was not difficult either. It replaces the old aluminum braid and its external connection, and allows the cable to go directly through to the battery terminal making for a much better connection that is less apt to corrode and lose that valuable starting amperage.
If your battery box has seen better days or you are having corrosion issues Bogert now makes a new stainless steel battery box that is FAA-PMA and STC'd for all Comanches except, serial numbers 1 to103 and 4247 to 4300.

We were completely amazed the first time we started up the Comanche. The propeller spun so fast, we thought we could taxi using the starter! Hot starts were never a problem, we never had to jockey the starter again and we also never had corrosion issues on the battery or any other terminals again. After having stranded us many times and kept us in hours of frustration, starting the plane and battery life was no longer an issue.

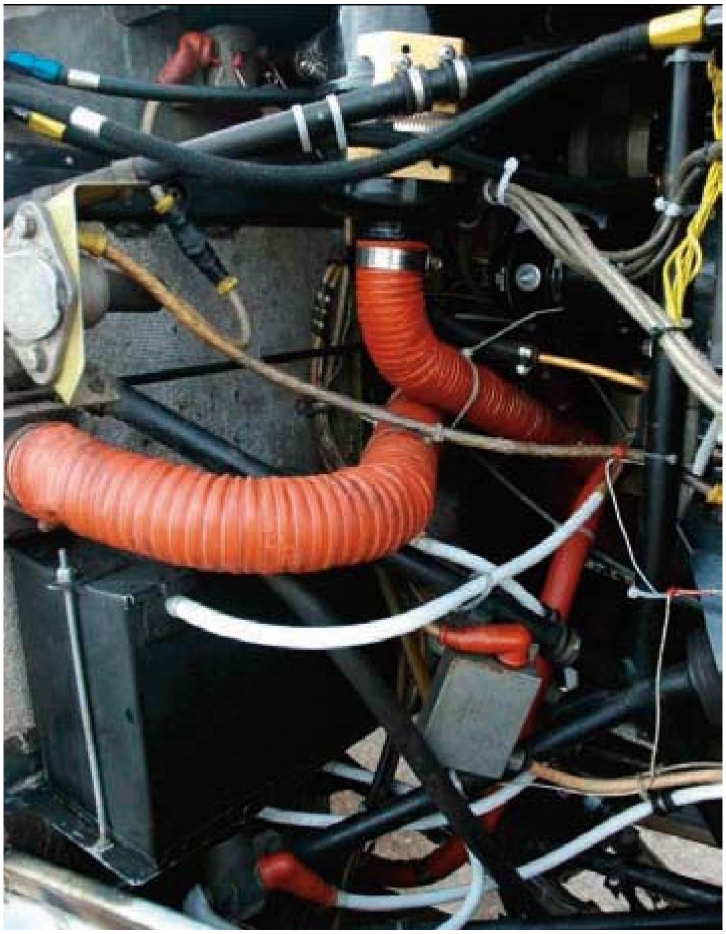
Only after performing all of these modifications did we learn of Piper's Mandatory Service Bulletin number 836Aa issued August 26, 1986 which states:

Field reports have been received of corrosion between the aluminum terminal and aluminum wire at the battery positive post, resulting in overheating of the wire due to high electrical resistance. If this condition exists and is left uncorrected, excessive heat build-up could result in an electrical fire. Corrosion and resulting high resistance can also occur in the battery to ground, battery to master relay, master relay to starter solenoid, starter solenoid to starter and engine return ground cables… If aluminum wire is found, replace the affected cable(s) with copper cable(s) at the next scheduled inspection not to exceed 50 hours! On each affected aircraft, locate and identify, inspect and replace the following cables with copper:

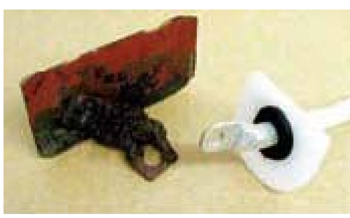
1. *Battery to Ground*
2. *Battery to Master Relay*
3. *Master Relay to starter Solenoid*
4. *Starter Solenoid to starter*
5. *Engine return ground cable (engine to airframe).*

The Bogert "Low Loss" cables have at least 55% greater capacity than those specified in the service bulletin and it sure shows. Our trusty 180 gave us many more years of reliable service and never again gave us any problems or issues when starting whether hot or cold.

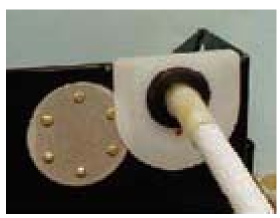
Many years later when I purchased my current Comanche, which just happens to be the first 260B model ever produced, the first thing I asked the previous owner was if it had the original starter. It did, but not for long. Prior to picking up the airplane, I had the local shop install a new Sky-Tec High-Torque Inline NL model.



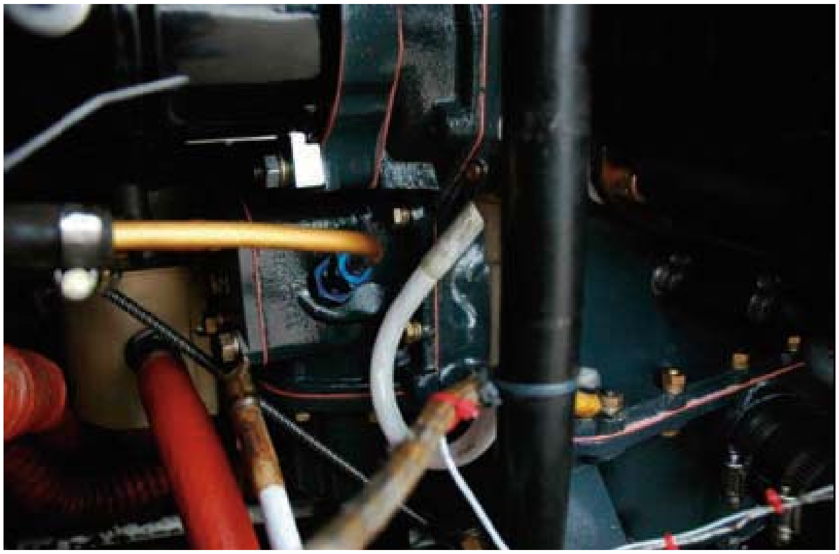
Battery box with the Bogert "Low Loss" copper cables.



Original vs Bogert's



Concorde RG-35AXCB Battery



Engine to frame copper ground cable included in the Bogert kit.

Front view of the Sky-Tec NL lightweight high torque starter

When I first went to start the plane with the new starter the propeller spun okay, but not like I was used to with the old 180. Since the battery is in the front (front right side of the firewall under the cowl) in a 260B and the cables are not very long (the longest is about three feet and most are a foot or less), I didn't think to replace the aluminum cables until one day when my vent tube on the battery box lid broke off and I called Bogert to inquire about getting one of their new battery boxes. I tried to order their new stainless steel battery box, but my serial number is 24-4247, which is one of the very few odd style boxes their new battery boxes are not STC'd to replace.

While on the phone they asked me if I had already put their "Low Loss" copper cable kit on, to which I replied, "No." The second question they asked was, "Do you have one of the new lightweight starters?" to which I replied, "Yes." They explained that these new lightweight starters crank weight, but they also require more amperage. They said if an owner installs a new lightweight starter and does not install a copper cable kit, not only are the conditions outlined in Service Bulletin 836Aa exacerbated, but the propeller may spin even slower on engaging the starter due to the higher amperage requirement which the starter just can't get from the battery through the aluminum cables. That hadn't occurred to me before, so once again I ordered the Bogert "Low Loss" copper cable kit. The battery box modification was not necessary on my 260B as the box design already resembled the Bogert modification.

The copper cable kit consisted of five cables and arrived in a small box. Over the course of an hour, I replaced each of the cables one by one. It was so easy, even a caveman could do it! Anyway, once the cables were replaced, I rolled the airplane out of the hangar, got in and engaged the starter. Wow! What a difference. Now the propeller was spinning twice as fast as it was with the aluminum cables. I was impressed with the speed at which the starter was turning the propeller. It was more like the end result with the old 180 and maybe even a little better. Once again I was very happy with both cold and hot starts and never had a problem again until my battery started going south.

The battery was only two years old and its degradation, of course, slowed the starter down quite a bit. So off I went to the store to get a new one. I was just going to replace the old battery with the same old Gill G35 I had always used. But, when I went to purchase the Gill, the saleswoman asked me about my starting system. I told her it was great, Sky-Tec NL with Bogert "Low Loss" copper cables and essentially the Bogert battery box modification. She said, "Great, then why are you buying a regular old G35?" "Uh, because that's what I have always used," I replied. She said, "With all that great stuff you have installed, you need to be using the Concorde RG-35AaXC." It has the highest cold cranking amps (440) of all the 35-series batteries and you just won't believe it when you go to start the plane." I was sceptical and the battery cost more than the regular old Gill I was used to using, but after listening to all the benefits I was sold.

I took it over to the hangar, installed it and WOW! I have never seen a propeller spin so fast on any airplane, period. You know that sick feeling you get when you are at a remote airport and no one is there; you are far from home and facing a hot start and know you only have a few chances to get it started before its dead. You are stuck in the middle of nowhere for who knows how long and when someone finally arrives they want to charge you $500 for a jumpstart or $1,000 for a new battery? All gone! No More! That situation never even gets a second thought from me anymore. Even when its 120 degrees out and I have just shut the plane down five minutes – I hop in and crank it over and the propeller spins like mad and she fires right up. Oh, and I really can taxi on the starter! I have come across other Comanche pilots at various remote airports trying to start their airplanes and fiddling with cleaning the battery connections, etc. I basically explain what I have done to my planes and then I show them. After they pick their jaws up off the floor the first question is usually, "Can you write down all those part numbers for me and where I order all this stuff?"

http://www.bogert-av.com
http://www.concordebattery.com/flyer.php?id=38
http://www.skytecair.com/Lycoming.htm

On Leaning and Combustion (Jun 2008)

Russ Greenlaw, ICS #4168

Any plane driver with an exhaust gas temperature (EGT) gauge knows that when one leans the mixture, EGT increases to a peak value, after which further leaning makes EGT decrease, with the engine eventually running rough due to misfire. But why does the temperature change with even slight changes in mixture? Let's look at the process (simplified a bit).

Peak EGT
Hydrocarbon fuels are combinations of carbon and hydrogen (Duh!) and when the amounts of fuel and oxygen are exactly right (peak EGT), all the hydrogen gets burned to form water vapor, and all the carbon gets burned to form *carbon-dioxide* (CO_2), with (theoretically) only a bunch of hot nitrogen left over. Chemists call this a stoichiometric "element measured" process.

Lean-Side
The lean-side of peak is simple to analyze – when you pull the mixture knob and go lean-of-peak, you are reducing the amount of fuel, hence the amount of heat and pressure produced in each cylinder. The amount of air is still the same so the combustion temperature and exhaust gas temperature both decrease. All the hydrogen and all the carbon should still be fully burned, with some oxygen left over, unless you lean so much that the engine begins to misfire and run rough.

Rich-Side
It is often said, and written, that when one richens the mixture from peak EGT to rich-of-peak the exhaust gas temperature decreases *because the extra fuel cools the combustion gases.*

I pondered how this could be since the amount of extra fuel is very small, and the heat required to vaporize it would also be very small. Furthermore, the extra fuel is itself burned or partially burned, and therefore would contribute to heat inside the engine's cylinders. In other words, a little extra fuel should not make cooling of the process.

One day it came to me... the extra fuel in a rich-of-peak mixture doesn't cool the combustion products at all, but rather something in the fuel fails to get burned and that is what reduces the temperature in the cylinder. I reviewed a chemistry book, one about power plant engineering, and several on thermodynamics, to look up the numbers.

It happens that carbon gives off about 38% more heat per molecule than hydrogen does (perhaps that's why barbecues run on charcoal instead of hydrogen). More significantly, if there is too much carbon for the available oxygen, then some of the carbon ends up as *carbon monoxide* (CO) instead of CO2, and CO gives off **way less heat** than CO2 – by a ratio of more than 3 to 1. Perhaps that is why blowing on your barbecue makes it more hot, very quickly.

When you move that mixture knob to the rich-side of peak EGT, you are increasing slightly the amount of fuel, so there is now an excess of fuel relative to the oxygen. For some reason, the hydrogen gets first shot at the available oxygen, so with a rich mixture, the hydrogen gets fully burned and the carbon is left to fend for itself. Some of the carbon gets fully burned to form CO2, some gets partly burned to form CO and perhaps some of it remains unburned in the form of soot or black smoke.

So, when you push in that mixture knob and richen the mixture to the rich side of peak, the total heat produced in each cylinder drops because you are now making some of that nasty carbon-monoxide instead of only green-plant-friendly carbon-dioxide.

Less heat accounts for *some* of the temperature decrease. Note also that a rich mixture has more hydrogen, hence produces more water vapor than a peak mixture. It so happens that for any given temperature increase, water vapor requires 85% more heat than plain air, so having a bit more water vapor in the combustion products helps account for the decrease in combustion temperature.

Rich Mixture Paradox
There is a paradox... a slightly rich-of-peak mixture burns cooler but produces more power than a peak mixture. Since power comes from cylinder pressure, and cylinder pressure comes from combustion temperature, how can a cooler, rich mixture be more powerful than a hot, stoichiometric mixture?

It seems that hot water vapor, also called steam, produces 60% more pressure on the piston than air for a given temperature. In other words, cylinder pressure decreases less rapidly than the decrease in cylinder temperature. That is how a cool, rich mixture can produce more power than a hot, peak mixture.

Conclusions
The next time someone tells you that the extra fuel used with a rich-of-peak mixture actually *cools* the engine, tactfully explain that (1) the excess fuel causes some of the carbon to form CO instead of CO2 (giving off less heat); (2) the extra water vapor (due to more hydrogen) absorbs more heat than a perfect mixture, causing lower temperatures; and (3) you still get more power because that extra water vapor produces more cylinder pressure than a drier, peak mixture. And you can say "stoichiometric" in there someplace.

Oil Filters (Aug 2011)

Q I have a 64 turbo PA-30 with IO-320-C1A engines. The oil filters are mounted on the firewall behind each engine.
The oil filters in the plane when I got it were not Champion filters. I can't figure out what Champion filter to use.
The Champion catalog says to use CH48110-1 filters for this plane and I bought them, but they have a male thread (a little less than one inch in diameter) protruding from the bottom of the filter. The filter mounting points on the aircraft have a male thread and thus would need a Champion oil filter with female center hole, not male. Is this unusual or is the Champion catalog wrong. When I called AC Spruce, they said the CH48110-1 filter is what they show for the plane, but it won't work. I'd appreciate any suggestions you might have.

A I am pretty sure you need a Champion CH48103-1 filter for that application.
I have seen that installation before on the remote mounted filtering system and they used CH48103-1 filters.
Lucky Louque

A The CH48110-1 is the standard engine fitted filter − Spruce was correct. But you have an aftermarket setup on your firewall, and apparently it takes a different filter. The attraction of the firewall mounted filter is that it is easy to service.

I assume that you don't have the original filters that were on the plane. If you did, then Spruce could match them with a Champion filter or a Kelly filter (both of which Spruce keeps in inventory).

I'm guessing that the filters you had were Kelly, since that is a popular brand. I can't suggest which series or part number of filter for you to install because I don't know the brand/part number of the oil filter bracket that you have on your aircraft. If you look at the unit and identify the manufacturer, you can call that manufacturer and they will help, of course. If you have the model number of whatever filter was on there when you bought the plane then the easiest method is to buy the same filter.

What you need is a filter that is approved to go with the aftermarket installation that you have on the aircraft, not the filter that would have been fitted originally to the engine (since the original filter has been replaced by this aftermarket apparatus).
Pat Berry

A I have the firewall mount from Airwolf on my PA 39 and it takes a Champion CH48109.
You might want to check with them to see if you have the same setup.
Dave Fitzgerald

Bendix free lightweight starters (Sep 2011)

Q I am having problems with the Bendix drive in my starters. Without constant spraying with WD 40, it will hang up. This is now a problem with both starters. Would it be a good idea to replace these starters with one of the newer Bendix free lightweight starters?

A Do you have the copper cables installed? If not, then that should be first on your list. I have had the Skytec starters for 10
years and have never had a problem. And, you will save about 12 pounds.
Check to make sure you have enough electrical cable slack since the connection point to the starter is a bit further forward.
Hans Neubert

A Like Hans, I also have the high-speed starters and I love them. They do need a battery that is pretty much fully charged, where the old Bendix starters can turn on about eight volts, but if you keep this in mind you'll never have a problem. SkyTec is owned by a man who either has a Twin Comanche or used to – if you ever have a problem they will send you a refurbished unit as a replacement – good service. I think that they are worth the money. It really isn't worth the money to try to make the old starters perform better; I really feel that a change is worth the investment.
Pat Barry

A I have experienced problems like this with my starters in the past: once when I first got my Twin Comanche about 22 years ago and then again a couple of years back. Both times I simply replaced the Bendix drive and it totally cured the problem.
This is a pretty easy and relatively cheap repair. And both times it made my old starters act like new. The starter shop I have used here in the Dallas area told me that it is not really feasible to repair those Bendix drives and squirting stuff in them is a stop-gap measure at best. Ultimately it will lead to them "gumming up" even more so.
To be sure, the high-speed starters are nice, but as Pat pointed out even they have their drawbacks. *Dave Clark*

Excess oil blow (Oct 2011)

Q How much oil is enough (five quarts?) to prevent excess being blown through for IO-320-c1A?

A I try to keep mine between five and six quarts. Don't forget that the left engine reads one-half quart high, and the right engine reads one-half quart low (there are not left and right specific dip sticks), due to the engine being hung on the dihedral of the wing.
Dave Fitzgerald

Hot Oil & Temperature Gauge (Nov 2011)

Q I have a PA24-260 that is fuel injected and is 30 hours SMOH. With OAT at 80-90 degrees Fahrenheit, the oil temp gauge wants to go to the red line and stay there in level flight. I sent in the cluster and calibrated the gauge with a new probe, but with no change. Can it be the Vernatherm valve? After operating the engine at red line, the thermometer reading of oil is 195 degrees from the drain plug. Do Comanches normally run hot? Is this dangerous?

A Is your engine a Lycoming IO-540-D4A5? If so, I have seen two of these with the same over-temp problems and the problem was with the Vernatherm System. Not the Vernatherm itself, but the seat in the housing that the Vernatherm screws into. First of all, the Vernatherm is designed to activate and start expanding at about 170 degrees Fahrenheit. When it expands, the face of the Vernatherm goes against a machined seat in the oil filter adapter housing, forcing hot oil to be rerouted through the oil cooler. We have found that aluminum seat to be worn, chipped and fretted in many of these. Remove the oil filter adapter housing, remove the Vernatherm valve and look into the hole that the Vernatherm screws into and inspect the seat that the Vernatherm closes against. The face should be a machined flat surface with a sharp edge. There should be no marring, fretting, chipping or any deformation or wear on it. If there is, it is most likely your culprit.
Lucky Louque

Magnetos (Jan 2012)

Q Where can I have my magnetos refurbished for my '61 PA24-250? Or is it better to just get new ones?

A I was going to repair my Bendix mags for my left engine on my PA30. After I totaled up the cost of the parts, I decided that I'd be better off simply getting exchange units through Aircraft Spruce (which sells all of the Bendix parts, as well as rebuilt mags). The cost was in the mid-$600 area for the rebuilt units. For the price, I was happy to have new everything.

Your IA could remove your mags from your aircraft, open them up, inspect them, and tell you what needs to be replaced. The points are like old-fashioned auto engine distributor points and they wear out and get dirty. The coil can fail over time, as well as the bearings. But as I mentioned, the prices for individual magneto parts can be quite high. Having a rebuilt unit should address all those issues.

Aircraft Spruce also has the electronic Bendix timing tool for about $48, plus a little tool for holding the pulley internally for about $12. You might want to get these tools if you plan to time your own mags.
Your IA has to sign it off, but perhaps he can teach you how to time the mags.
Once you learn how, you'll find it easy to do in the future.
Pat Barry

Fuel Flow Surges (Mar 2012)

Q I'm getting a fuel flow surge while in flight. In normal cruise, the fuel flow indicator slowly pulsates from 12 to 15 gallons per hour. As the fuel flow indicator rises or falls, the EGT on all cylinders shows a corresponding rise/drop. I've verified this with my JPI graphic engine monitor (with fuel flow option). I am wondering if the fuel servo would have something to do with the problem. Any recommendations would be appreciated.

A The servo IS the problem. It is time for a servo overhaul. *Zach Grant*

Original Engine Serial Numbers for Logbook Reconstruction (Apr 2012)

Q I have a PA-24 260B with serial number 24-4582. The engine is an IO-540 D4A5 with serial number L-3796-48. I'm trying to find out if this engine came with this airframe to help reconstruct the airframe logbooks.

A The engine is not part of the airframe records, except when its serial number is entered as being removed or another engine serial number was installed.

Reconstructing the airframe logs is not related to the engine in any way since the engine is a different component. Of course, you can always go back to Piper, but after the bankruptcies, I don't know if they would have those records or be willing to share them.
You might call Lycoming and ask them if the manufacturing date matches the original manufacturing date of the airframe. I checked the FAA.gov website and while they show the engine type, they don't show the date of engine manufacture.
Pat Barry

Engine Sizes for Overhaul (Apr 2012)

Q I have a '59 Comanche 180.
Time is getting close to overhaul. Can I install the 250 HP engine in the 180 HP model?

A You can, but why would you?
By the time you change everything that needs to be changed, you would be money ahead to sell the 180 to someone who wants a 180, and buy a real 250. The 180 is highly sought after for its economy. Good ones do not take long to sell!
Zach Grant

Exhaust Stack Repairs (Jun 2012)

Q I have just had an exhaust stack snap at the flange. In trying to get it replaced, I discovered that the stack is longer than the original Piper part by about six inches, and the extension is curved at 30-40 degrees.
What is the origin of this extension, and where does one get a replacement?

A These are probably "Gulf Coast stacks" extensions. They are no longer available. However, you can send the part to any aerospace welder and have it repaired, or you can take it to a local muffler shop and have them duplicate it, and your IA can install it as an owner-produced part.
Zach Grant

A Like many Twin Comanche owners, I had that problem in both of my engines. The first time I sent the stack to a company in Jumping Branch, W.V., who not only put a kind of "ball joint" connector in the stack just below the flange (which removes the big stress from that area), but they also welded on extensions, such as you describe to turn the exhaust downward away from the belly of the engine nacelle.

I would highly recommend both of these modifications. That company was later bought out by Aerospace Welding Minneapolis who did my second stack.
Their contact info is: Aerospace Welding Minneapolis, Inc.
1045 Gemini Road
Eagan, MN 55121
(651) 379-9888

Zach is correct about the extensions themselves, i.e., probably any good welding shop could put those on for you. However, if you want the flange repaired properly, you will probably have to go somewhere that has the jigs for that exhaust system. It is very difficult to "eyeball" that repair and get it right.
If not welded exactly right, it will only break again.
Dave Clark

Vacuum Regulator Repair (Sep 2012)

Q I think the vacuum regulator is sticking on my PA24-250.
When I do my run-up, the vacuum gauge will sometimes read as much as nine inches pressure. At other times it is in the normal range. I have tried to take the regulator apart, but I don't think I have the correct tools to repair it. Is there a kit to rebuild it or can you get an overhauled regulator?

A Put the valve back together, remove it from the aircraft, fill it with mineral spirits, shake it up really well, rinse, refill and let it soak overnight. Rinse and repeat as necessary.
If you can't get it to loosen up with mineral spirits, use some Hoppes gun cleaner; do the same thing – let it soak, rinse, dry and check. The regulator has become a little sticky. This is the cheap way to fix it and it will usually work, it just takes a little time.
Zach Grant