Oil Pump Priming, Overcoming Loss of Pressure at Startup
C-85 and C-90 and O-200 Engines

The Loss of Prime Problems:

There are two common situations where the oil pump won't pump; the most common is the "loss of prime" when the plane has not been used for a significant period with the effect of no oil pressure within 30 seconds at startup; the second is the heart-stretching first startup after a very expensive overhaul. There are cures for both listed here, thanks to the inputs from the web site writers.

Oddly, there are the non-believers who belittle those who have the symptom of no oil pressure on startup and apparently believe that it can never happen to their magic engine. It can happen, often does, and might even happen to them. Hopefully, their negative opinions will not cause those who need assistance and solutions for the malady to ignore the symptoms of no oil pressure at engine start. IT DOES HAPPEN!!!

Some "solutions" could be engine-damaging. Some flat won't work because they can't. Some are very good and make me embarrassed not to have used them the one time I needed a cure for no pressure. Ignorance of the exact path of oil flow in the engine is my excuse, since cured and explained here.

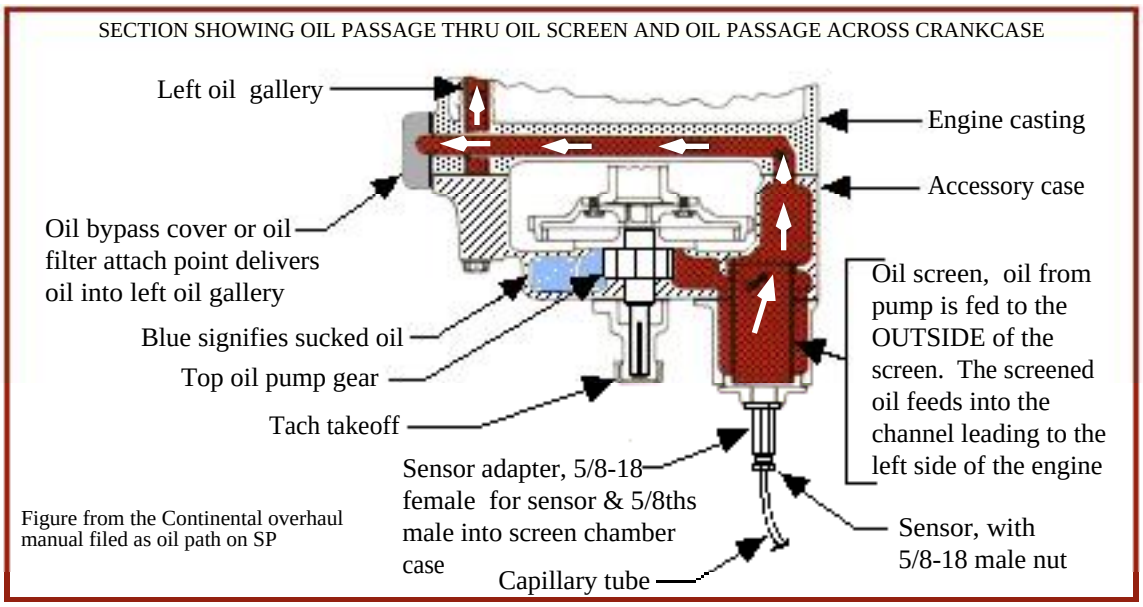
Those who have had the experience of visiting a farm in which the water was brought up from the well with arm power soon learned that one had to occasionally "prime the pump" by pouring saved water down the pump shaft opening and woe be to the kid who did not re-save some water for priming. The water helped create the seal and the like situation exists in our pumps in all the C- and O-200 engines. The pump suction and pumping pressure actions depend on some of the oil forming the seal between the gears, between the gears and the front and back of the pump chamber, and around the gear shafts. As the precision clearances around the shafts enlarge or the wear caused by the sides of the gears rubbing on the front plate and inside surface of the gear well increases, the oil is more likely to leak away when sitting, destroying the needed seal, and no pump action results until one reprimes.

The first section after the figures is the collection of inputs from the web sites about the loss of prime on engines in use. The usual symptom is to have no oil pressure after startup if the engine has been unused for a few months and progresses to a few weeks and eventually to a week or two between recurrence.

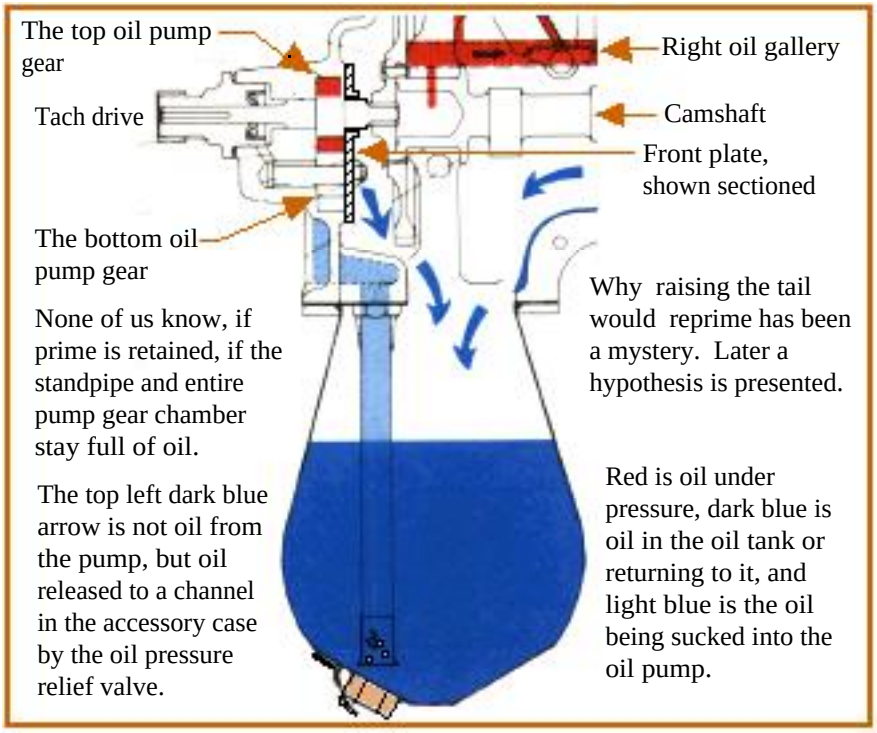
The second segment is about quickly getting pressure after an overhaul. Along the way, some great "findings" about carbon clinkers plugging up the standpipe and some good cures for the ills.

The figures by Continental do not clearly show the oil pressure indicator takeoff point, but it is at the rear end of the right oil gallery, quite close to the oil pressure relief valve assy. As one inputter has mentioned, this oil pressure pickoff point is near the "end" of the pumped, pressurized oil stream. Continental explains the oil path: oil from the oil tank is sucked through the standpipe in the oil tank into the oil pump gears and forced into a chamber which holds the oil screen, around the outside of the screen into the inside, thence forward into the case and across the case to the left side oil bypass pad. From there, it is diverted to the left oil gallery and along the gallery there are bleed passages diverting oil to the bearings and tappets. At the front, the oil goes to the right by passing through a groove cut in the forward camshaft shaft at the bearing and into the right oil gallery, dispensing oil along its path to the tappets and other important features on that side. Near the rear end of the right gallery the oil is fed to the oil pressure relief valve. It opens to release oil into the oil tank. Pistons/cylinders are lubricated by splash and squirt.

Understanding the oil flow makes the suggestions of repriming much easier to understand. The figures are from the Continental overhaul manual, with annotations by me to make the action clearer. The first is a top view showing the pressurized oil flow across the engine casting via a channel after leaving the screen.

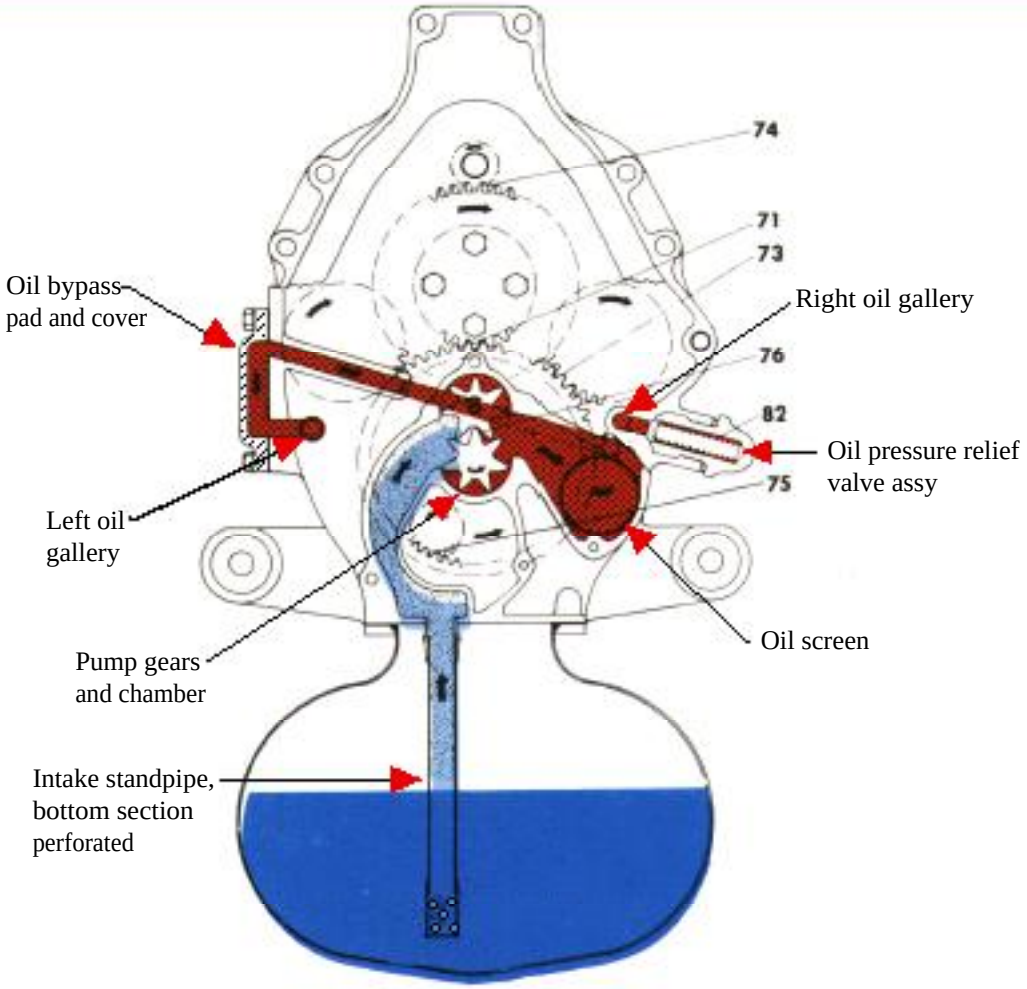


The next figure is a right rear side view, with colors denoting pressurized oil versus return oil. I accentuated the top gear and tachometer quill in the figure above and the front plate of the oil pump assembly below.



Note the small-diameter "leader" channels which supply oil from the gallery to the bearings and tappets; the leftmost is delivering oil to the rear bearing of the cam shaft. If you wonder how the other features of the engine, such as the gears and pistons, get lubricated the answer is splash, thrash and squirt. Oil which escapes from the bearings goes everywhere, essentially filling the case with oil droplets. That oil falls to the bottom of the case and drains into the open top of the sump tank.

This figure is a view from the rear of the engine showing how oil from the pump goes across the case via a channel and is then routed to the left oil gallery via the oil bypass or through an oil filter and adapter.



Rear view of all but -8 engines

The dark red is the pressurized oil from the pump, blue the intake oil. Oil is sucked into the pump, fed through the outside of the screen to its inside, then forward to a channel which takes the oil across the back of the case to the bypass pad area and the bypass (or the filter, if installed) routes the oil to the left gallery. The left gallery is the main oil distribution resource and at its front end, the oil is fed across the engine to the right oil gallery and at its rear end is the oil pressure relief valve from which released oil returns to the sump. filed as oil path rear full on SP Neal July 2004

Later, another of the colored pictures of flow from the Continental book is reproduced after some correction and adding pertinent comments. The set of Continental oil flow figures allows one to understand the paths and why some of the solutions for reprime will work, and why some cannot.

Oil Pressure Loss, a collection from various web sites:

NOTE: My editing annotations are *italicized.* Neal

0. First, check that there is no "clag" which is preventing the oil pressure relief valve from closing. If there is a bit of carbon which prevents the valve from closing, the symptom is low or no oil pressure. This figure shows the hollow valve. The released oil passes between the chamfered end of the valve and a mating surface in the accessory case. A calibrated spring forces the valve to "fight" oil pressure. It does not take much of a carbon bit between these surfaces to reduce the pressure to a low value. The gouges on the surface of the valve were made by carbon bits between the valve and its chamber. The holes (two) are in the valve so that no hydraulic lock forms to prevent the valve from moving. More diagrams at the end show how the parts work together.

Internet Inputs

1. Several months ago I began experiencing a delay in building up oil pressure when starting my Cessna 140 with a C-85. The first time it happened I followed the recommended procedure and shut the engine down after 30 seconds. I checked the gauge, oil line, fitting, etc. with no apparent explanation. I restarted the engine and still no pressure after 30 seconds. I started asking everyone I knew who had similar engines or aircraft power plant training for their opinion. I posted messages on Clark Cameron's 120/140 web site and referenced all technical correspondence in the International Cessna 120/140 Association's library. About half of the people I talked to said my problem was the pump losing its prime. Interestingly, the other half said that was a bunch of foolishness, oil does not drain out of the pump when the engine is not running.
Incredible to me that there are some (half?) who believe that physics excludes them and their engines... believe the first half, those that know it does happen!

I felt the pump was turning since the tachometer, which is driven by the oil pump, was working. So, to test the lost prime theory I removed the oil temperature capillary tube and filled the oil *(screen chamber)* with oil while someone turned the engine over backwards to pull the oil into the pump. I quickly reinstalled the capillary tube and restarted the engine. Sure enough I had oil 40 lbs. of pressure within 8 seconds. Everything worked OK for a couple of weeks then it happened again. This time I tried the 'Piper Cub' technique of raising the tail to prime the pump and it worked. One other time over the next month it happened and again raising the tail got me in the air.

A month later I had the plane down for its annual inspection and decided to get to the bottom of the problem. I pulled the engine, removed the accessory case and inspected the oil pump. What I found was the oil pump gears, though within specs, were at their outer limits. Although most of the play was the result of wear in the gear shafts *(the gears and shafts are steel, with the front plate made of aluminum and the accessory case of magnesium, so the wear is more likely in the shaft guides (bores) of the plate and the accessory case but it can be as noted or both)*, there was some wear in the bearing surfaces in the accessory case. A friend had a low time accessory case with the bearing bores at the other end of specification. I purchased an oil pump overhaul kit ($175.00) (*two gears and the front plate and four screws...the gears rub on the back side of the front plate and there create grooves which allow oil to "escape" so a new plate is usually a necessary part of the rework as well)* installed it in the new(er) case and reassembled the engine. With over 100 hours since the repair the engine is performing fine.

Using my old accessory case and oil pump I did some experimenting and found during prolonged shutdown a little oil drains out of the oil pump. But in no way is it left dry even after a month. However, oil in the pick-up tube drains back into the oil bladder within hours. When the pump starts turning, oil has to be 'sucked' up the pick-up tube before the pump actually starts pumping oil. With play in the gear shafts, the ability to suck oil up from the bladder is reduced by the air that is drawn in around the gear shafts. This means it takes longer to pull the oil into the pump. With my old accessory case and oil pump gears, had I allowed the engine to run longer than 30 seconds oil pressure would have come up. Also, had I run the engine faster during the initial 30 seconds I would have gotten pressure sooner. But both would have resulted in unnecessary wear on the engine.

I feel better about my engine now that I understand what was happening. Even though I probably would have been OK not making the repair, I am far better off with it done. Besides, a couple hundred dollars, and four days being land locked, is a small price to pay for such a great learning opportunity.

For those without a friend with a spare accessory case in good shape a proper repair is to do the kit installation as well as the accessory case overhaul. The overhauler builds up the gear shaft holes and gear wear indents and re-bores the holes for the shafts. Put together, the new gears/plate/recess dimensions mean...no loss of prime again.

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2. 150 OIL PRIME. . . Dear CPA,
I have an 0-200A with an oil filter STC and only 48 hours since rebuild. Just after the engine was installed on the airframe and about 3 months after the engine was assembled, we started it for the first time. There was no oil pressure. My mechanic suspected that it lost its prime.

We pulled the oil pump *(Tank, he meant)* and hooked up a hose to the oil pickup tube .and filled the hose with oil and got it primed right away. Then ran it normally for all of the 48 hours it has now. Never any problems with oil pressure. Started it this time and no oil pressure again on start. I put it back in the hangar and took off the cowling and am awaiting advice. I am almost afraid to put it back on the line with another prime trick as this does not seem normal. I am an A&P and the person who built the engine has the I.A. I live close enough to Columbia in Pennsylvania to just truck the engine to them if you think it needs major surgery. I want it to be a safe engine. Cliff Wilson,

See the first figures in this file to follow the oil path when fed in this way. This method is not recommended because of its difficulty compared to the other, better answers.

From CPA:
To: Cliff The easiest way to prime the oil pump for your installation is to remove the oil filter and pump oil into the non-threaded port of the oil filter adapter. A piece of clean hose the size of the hole is all you need and several ounces put into the pump cavity should be all you need. With all the bottom spark plugs removed spin the engine by hand and make sure you have an oil flow out the same port. Spin the filter back on and put the plugs back in and you should be ready to run.

If there is no filter adapter installed, remove the oil bypass plate as has been done in this picture of the oil bypass pad with the gasket still installed; feed the priming oil in the top hole..the bottom hole feeds the left gallery and oil injected there would not get to the pump.

Removing the top plugs is easier. The method of feeding oil in this way is the best solution, except for one newer, explained and shown later.

As most of the respondents have noted, moving the prop backwards during the oil injection will more quickly prime the pump.

The pump is designed to hold its prime and I can understand how after 3 months of inactivity the build up oil could have drained off the gears. After 48 hours flight hours and if there have been no oil pressure problems and if the plane is being flown regularly, every two weeks, the pump should not be losing its prime. I would prime the pump and monitor the condition and watch for any change in the oil pressure gauge readings. If the oil pump loses its prime again, that would be an indication the pump cover plate is not fitting correctly letting air into the pump cavity. That means the accessory housing needs to come off to get to the pump and cover plate looked at *(not enough said...see the other entries...the cavity and gear and bearing dimensions also have to be checked..."looking at the plate" doesn't do much unless deeply scored or bent and replacing it might not cure all of the problem). Some who have taken the accessory case off state that it can be done without removing the engine, but the engine needs to be shifted forward and supported there; others claim that one might as well dismount the engine and work on it that way.)*
. Tom Carr, CPA Tech Rep mailto:tom.carr@cessna.org
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3. No oil pressure!! Well its not exactly no oil pressure but there is none indicated. *(I have read that twenty times and still don't understand it.)* I went to some AF training for about 50 days and now I'm back. Yesterday I cranked up the 85 and no oil pressure was indicated. Lifters never made noise and everything seemed normal. Had the same thing happen about 1.5 years ago after a month of sitting but eventually got the pressure to come on-line a little later than normal. So I thought maybe the line leading to the gauge was gummed so I took it off and blew it out and put it back on with no results. Then ran the engine again with the hose disconnected to see if there was any oil coming up and nothing came out. Yes there is plenty of oil, and no the engine doesn't seem to run any different or rough or making any new noises. Could it be the pressure regulator? Engine was probably run 2-3 minutes yesterday and is still running great and normal. Please help!

Note the old HANGAR tale about the lifters not making noise...see an explanation elsewhere in this file...and that, even though he PROVED there was no oil pressure, he states "its not really no oil pressure".

One of the mysteries is why those who believe they can cure "slow pressure" by exchanging the oil in the oil pressure line/hose between the firewall and the fitting at the engine. The other half of the occluded or gummed (never seen) or plugged line is between the firewall and the gauge.

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4. Oil pressure. Might the oil line have lost its prime? How fast have you run the engine in this condition? *I don't believe he meant "oil LINE" has lost its prime, but oil pump system?*
We couldn't figure out why we weren't getting oil pressure after repairing the starter after a gear shattered last fall; we had turned the prop back and forth several times when we were checking the accessory case and other gears for metal particles, and it seemed that caused it to lose the prime.

We parked the plane on a downhill slope and put a few blocks under the tailwheel to get the nose as level as we could, and ran the engine at about 1000 RPM (no faster for fear of damage), but still nothing. Then one of the A&P's suggested running it up faster. I took it up to 2000 RPM and oil pressure came back.

DANGEROUS!!! Most of the suggestions here would be better than "more speed".

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5. oil pressure Try pumping oil into the fitting for the pressure gauge. Using a small oil pump can from the local hardware store. Push at least 1/2 quart through it and then try it again.

This is a picture of the oil pressure gauge fitting on most of the engines, size two, though later O-200's used size four fittings and hose. Note the 1/16ths inch hole in the fitting; oil fed in through it would be a slow (the intention of the small hole is reducing oil loss if the line/hose to the gauge breaks) process and getting the fitting out and back in are difficult if one uses that method.

Any oil fed into the oil pressure gauge hole has to go into the right gallery, losing a little along the way, then across the engine into the left gallery, losing more, and then into either the oil bypass cover (the best case) or into the filter (the worst case). Any oil that gets from the left gallery to the crossover channel to the top of the oil pump will re-prime. If there is an oil filter installed and it is empty, then a lot more oil is necessary and if the oil filter is full and used, then the reverse flow will take some "junk" back with it. Consider the other insertion points suggested in the other inputs and skip this solution. It takes an incredible number of thumb strokes to pump a goodly part of a pint of oil!

Half a quart appears to be a good target quantity for all methods.

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6 Oil Pressure (Pump Lost Prime) OK - Go to Walmart and buy one of those hoses that will screw on the top of a plastic quart container of oil and screw it on to the container. What you want to do is put oil

into the pump under pressure. To do this, remove the oil temperature sensor bulb and jam fit the end of the hose into the hole where the sensor bulb came out. Squeeze the bottle while your buddy turns the prop backwards slowly for a couple or three turns. This will force oil into the pickup side of the pump --put it all back together and you should see oil pressure if the problem was due to the pump losing prime.

Me...This will force oil <u>through</u> the oil pump gears to the input side, re-create the oil seals around the gear shafts and between the gears and the sides of the gear chamber. Plan on using an oil container with at least half a quart in it.

After I started this, another input came along with the same solution, but with good additions, so it is presented here instead of the order received. Note that both advocate turning the prop backwards.... it will force oil into the output side of the pump, <u>through the pump gears, to the pickup side)</u>.

BILDEK Re: Oil pressure reads "zero" Just went through this a couple of weeks ago with captnice. No oil out gage line, no oil out left hand gallery! we put tail up on box to raise aft of engine , take out oil temp bulb, remove top spark plugs, using pump can start pumping oil into screen housing while someone turns prop backwards, about a coke cane full will prime pump. put temp bulb back in leave gallery plug out and spin engine over with starter, hopefully you will have flow out of gallery, if so put plug back in and spin engine over until you have flow from oil pressure line. If you get flow there, put everything together , plugs, press line , gallery plug. I used to have Luscombe that I did this ritual every time I flew. Good luck.

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7. Post subject: Good tip by Ray (*see number 6).* When I rebuilt our engines I pressurize the system prior to the first run. I have an automotive oil pump, rigged to run from a drill motor, in a one gallon coffee can. All four or six quarts of oil is pressurized through the screen cavity and into the oil sump. Moving the prop during this filling gets oil to all of the bearings, lifters, cam and oil pump as well as drip oil to the cylinders and rings. The gauge reads bypass pressure of around 40 lbs. Any gross oil leaks can be found this way (internal or external) and when the engine is started for the first time oil pressure will be instant.

Me...This is such a good idea that it appears here and I repeat it in the section on "first start after overhaul". The pump system he uses is one of those things that, ideally, would be rentable.

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8. Post subject: Well, went back out yesterday to try what Joe said *(Me...number five above),* and I did that and cranked it up and still nothing. Then decided to lift the tail for a while to see if I could get any to drain down and that didn't work either. Stumped I tried putting even more oil in through the fitting the pressure hose connects to and SUCCESS. Guess I just didn't put enough in the first time even though oil was dripping out of the fitting, but after the second round oil was streaming out pretty good. Thanks for all the help I was starting to sweat pretty good.

Me...He stated that you need to force in a lot of oil, maybe a pint. Oil fed in here goes in the end of the right oil gallery, though the oil gallery, across the engine to the left oil gallery, back to the oil bypass pad, and across the engine to the top of the oil pump. Part of the reason that one needs to feed in a lot of oil is that oil is bled from the galleries to the bearings among other things. Note that we don't know how well or poorly this will work if there is an oil filter on the engine....it might take lots more oil. If you have a firewall-mounted oil filter, do not use this method.

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9. Oil Pressure Congratulations! If the pump loses its prime, you have to figure out a MacGiver sort of way to get oil under pressure through the screen opening and turn the prop backwards to suck priming oil into the pump. Some people carry a small oil filled plastic mustard container--the kind with the conical dispenser top that will fit snugly inside the oil temp sensor hole and enable one to squeeze the bottle and turn the prop backward at the same time.

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10. Oil pressure I had the same problem a few years back and found the oil pump gears to be the problem. I totally agree with the priming discussions above, but they are only a temporary solution around the problem, not a solution to the problem.

What I found was that as the oil pump gear shafts and bosses wear they allow air to be sucked in by the oil pump rather than oil being pulled up the pick-up tube. Higher RPM's will help get the oil circulating quicker simply because the oil pump is working harder and to do so it pulls both air (around the shafts) and oil. Once oil reaches the pump gears a seal is made and the oil pump works fine. The reason the problem surfaces after the engine has sat idle a while is that the oil in the pump is able to drain back to the sump because air can enter the pump via the worn shafts.

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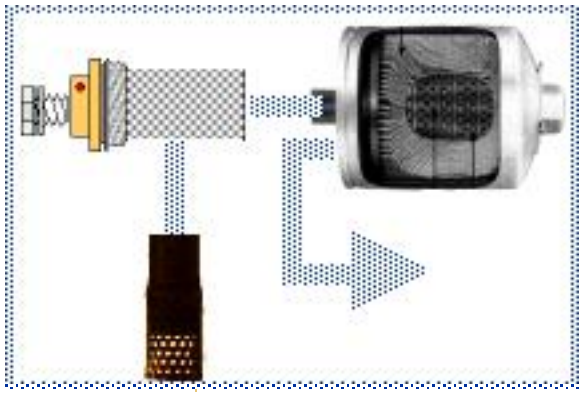
11. oil pressure Hi. I just wanted to share my experience! I did have oil pressure but it took 30 seconds or so to get it and it was some what low until it warmed up. I thought it may be a problem with the pick-up tube. I removed the oil tank and bingo the screen that is soldered to the bottom of it had broke loose. It appeared that it was never soldered very well. The screen had moved up the tube from the suction, leaving only 5/8" screen on the end of the tube. As if this wasn't enough problems, the screen was almost plugged with small carbon or Permatex chunks. Since the repair , good immediate oil pressure. jw

He was misled by not having another standpipe to compare...the screen left open at the bottom is about 5/8ths long, and about the same amount is blanked by the tube. The solder jobs do vary, as these pictures show..one by a journeyman and one by an apprentice but the amount of screen open is the same. About half the screened portion is blanked and half is open to suck the oil through. DO NOT, as one might conclude from his note, de-solder and shift the mesh part since there is not that much room in the tank...and, as evidenced by many thousands of engines, shifting the screen is not "better". Cleaning them of any carbon clag certainly is a good move.

We tend to assume that either the filter we add or the screen at the output of the oil pump will catch all such carbon bits and keep them from recirculating....BUT...his input did present a different concept. Because the oil that has done its duty in the engine dribbles back into the oil tank, any carbon deposits which go with it which are too large to go through the holes in the perforated section of the standpipe tend to stay in the tank, possibly occluding holes and thereby lessen the amount of oil which can be sucked up. The first place to "see" carbon chunks is the standpipe screen, then the big (but fine mesh) screen after the pump and then the very dense filter if we have it. So, thanks to John for the thought jogger and note his comment about where some of the Permatex chunks can show up if one is not very careful and parsimonious in its use. Having seen the result of an A&X's replacement of a prop seal made "better" by lots of RTV, some of which was hanging inside the engine, use caution.

In the middle, the end solder seal, good and poor. The left and right pix show how half of the mesh part is blocked by the tube and solder, with about 5/8ths inch of the mesh open to pass oil when a suction is established by the pump. As John Warren noted, his low oil pressure was at least partially caused by the

holes being blocked by big pieces of carbon. From the simplified path shown next, note that the oil in the tank first goes through the standpipe "filter" and then through the much more dense screen and then through the filter if one is installed. (The Paradise owner who had to consistently lift the tail finally got tired of doing it, took off the oil tank and found that he had left a paper towel in one of the "holes" in the engine while replacing accessories and the paper towel wound up in the tank, wrapped around the takeup tube. He flew it on many flights and lots of hours before finding the problem.)

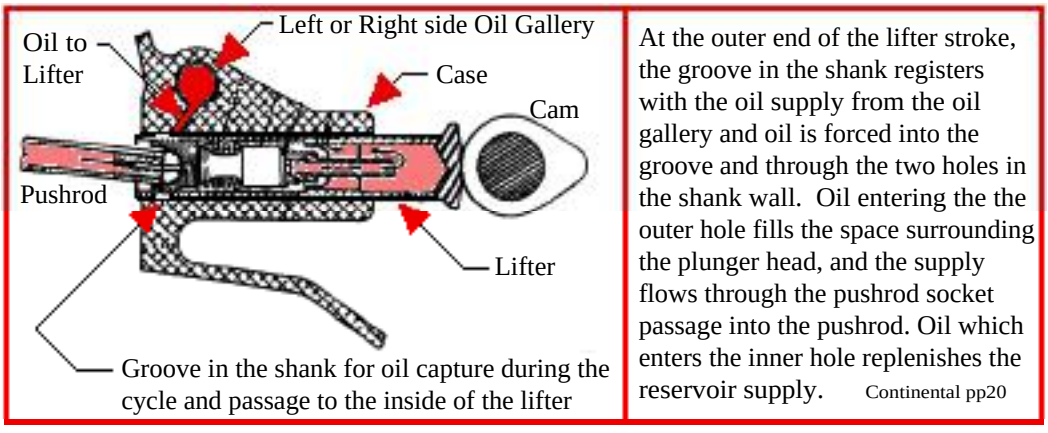


12. oil pressure I made the post saying what was the easy patch for your problem, not that it was a fix. The fix would be to remove the accessory case and send it to Drake Air or Divco *(Me...addresses at the end)* and have the oil pump cavity repaired and a new oil pump gears installed. The pick up tube is another sore spot in the system (good info).

13. No oil pressure Assuming the gauge is working properly, a no oil pressure reading means no oil pressure anywhere in the engine. This being the case, there will be damage in short order. That's why Continental recommends shutting the engine down if oil pressure doesn't come up after (*he meant to say within)* 30 seconds.

I have been told by several knowledgeable people the valve lifters are at the 'end' of the system and the valves will be the first thing to indicate a problem by making lots of noise if pressure is lost or is too low. Fortunately I cannot verify this from experience.

According to the overhaul manual, pp 16. The oil supply to the lifters comes from the galleries, just the same as for the main bearings. There is an oil reservoir in the lifters and a small amount of oil is expected to be lost on each lifter action and some of the oil in the lifter is boosted through the pushrods to the bearings of the tappet assemblies, but that loss is replenished on each return stroke of the lifter via the oil channel to the galleries. This is not the "end" of the of the oil supply system.



At the outer end of the lifter stroke, the groove in the shank registers with the oil supply from the oil gallery and oil is forced into the groove and through the two holes in the shank wall. Oil entering the the outer hole fills the space surrounding the plunger head, and the supply flows through the pushrod socket passage into the pushrod. Oil which enters the inner hole replenishes the reservoir supply. Continental pp20

During loss of pressure, it is true that the lifters' oil reservoir supplies would eventually be depleted and the lifters would be clattering, but by that time the "silent" bearings would have been damaged, along with

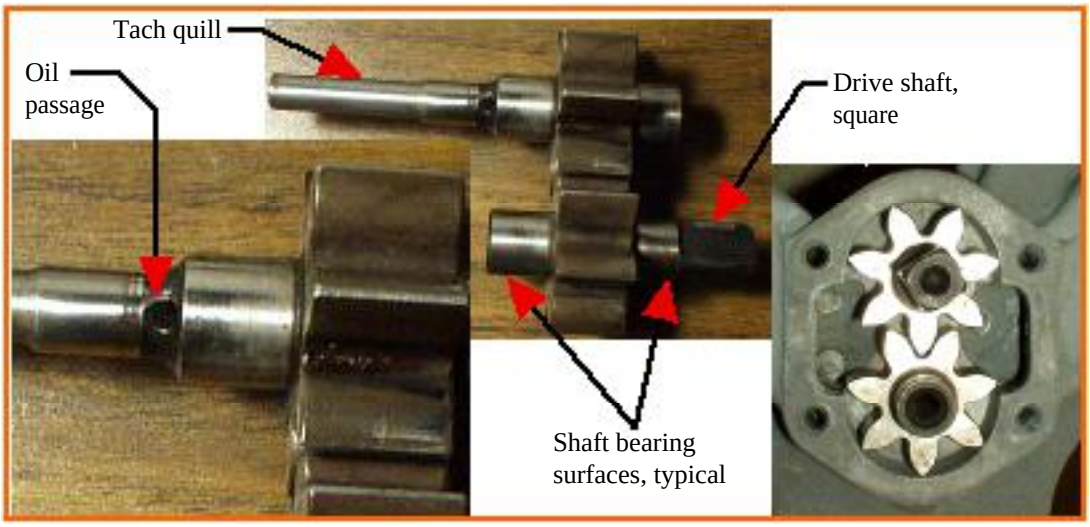
other rubbing things. If you can hear the lifters, it is likely that you will need a lot of assessment. And maybe lots of new parts!

The pump:

The figures show the gears and their support surfaces. Why Continental did not use Oilite bushings with a longer life than aluminum (the plate) or the accessory case (magnesium) will remain a mystery.

On the left is the inside of the plate. I tried to angle it to show the partial shiny contact marks where the gears seal to the wall, but was not very successful. On some plates, the gouges are such as to be significant and require replacement of the plate, as will wear of the shaft support shoulders. The center figure shows the gears and the plate and the right is the other side of the plate.

In the next figure, I have included an expanded picture of the tachometer quill end of the assembly in order to accentuate the oil weep hole which is one of two drains from the tach drive chamber. On the right, the gears in their pump recess of the accessory case. The bright sheen to the gear surfaces indicates reality...the surfaces are machined flat, perpendicular to the shafts, and very smooth in order to form an oil seal with the surfaces of the case recess and the face of the pump recess cover plate. Clearance between the gears and the nest/plate is 0.0015 to 0.003" when new.



On the next page, the interior of the gear chamber indicates the wear pattern where the gears have rubbed on the magnesium of the accessory case. There are a couple "smear" spots which suggest that something, maybe a big chunk of carbon, was squeezed between the gear face and the recess. One can be seen above and to the left of the upper hole. For those who note the curled "chip" at the left stud, it is part of a Helicoil and not in danger of falling off.

Reprime after a Loss of Prime:

When the prime is lost in the oil pump, the methods used to get oil to the pump to re-prime it are prominent in the suggestions above and are re-listed as follows, with the two most-recommended first. Have at least a pint of oil available in the container used to force oil in to prime. In each case, put the removed parts back in place. Many recommend taking out the top plugs to make turning the prop easier, either by hand or for faster motoring the engine with the starter after the injection to prove flow.

1. Remove the oil filter or the oil bypass cover at the left rear of the engine, and use a combination of hose and reservoir to force oil into the top hole; it leads to the channel which normally brings oil from the pump to this spot. This oil fed in will get to the top, output side of the oil pump. Again, turn the prop backwards to force the oil to fill the gaps around the pump gears and in the chamber. As at least one has stated, prove that the pump is primed by turning the prop forward and note that oil comes out.

2. Remove the oil temp sensor. Using a method of forcing oil into the oil temp sensor hole (several suggestions are in the emails), with ignition off and gas selector off, turn the prop backwards while feeding in the oil. One of the figures explains why you have to feed in a lot of oil. Many find it easier/better to remove the top plugs in order to turn the engine over more easily.

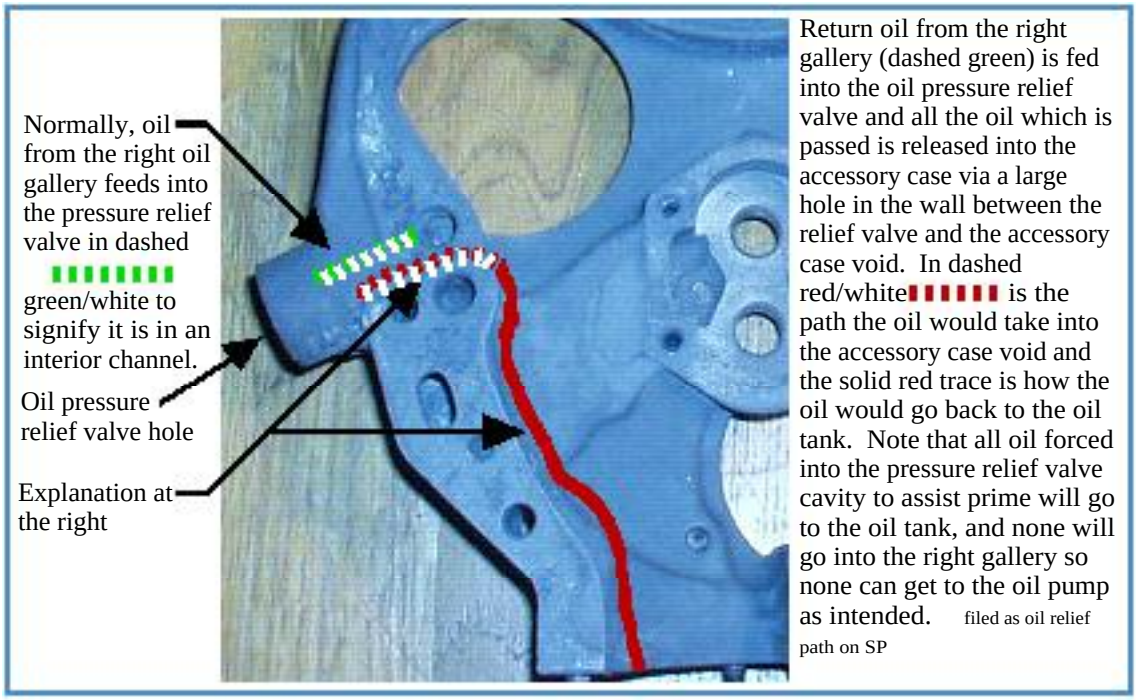
3. Remove the plug at the end of the left oil gallery at the front of the engine (a BIG Allen wrench is needed on some or a big Crescent wrench for others) and pour/force oil, lots of it, in this way to the pump. If the oil bypass cover is still on the engine, most of the oil fed into the front of the oil gallery will get to the channel which goes across the case to the output side of the pump. Same protocol...turn the prop backwards while feeding in oil to make sure it gets spread.

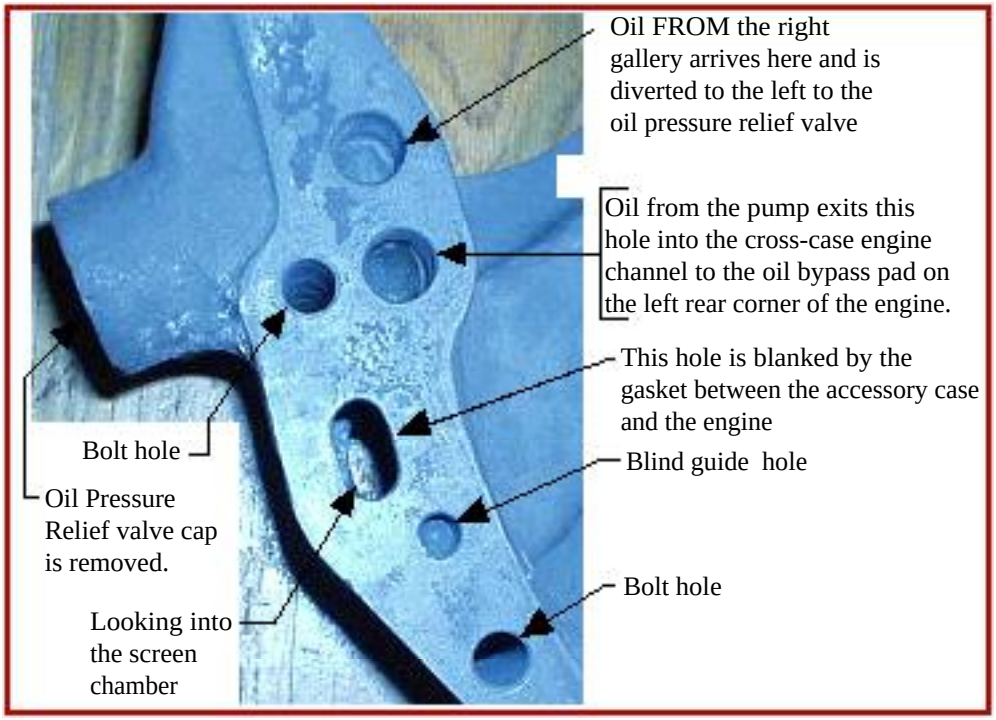
We are not sure if oil will readily flow through a filter "backwards" nor do we know if a filter stays full of oil at any time except when it is changed so as to make us dribble dirty oil, so the filter should be removed and the bypass cover be put back on, with gasket, before using this method. If anyone finds that the filter does pass along this oil without restriction, tell us and this comment will be changed. And, if oil is fed back through a filter, some of the "gluck" which was removed from the oil will surely be washed back into the oil. Not a good thought so do not try to feed oil back through the filter. Compare this method with number 1 in this section. New engine, new filter, feed in enough oil to more than fill the filter!

4. Possible but not recommended is to overfill the oil tank such that the top of the oil is over the top of the oil pump chamber, turn the prop backwards, and then remove the excess oil, an easy task <u>if</u> one has the quick drain feature on the oil tank. Not recommended.

5. Remove the oil pressure gauge fitting at the engine, and force oil into that opening. Not recommended. If the volume of oil is great enough, some would be forced into the right gallery, forward to the crossover point at the front of the engine, into the left gallery and through the gallery to the channel leading to the output of the oil pump. See page six for the reason one should not try to feed oil into the line or hose to the oil pressure gauge fitting.

6. Some suggest feeding prime oil into the oil pressure relief valve hole but all oil fed in here will simply be dumped into the sump area, away from the oil pump. <u>None</u> of the priming oil would go to the oil pump. This view of the pump side of the accessory case indicates the path of oil fed in here.





Without an accessory case on one's lap, it is confusing to the extreme to try to follow the pictures from the Continental books and write-ups so this is how the oil is routed on the right side (you are looking at the pump side) of the accessory case.

First start after overhaul:

1. Not yet mentioned for new installations, either after an accessory case/pump overhaul or with a new engine, is to coat the pump gears and recess and shafts with grease. The grease would not drool from the gears during the assembly period as would all oils. Grease would serve as the first seal in the pump and would shortly be absorbed into the oil. The grease should be petroleum based, with no additives such as Lithium. And today, this suggestion came in: Vaseline or petroleum jelly. From a member who did this on 4 July '04, he saw pressure on the gauge within seconds of startup, with no other priming.

2. These comments by two of the respondents bear repeating because of the advantages in re-priming the most reliably.

Ray Hunter says: "But I still would feed oil in through the oil bypass path to the top of the oil pump just before starting and make the first start without the oil filter (or cooler, if that is usually installed) but with only the bypass plate and gasket in place." *Excellent ideas.*

And Randy L. Thompson said: "Good tip. When I rebuilt our engines I pressurize the system prior to the first run. I have an automotive oil pump, rigged to run from a drill motor, in a one gallon coffee can. All four or six quarts of oil is pressurized through the screen cavity and into the oil sump. Moving the prop during this filling gets oil to all of the bearings, lifters, cam and oil pump as well as drip oil to the cylinders and rings. The gauge reads bypass pressure of around 40 lbs. Any gross oil leaks can be found this way (internal or external) and when the engine is started for the first time oil pressure will be instant.

3. An alternative, but look at the other possibilities first: Removed.

Oil Viscosity Effects:

The viscosity of the oil at the time of shutdown will affect how much of the oil at the pump drains into the sump and leaves the oil pump unprimed if the clearances are excessive. The viscosity depends on the temperature at the time of shutdown. To get answers, I interrogated the net and got a better answer than hoped.

On the net, this question: "Does viscosity of oil change as its temperature changes, and do multigrade oils get thicker, more viscous, as they warm?" Gregory Travis {greg@sherrill.kiva.net} wrote this good and complete response.

Yes and No. ALL oil gets thinner as the oil temperatures increase. Single or multiweight. The difference is in the RATE of viscosity loss with temperature increase. A multiweight oil has viscosity improvers which retard viscosity loss with increasing temperature. That means that a multiweight oil can start with a "thinner" base oil (which helps low-temperature performance) while still retaining appropriate viscosity at engine operating temperature.

By definition, a multi-weight oil will have the same kinematic viscosity as a straight-weight oil when both are hot. See the following table and note the equality of viscosity at 210 degrees.

Viscosity is a measurement of an oil's "thickness" - specifically, the amount of oil that flows through a calibrated orifice at a specific temperature. This is referred to as the oil's kinematic viscosity and the usual unit is the centistoke. Water has a viscosity of approximately one centistoke (water's viscosity is not affected by temperature at temperatures between about 5 and 95 degrees centigrade).

Single weight oils have their viscosity tested at only 212F. In other words, the oil is heated to 212F and flowed through the calibrated tube. Flow rate is converted to kinematic viscosity (centistokes) which are in turn converted to an SAE classification such as 20, 30, 40, or 50. For example, a straight-weight oil must of a kinematic viscosity between 16.3 and 21.9 centistokes at 212F to be classified as a 50 weight oil.

Multiweight oils are tested at both 212F and 32F. The viscosity measured at 32F is represented in the xW portion of a xW-y rating - for example 20W-50 means that the oil was equivalent to a 20 weight oil at 32F and a 50 weight oil at 212F.

OIL TEMPERATURE	50 Weight (singlegrade)	20W-50 weight multigrade
32F	3650	2100
50F	1500	1000
150F	62	55
210F	20.5	20
250F	12	12
300F	8	8.2

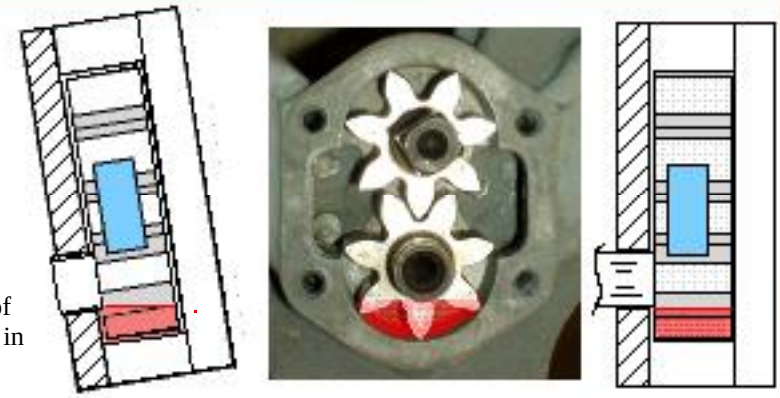
Those numbers above are actual direct kinematic viscosity results for Philips aviation oil at the temperatures indicated. As you can see, there is absolutely no difference in actual viscosity of a 50 weight "straight" oil and a multiviscosity oil at engine operating temperatures. In fact, there's very little difference between the two at ambient on a typical summer's day. Note that if the viscosity of a multiviscosity oil is less at ambient, then it is more likely to leak back via the oil pump, leading to loss of prime and no pressure at startup.

Note how either type of oil would be much more likely to escape from the pump because of the lower viscosity, and note that at ambient temperatures the multiviscosity would be more prone to escape based on its low temp viscosity. Too bad we have no table for 10-xx multigrade.

C. Earlier, I said I had not figured out why raising the tail would do anything, but I know it does for many who use the method. The figure following explains "why".

Oil inlet and outlet openings in blue and the bottom shaft and hole are drawn to show that a gap there makes the lowest possible level of oil escape

The bevelled faces of the gears are shown in gray



A theory for why picking the tail of the plane up helps when one simultaneously turns the prop backwards. Even if most of the oil drains away from the pump cavity, there will always be a little oil in it at its bottom because all the leak paths are higher than the residual oil shown in red. On the left is the cavity as it would appear if the plane is in a normal ground angle of 12 to 15 degrees. When one lifts the tail to make the plane about flying position or near zero angle, the residual oil is spread across the width of the bottom gear rather than in the "corner" when the plane is at an angle. That small amount of oil will be spread across the width of the bottom gear and will form a seal with the top gear when the prop is turned backwards. You have now created a Primed Pump.

D. "Priming by hand is OK for a while, especially to get you back home where you can fix (or have fixed) at a convenient time, BUT the only cure is to overhaul the oil pump." Odd how so many make this statement and forget that the accessory case recess is an important part of the pump system and needs to be rebuilt if the pump repair is to be a complete one. Pump recess, gears, and plate are the "system".

E. The hole in the bypass pad is 0.43 diameter and I would expect the hole in the F&M oil filter adapter to be the same or maybe a bit larger. The hole in the oil temperature adapter with the sensor removed is 5-8ths-18. The hole in the oil screen shroud with the oil temp sensor and the adapter removed is also 5-8ths-18. The front holes in the galleries are 5/8ths. The hole for the oil pressure fitting is a 1-8th NPT, about 0.36 diameter; do not attempt to feed oil in through the hose/copper line or fitting because the anti-loss

hole in the fitting is 1/16th diameter. Since feeding in oil in the oil pressure relief cavity can not prime the pump, its hole size is not presented.

F. For those who note that their inputs have been edited, blame the word processor spell checker. I got so tired of saying "skip" a mis-spelled word that I finally just let the program make the corrections. Sigh.

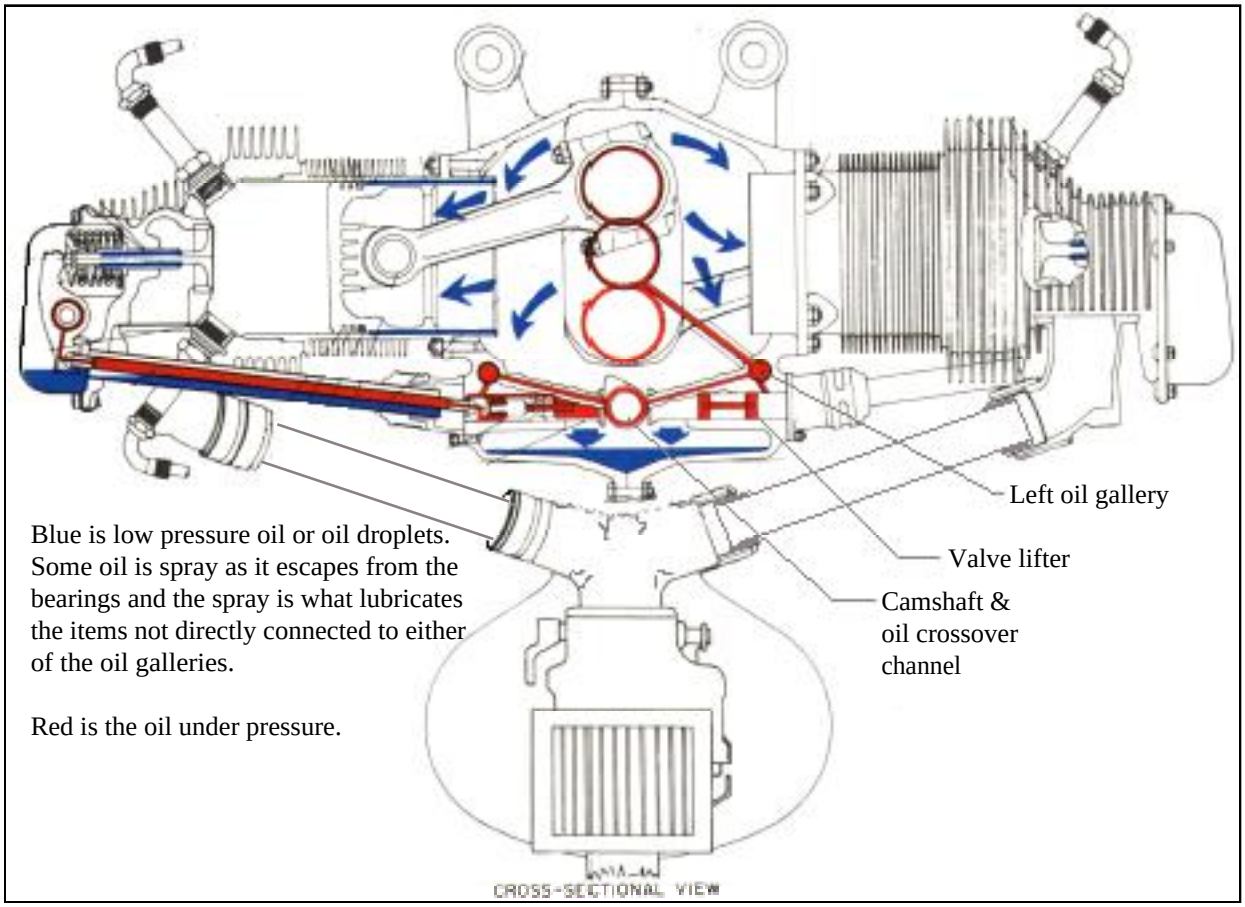
I annotated using text in red so it was easy to differentiate but so many printers fade the red to a hard-to-see gray that I went back and italicized instead, leaving only a few critical items in red and italics.

G. Credits: The 150 oil flow story by http://150cessna.tripod.com/oilflow.html The best I have seen with respect to where the oil goes and what paths it takes.

H. Half a quart appears to be a good target quantity for all methods of priming except for the initial start after overhaul. The oil screen void holds a bit over half a cup.

I. "I used to have the same problem with my Taylorcraft/Cont. A-75. If I drained the oil and cleaned the screen and didn't run it as soon as I put the oil back in it wouldn't prime the pump if it sat for a day or two. I would have to pump oil into the oil temp fitting or somewhere on the accessory case where I could get oil into the oil passages. This happened a couple of times before I figured out the cause. NO more problem if I refilled and ran it *(very shortly)* afterward." Bob Olds A&P Charleston,Arkansas

A very good hint for this reason and to find any leaks before leaving the field and justification for a check ride.



This figure, also from the Continental overhaul manual, but corrected and annotated, serves to show how the oil gets from the left gallery to the right gallery (via a channel cut in the forward bearing portion of the camshaft at the front bearing (but in the shaft, not the bearing) and a bit more of the reservoir and path of

oil in the lifters and the pushrods and tubes. There are plugs in the front end of both galleries which can be removed, as a path for insertion of priming oil. It requires taking the cowl off and feeds oil directly to the oil bypass so one will usually find it easier to go to the bypass or filter adapter instead of at the front of the left gallery.

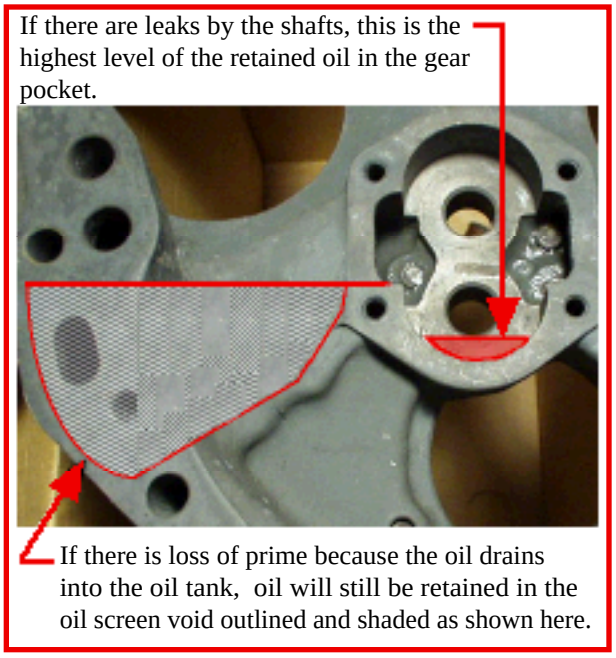
Addendum:

J. "The oil pump gear cover plate inside the case is leaking oil. It's a metal-to-metal fit to the case, and if the rebuilder doesn't use a bit of sealant on it the oil will gradually drain out of the pump gears, leaving them dry and unable to generate enough suction to raise the oil from the tank."

Me. Unless Continental says to use a sealant between surfaces, don't. I know of no sealant which would have a thickness of zero so to use it is to increase the distance between the gear faces and the "nest" between the plate and the case. The limits are 0.0015 and 0.003 with no sealant. After writing this, the official word to never use a sealant.

A good idea from another: Lap the flat rear surface of the oil pump cover. There is no gasket, so the cover to accessory case fit must be precise.

K. After the article was "done", this input came along and yielded an immediate: "of course, that would be a great explanation",



"Tipping the airplane forward might help, if it's a taildragger, as the residual oil in the screen would run forward and drop into the pump."

Trying to prove the hypothesis, I tested and we tested, and the conclusion was always the same. Note the figure; if oil can leak back to the oil tank via the gear shaft clearances, then the red horizontal lines in the figure would be the top of the oil pools, one in the gear chamber and in the screen housing void of the casting. The front to back depth of the void for the screen varies constantly, as does the shape, so it is impossible to show the actual shape and size of the oil pool.

The tests were to seal the accessory case with the screen assy in place and then pour milk (so as to get a contrast which would show in pictures) into the screen chamber. With the accessory case tilted about 15 degrees as it would be on our planes, I measured the amount of oil (milk) which would run back into the gear chamber if the tail is raised. None. Not a drop. The shape of the void is such that tilting the accessory case toward vertical actually causes the fluid level in the screen chamber to drop. Even if you were to lift the tail such as to give the accessory case a greater than 5 degree forward angle, not a drop of oil transfers to the gear chamber. Surprise.

The theory does not work out. None of the oil in the screen chamber will shift to the gears of the pump if the tail is raised.

I used milk as the oil substitute and used transparent tape to close off the holes of the screen chamber. I could see in to the screen chamber and watch the level in the void versus the high point "dam" of the void noted by the red line. Same results. No transfer of milk from the oil screen cavity to the pump nest. The following figures illustrate the effects.

Using milk instead of oil, I filled the oil screen cavity with milk when the accessory case was at about 19 degrees to the tail, much more than the usual 12 degrees of a resting plane. Note the milk in the bottom of the oil pump cavity and the milk that can be seen on the "ledge" which is the highest point of the levelled milk in the oil screen cavity.

An off-angle view to better show the level of milk in the oil screen cavity. The milk in the oil pump cavity has been sopped so as to measure whether tilting the tail up would cause oil to transfer from the oil screen cavity to the oil pump. No, it won't.

Tilted forward about 5 degrees nose down and note no milk has seeped into the oil pump cavity. The oval hole is an opening into the oil screen cavity. The oil screen is installed and is made leak-free with a plug and Teflon seal.

Tilted more than five degrees nose down and still no significant transfer of milk to the oil pump cavity. What does make some move into the oil pump cavity is an extreme right wing high attitude. And sloshing side to side makes some shift as well.

Accessory Case Rework:

www.divco.com no longer does Continental accessory cases (they do Lycoming) Tulsa Oklahoma 2004

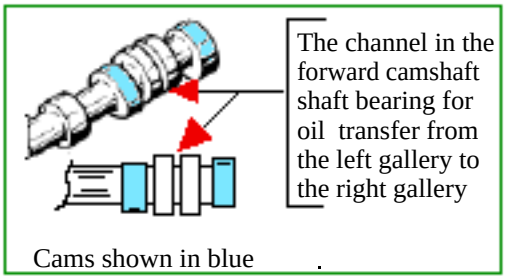
www.drakeair.com Tulsa OK 800-542-6899 pp135 Trade-a-plane $840 Sept '04. A Canadian applied grease as discussed before and got oil pressure on startup within 8 seconds. In a subsequent call to Drake, the cost has risen to $840 and one must send in the gears and the front plate at the same time. The person I talked to was the "helicopter" person because the accessory case person was on vacation. I will follow up with another call and include whatever I find. Keith in Sept 2004 confirmed the new price is $840 because they assessed their efforts and found they had made a total profit of less than $100 on all the cases they had reworked in the last five years. They were baking out the oil on one and it caught fire, burning out the bottom of the oven as well. Their suggestion? Go to Aviall and get a new accessory case for the O-200 for about $600. Their method is and has been by welding and then machining.

Although ECI advertises they do accessory cases, three queries to them has netted no reply. And then member Ross did get through to them to find that they do not do accessory cases.

IF THE PUMP CAN SUCK AIR, IT WILL!!!!

Last Minute Stuff from the Internet

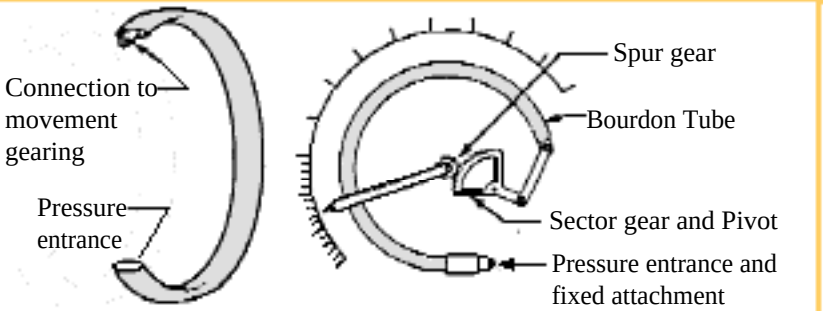
A. "I asked the question to a reputable engine shop owner just yesterday and was told that on the C-85, oil has to traverse all the bearings, cylinders, valves and other engine sections before reaching the gauge which is at the complete end of the circuit."



Not so. The oil does not traverse any but the front camshaft bearing surface of the shaft, with oil crossing from the left oil gallery to the right gallery via the slot shown here. All oil which is forced to and through the bearings and valves and tappets either drools from or is squirted from the clearances or returns and then simply falls into the case. None gets back into the right gallery. ONLY the EXCESS arrives at the oil pressure point of the right gallery. No oil is "fed" to the cylinders; they get only splashed oil.

B. "Having some air in the gauge line may indicate no pressure on the gauge but does not necessarily means no oil pressure in the engine"

Whether there is air or oil or kerosene (to momentarily make the users feel better) in the line from the oil pressure sensor line at the engine or part way, or all the way to and even into the Bourdon tube of the gauge, it makes no difference as to the presentation on the gauge. Pressure in a line is the same pressure all though the line and in the gauge....there is no low-pressure or no-pressure section regardless of the medium in the hose/line/gauge!! The medium in the line from the pickoff point to the gauge which would prevent it from indicating the pressure would have to be frozen. The tube from the pickoff point to the gauge is in two sections. Oddly, all reporters of the benefits of kerosene or light oil in the tube neglect to mention "purging and filling" the tube from the firewall to and into the meter.



From Scott, makers of the oil temp sensor and oil gauges for our planes: The Bourdon tube mechanism works on the principle of the party hooter. An oval, coiled tube, with one end fixed and with the other end coupled to the pivot and gearing which moves the indicator arm. When pressure is applied, the tube uncurls and causes the arm to the sector gear to move and the gear movement is transferred to the needle via a spur gear at the needle axle.

C. "I agree air in the gauge line will effect the time it takes the gauge to indicate oil pressure. But, none of the priming techniques, suggested in the posts above, will get oil into the gauge line. If priming temporarily solves the problem then the problem is not the gauge but somewhere else and most likely the pump."

No to the first part but the last part is correct. Take another look at the Bourdon tube used in the pressure and temp units....and realize that the Bourdon tube does not know what liquid/gas is inside pushing, it just reacts to the push.

D.."The location of the oil pressure sensor position also explains the 30 sec. or so delay we sometimes see"

It certainly has an effect, but tiny, if you understand that the slow appearance of pressure on the gauge means that it took some time for the pump to prime, to have a full output, to fill the drained-back voids such as the filter and the crossover channel and the galleries and the bearings and the tappets. If everything stayed full while the engine is not running, you would have oil pressure instantly, but normality is that the pump has to fill the system. ----------

E. And don't forget the obvious:

"My oil pressure was slow to come up, near the 30 second limit. I changed the gauge, and now it comes up in less than 5 seconds."

Just to be sure you don't go about using one of the fixes here when the oil pressure line fitting is clogged, take the fitting of the oil pressure line out of the engine to verify that there is no flow. Messy but effective. *If you must, disconnect the copper line or hose for the test but leave the engine fitting alone.*

Me. What we need is a Pyrex case and accessory case so as to observe where the oil goes at shutdown. After this study, one wonders if the oil in the left gallery and filter will eventually drain back through the pump to the tank, leaving the pump trying to pump a lot of oil to replace the air. Sigh.

Best Solution:

The best solution to the recurring lack of oil pressure at startup is this feature added to the oil filter adapter. It suggests doing something similar to the oil bypass plate if no filter is utilized. Cut the safety wire, remove the cap, feed in oil via the opening, turn the prop backwards, reattach the cap and safety wire and give the engine another try.

Conclusions:

For a newly overhauled accessory case, apply a petroleum-based grease to the oil pump gears and shafts before installing the oil pump plate. This maintains the prime and ensures a good suck to pull oil from the oil tank. Running, the grease will be absorbed into and diluted by the oil.

For engines which have frequent, short time between loss of prime, plan on getting the accessory case overhauled.

Common feature; while feeding in oil, have the prop turned backwards, easier with the top plugs out, and safer. Ignition off of course.

To keep the engine useful until overhaul or accessory case removal, the best ways of regaining prime are:

- Best with a filter...see the Best Solution, where the filter adapter has been modified with a filler port. The cowl can stay in place.
- Next best with a filter. Remove the filter and feed in at least a pint into the TOP hole of the adapter, replace the filter, and try. The cowl can stay in place.
- Without a filter, remove the oil bypass cover and feed about a pint into the TOP hole. The cowl can stay in place.
- Remove the cowl, remove the left gallery plug at the front of the engine, and feed oil in there, lots of oil if there is a filter. Resafety the plug if that type.

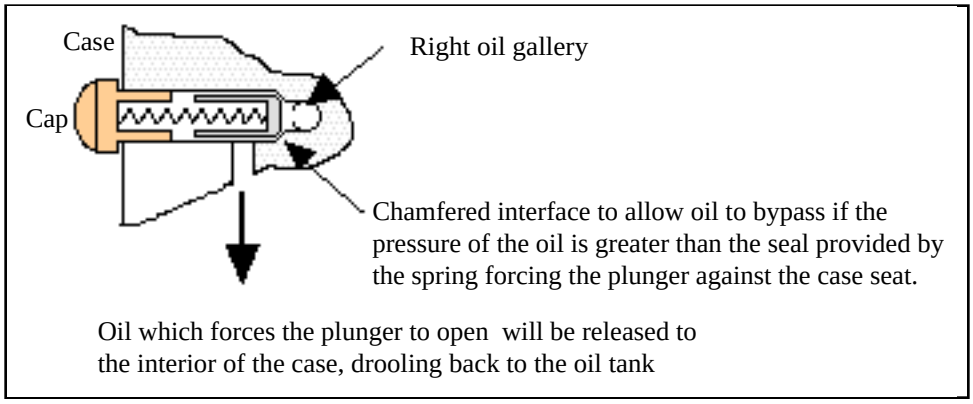
Worst:
To feed oil into the oil pressure copper tube or Neoprene hose or to remove the fitting from the engine and inject there. Tiny opening, and injection there means you have to fill the right gallery, the left gallery, and the filter if installed.

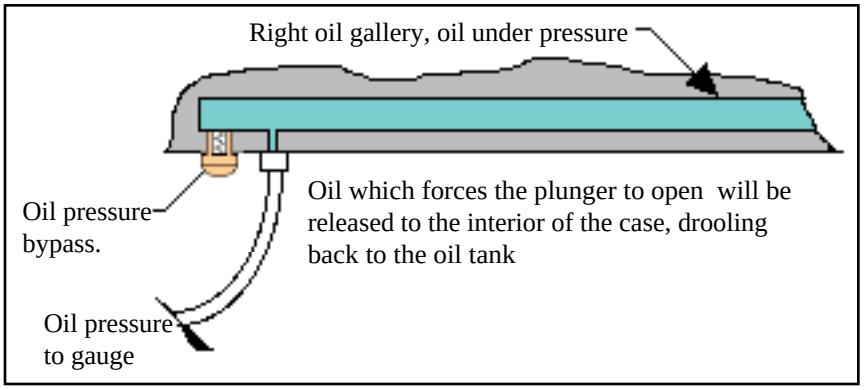
Neal F. Wright
Cougarnfw@aol.com

July 2005 filed as: oil pressure loss all

If you have suggestions for improvement, by all means send the information to me for inclusion in the next version.

After "finishing the article for the nth time", it was apparent that many do not understand the relationship between the high pressure oil in the right gallery, the oil pressure pickoff point and the oil pressure relief valve assembly. These two figures indicate the workings





Odd Category:
A. "Our A&P said it is likely that some of the heavy oil found its way into the capillary tube that goes to the gauge and is slow to move and thus doesn't allow pressure to transfer to the gauge side of the blockage until it gets warm. He suggests that the capillary tube is probably slower to get warmed up than the engine and engine pressure is probably fine."

Wow. More strange things are attributed to the magic material in the oil pressure gauge line! Physics is physics and one of its tenets is that when any closed space is pressurized, whatever the gaseous/liquid media

in the space, the pressure is the same everywhere in the space. In shock absorbers for the landing gear, there is not one pressure on the air and a different pressure on the oil. Same for the oil pressure gauge and line. Whatever is in the line and gauge, air or kerosene, or "heavy oil", that pressure is instantly going to be acting on the Bourdon tube mechanism of the gauge. The comment about "heavy oil", one hopes, won't prevent the owner from ignoring it and looking for the right cure. Unless the material in the oil pressure gauge system is frozen or nearly so, it will show the true pressure in the engine if not otherwise blocked.

B. Some of the respondents recommend removing the top or bottom plugs (I do not know why anyone would remove the bottom plugs when the top plugs are so much easier to remove but one did) in order to more easily turn the prop backwards when priming and proving flow by forward prop movement after priming and "no plugs" does ensure that the engine won't run in the case of a faulty mag switch or hookup. To remove bottom plugs means the cowl must be removed. Because the best? solution to reprime is to feed oil in via the bypass channel, the cowl need not come off for top plug exchange or oil injection.. If there is a strong second person standing behind the prop and doing the reverse movement of it then there is no reason to remove the plugs. Your choice.

Oil Filter Anti-flowback?

August of 2005; in a string last week, it was mentioned that the 48108 filter (used with the F&M filter system) had an anti-flowback flapper valve. John C. and Victor Grahn checked their stocks of filters and could see the anti-flowback seal but there seemed to be a difference with the late '04 manufacture and the earlier manufacture. I asked the Champion oil filter manager whether the 48108 filters had an anti-drainback feature. He stated that both the 48108 and the 48108-1 filter (the model that supplanted the 48108 a year plus ago and the only one authorized for use with the F&M filter system), do have an anti-drainback feature.

Here is his response:
Yes, the Ch48108-1 has a anti-flowback valve in it. Only the CH48108-1 and the CH48109-1 filters have this valve. As you've stated, it was designed to make sure that oil will stay in the filter after the engine is shut down.

Let me know if you have any other questions.

Regards,

Alex Feil
Piston & Power Supplies Products Manager
Champion Aerospace

Later, another query as to why John C. and Victor noticed a difference and Alex responded that they had changed the design of the anti-flowback feature so as to make it more effective. John C. and Victor believe that the filters made after December of '04 have the better anti-flowback component.

Nobody tells you what the capacity of the filter is but we know. The filter holds a quart, so plan on putting in 7 quarts instead of the usual six for the O-200, and an extra quart for the C engines as well. If it makes you feel better, put in the pre-filter usual, do the runup check for leaks, wait a while and note that the level is down a quart, and add a quart.

Oddly, an email input by an owner who came to the conclusion that for a fill up after installing the filter, he only needed the usual six in an O-200....but that is not true because the filter "holds" the quart of oil all the time and it is not IN THE ENGINE doing what it should be. Think of it this way if you wish; if all the oil was lost to the point there was no more to pump, there would still be a quart in the filter. Compensate for the filter by adding a quart.