Burping The Rotax 912

If you're interested in a spirited discussion, or a heated argument, I would recommend that you bring up the subject of burping the Rotax 912 engine at your next EAA meeting. Let's start off with the definition of burping. When we talk about burping the Rotax 9 series engines (912, 912S, 912IS, and 914) we are essentially talking about the method by which we remove all of the oil from the crankcase of the engine and send it back to the oil tank. The Rotax 912 utilizes a dry sump oil system. However, the dry sump system used in the Rotax is a little different than what we would typically encounter. Even Wikipedia identifies a dry oil sump system as a "system that uses two or more oil pumps". Typically, one pump that sucks oil from the oil tank through to the oil pump and subsequently supplies pressurized oil to the engine to lubricate all of the engine components, and a secondary oil pump that collects the excess oil in the bottom of the engine and pumps it back into the oil tank. One of the great advantages of having a dry oil sump system is the ability to remotely locate the oil tank. This allows the design of the engine to be very compact in comparison to an engine with a wet sump. Typically, in a wet sump system the "oil tank" is co-located within the engine, positioned at the bottom of the crankcase, so that all of the oil that is run through the engine oil system simply drains back into the sump (oil tank) where the main oil pump suction tube is located. The overall frontal area for a wet sump engine of the same size can easily be increased as much is 20%. The primary downside of a dry sump engine is, of course, that we have two oil pumps. And with two oil pumps comes an increase in the maintenance, weight, complexity, cost, and the potential for an oil system failure. Simple is always better.

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Rotax, in their infinite wisdom, devised a method by which they could take advantage of the dry oil sump system without all of the downsides of a typical dry sump system. The Rotax engine utilizes a dry sump system with only a single oil pump to suck oil from the bottom of the oil tank and pump it through the engine. (Figure: 1) The ingenious way by which the oil is returned to the oil tank is essentially by locating the engine crankcase breather tube on the bottom of the engine and allowing crankcase pressure to push the oil back into the oil tank. All engines create crankcase pressure. This is simply a result of the pressure within the combustion chamber leak-

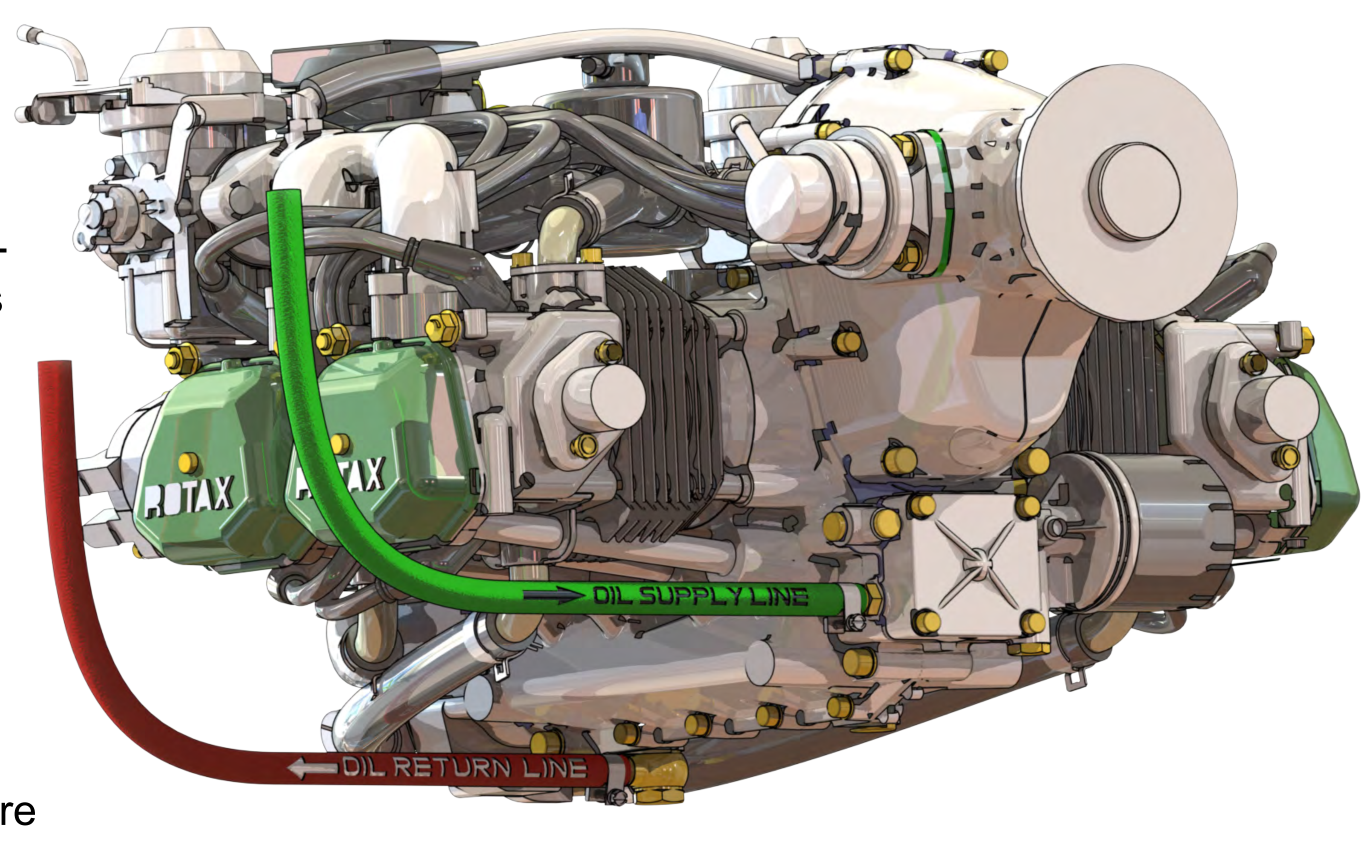

Figure: 1 Engine Oil: Supply Line and Return Line ing past the rings during the compression stroke. Even without the engine running, as the piston approaches top dead center, on the compression stroke, the pressure within the combustion chamber continues to increase until top dead center is reached. During this process, even on the best of engines, there is some air leakage around the rings, and particularly at each of the ring end gaps. This leakage of air from the combustion chamber, past the rings, into the engine crankcase is what supplies the crankcase pressure that forces the oil back into the oil tank. During normal engine operation with the engine running, each piston is leaking a small amount of air during the compression and especially the power stroke. As the oil pump draws oil from the oil tank and into the engine, through the passageways, it eventually finds its way back to the bottom of the crankcase where the return line to the oil tank is located. In typical Rotax fashion, even the method by which the oil is introduced back into the oil tank is ingenious. The design is undoubtedly tied to the rich Barvarian culture which has perfected the art of drinking beer. The oil, just like beer, has a tendency to foam when simply dumped into a container. The technique of placing the tap against the edge of the glass to reduce foaming is also used in the oil tank. As the oil enters the top of the oil tank, the line returning the oil is positioned against the side of the oil tank at an angle to allow the reintroduction of the oil as smoothly as possible, reducing its tendency to foam. (Figure: 2)

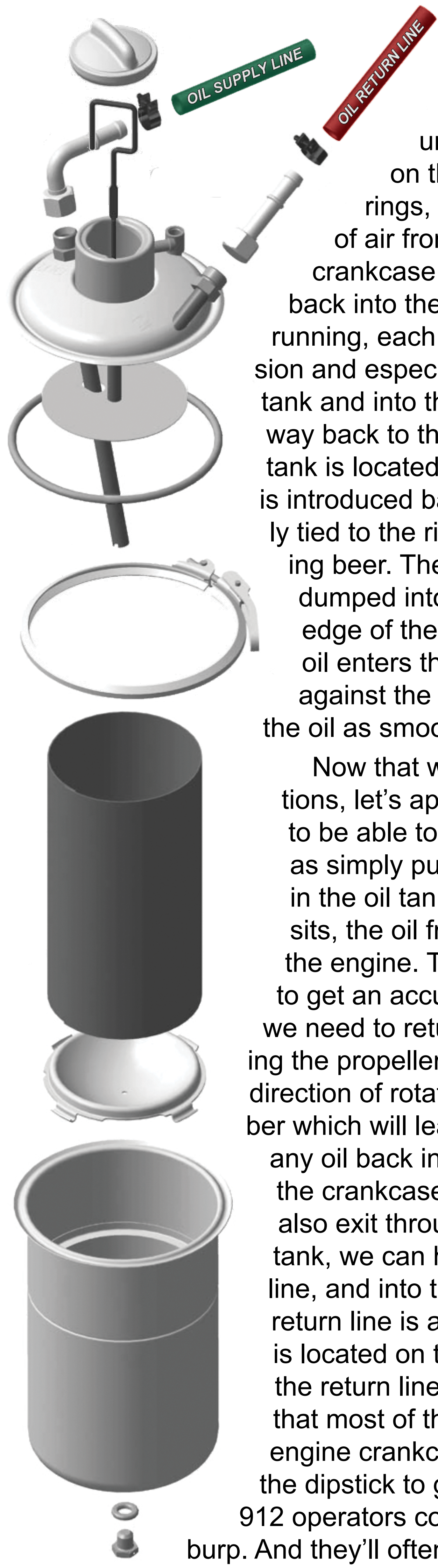

Figure: 2 Oil Tank Assembly

Now that we have a basic understanding of how the oil system functions, let's apply this to the principle of burping. Before we fly, we need to be able to check the oil quantity. However, this isn't quite as simple as simply pulling out the dipstick and checking the oil level. We have oil in the oil tank, however, we also have oil in the engine. As the aircraft sits, the oil from the oil tank can slowly leak from the oil supply line into the engine. This leaves the oil quantity within the oil tank low. In order to get an accurate accounting of the total amount of oil in the system, we need to return the oil from the engine back into the oil tank. By turning the propeller in the normal direction of rotation (and only in the normal direction of rotation) we can build pressure within the combustion chamber which will leak past the rings and pressurize the crankcase returning any oil back into the oil tank. When we have introduced enough air into the crankcase to displace all of the remaining oil, any additional air will also exit through the oil return line. With the oil cap removed from the oil tank, we can hear that air exit from the crankcase, through the oil return line, and into the oil tank. The sound that the air makes as it exits the oil return line is a very distinct "burp" or "gurgle". Because the oil return line is located on the bottom of the engine, all of the oil will be forced through the return line before any air can enter. By default, this is an indication that most of the remaining oil has been removed from the bottom of the engine crankcase and is now in the oil tank. At this point, you can check the dipstick to get an accurate reading of the oil quantity. We often hear 912 operators complaining that seems to take forever for their engine to burp. And they'll often complain about having to pull the propeller through 40 to 50 blades in order to get the first indication of a burp. Frequent-

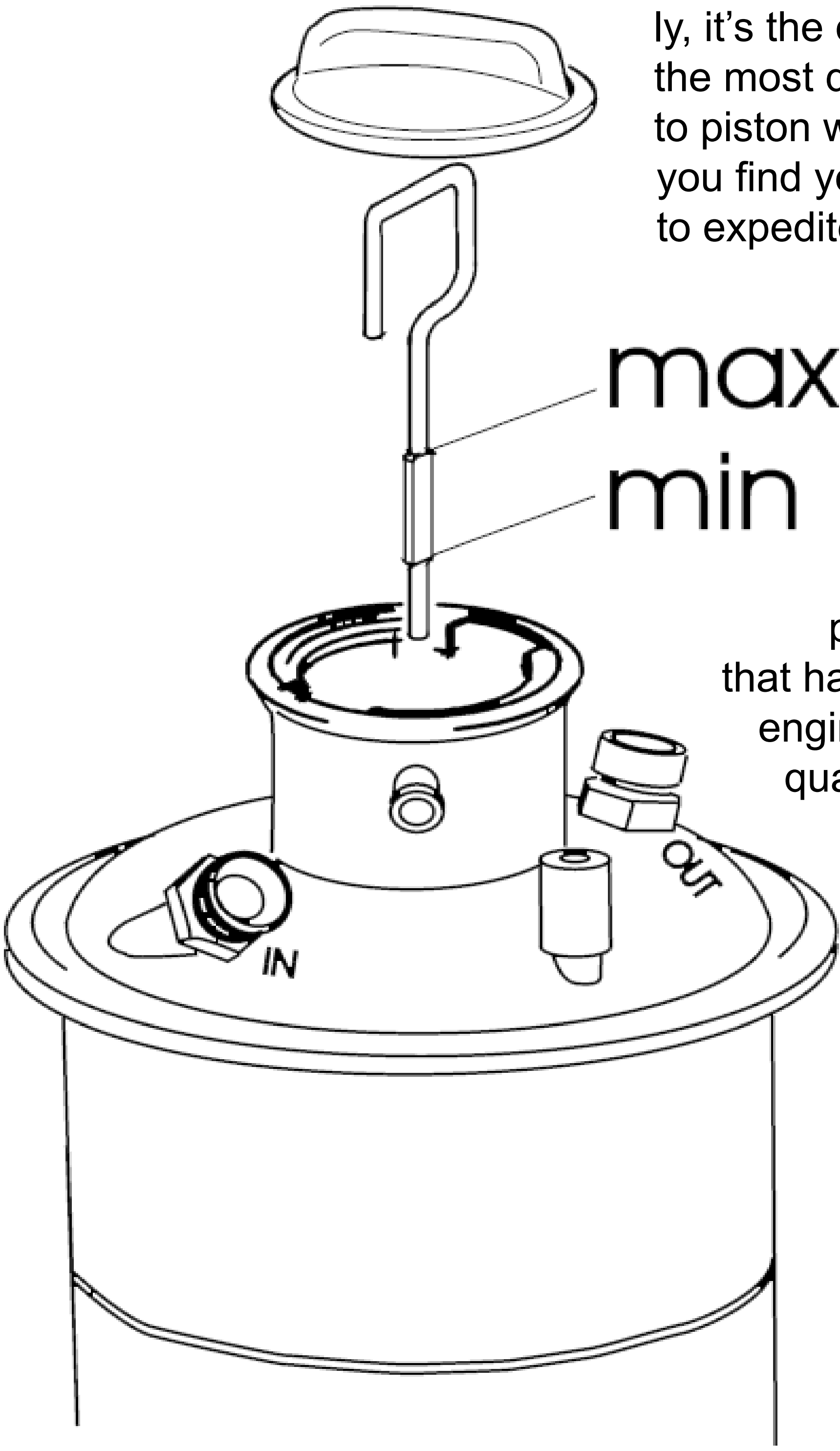

Figure: 3 Dip Stick

ly, it's the owners of the newer airplanes that seem to have the most difficulty. This is pretty easily explained. The cylinder to piston wall clearance on a Rotax 912 is extremely tight. If you find yourself pulling the propeller through quickly in order to expedite the process, the pressure within the combustion chamber rises and then instantaneously dissipates. The volume of air that has a chance to leak past the ring end gap is very small. This requires that you pull the propeller through many, many, times. If you simply rotate the propeller blade until you have one of the pistons at top dead center, then wait a few seconds for the air to bleed past the rings, you will find that the volume of air that has entered the crankcase is much greater. After the engine has been running, it is very easy to check the oil quantity accurately. During normal engine operation the oil is continuously forced back into the oil tank. The only additional oil that you will have to move from the crankcase to the oil tank is any oil that is dripping off of the internal engine components and pooling at the bottom of the case. When the engine is cold it will naturally be more difficult to move the oil back into the oil tank simply because of its high viscosity. It is also normal to see a slightly less amount of oil on a cold engine versus an engine that has just been running. This is primarily due to the high viscosity oil sticking to internal engine parts. The argument about checking oil resides around the concept of checking oil after its hot being more accurate and easier to check, versus the necessity to check oil before a flight as an integral part of a proper preflight inspection. We favor the check before every flight and after every flight procedure. This will ensure that you have the proper oil level before takeoff, as well as giving you a really accurate reading at the end of the flight. This procedure can also alert you to the possibility of high oil consumption or an oil leak. The oil level should be in the upper half (between the "50%" and the "max" mark) and should never fall below the "min" mark. Prior to long flights, oil should be added so that the oil level reaches the "max" mark. (Figure: 3) Oil consumption on the Rotax 9 series engines is notoriously nonexistent. We recently did a flight from the upper Peninsula of Michigan to Northern California in a Rotax 912 powered Rans Coyote. The oil level was down only about 1/8" from the start to the end of the flight. Checking your oil level both before and after each flight should give you a broad overview of the condition of many internal engine subsystems. Knowing that everything is operating consistently will leave you with that warm and fuzzy feeling that makes the difference between a happy, comfortable flight, and a flight that is fraught with concern.

Carol and Brian Carpenter are owners of Rainbow Aviation Services in Corning, California.
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