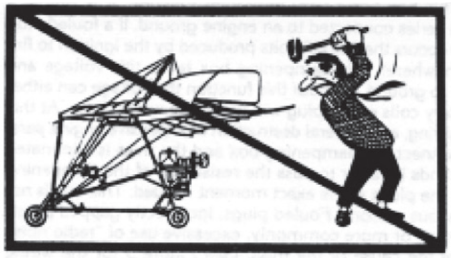

The Proper Care And Feeding of the Rotax Motor

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Part 2 — What To Do When It Quits

In January I discussed the periodic preventative maintenance of a Rotax motor. While assuming the owner follows the tips listed, there is an outside chance an engine can still fail. But before it quits there are still a few more extremely important functions an operator can monitor.

Gauges: An engine without a few basic gauges is a time bomb. If you never check the oil or watch the oil pressure and water temperature gauges in your car then you probably can't relate to the importance of a few simple gauges. Many cars today are equipped with "Indicator Lamps" (also referred to as "idiot lights"), which tell the operator a problem exists. This means that by the time the light goes on you have either neglected to perform standard maintenance and/or your engine is about to fry. A few basic gauges can do a lot to warn a pilot of a problem long before it's too late.

Tachometer: A good tach that reads to at least 8 grand is possibly the first priority. This will tell you if your engine is either running wild, overloaded, or not turning full power before you reach the trees at the end of your runway. A real good investment. Also if you have a problem it is useful to note at which rpm the trouble persists. Relating this to an experienced mechanic can help him understand your problem better.

Cylinder Head Temperature: A cylinder head temperature gauge (CHT) will tell the operator if the cooling fan or the ignition timing is working up to par. A slipping fan belt or blocked air cooling system will show up *only* on a CHT gauge. The CHT should run between 325 degrees F to 375 degrees F. Meltdown happens around 480 degrees F. A CHT will also show a lack of lubrication, high friction, or poor piston-to-wall clearances. 2-cycle engines have a tendency to seize when power is being reduced after a full power run. At full power the engine may be able to overcome the increasing friction of expanding pistons or poor lubrication against cylinder walls. When power is reduced the engine may no longer be able to overcome the friction and the engine will seize. A CHT gauge will show this condition where an exhaust gas temperature gauge (EGT) will not.

Exhaust Gas Temperature: An exhaust gas temperature gauge (EGT) shows *quickly* the fuel-air mixture in the combustion chamber. This is a great tool in tuning the carb to the operating conditions. Temperature, altitude, and humidity can change the EGT of an engine radically. [*See "The Proper Care And Feeding of a Rotax Motor," January 1987* for the altitude and temperature correction chart for Bing carburetors.]

An EGT will nearly always show a change (lower) when the choke is applied. EGT probes are supposed to be located 4 inches or 100 mm from the piston itself. Many times this is impossible. Exhaust manufacturers generally don't worry about your EGT probe placement. If you want to read both cylinders (single EGT reading both cylinders supplied by one carb), place the probe immediately after the "Y." If you want to read each cylinder separately place each probe from a dual EGT before the "Y" on each side. This will show a separate condition for each side of a twin cylinder engine. This is especially useful on a dual carb motor. A difference in temps and an impending problem should immediately grab the attention of a watchful pilot. A single occurrence should prove economical for the expense of either a CHT or EGT gauge in costly engine repairs and hair-raising experiences.

An EGT gauge should read around 1000 degrees F to 1300 degrees F. EGT readings are subject to probe placements. A lot of pilots get real paranoid with high EGT readings. Read the plugs. If the plugs are sooty and the engine bogs when you apply the choke, relax. This is your *constant* from which you will judge a pending engine problem. A properly monitored 2-cycle should be nearly "ironclad" from a major disaster. Some of us are more meticulous than bold and vice versa. You decide how informed you can afford or care to be.

The Choke Circuit: I recently had the pleasure of a strictly business visit from the most well-known, vivacious, and experienced female pilot in the business. I felt a little strange explaining and demonstrating the fine-tuning and troubleshooting uses of the "choke circuit" to an experienced veteran. It seems many pilots are unfamiliar with the real potential or operation of this "enrichener circuit." Quite simply applying the choke at *any* throttle setting supplies the engine with a blast of very rich, nearly raw fuel. The key here is, this is a *bypass circuit* that works at any point in the throttle opening. If you experience a problem during flight, *apply the choke*. If the problem gets worse it is probably a fuel-rich engine. If the engine responds favorably or speeds up, the engine *wants* the fuel, indicating a too lean condition at this rpm. If applying the choke does nothing it is likely an electrical problem. Please guys, no more phone calls without first performing this test. The choke has to be able to be applied by the pilot quickly at any time in flight. If you do not have this capability it would be wise to get it. Consult your favorite parts dealer for the stuff to do it. It's not that expensive.

What To Do When It Quits: There are two major mistakes most pilots make when an engine failure is experienced. First, it quit for a good reason. Find out why before trying to start it, otherwise you will likely destroy the evidence. Secondly, don't automatically blame the engine for the trouble. There are two essentials to make the engine run—spark and fuel. The majority of the problems quite often are a lack of one or the other.

Fuel Supply: If an engine failure occurs first check the fuel supply. Remove the float bowl. On the Bing carb this is easy—flip the bail and carefully lower the bowl. Remove both floats if they are not already attached to the carb body. With both floats removed a reservoir of fuel will remain. Measure down 1/2 inch to 9/16 inch from the top of the bowl. The remaining fuel should be at this point. Check and confirm this level when the engine is running strong. A smart thing to do is to mark this level ahead of time so in case of a problem in the field you are ready to check this at a glance. A carefully scribed line will do nicely. [*See Figure 1 for example.*]

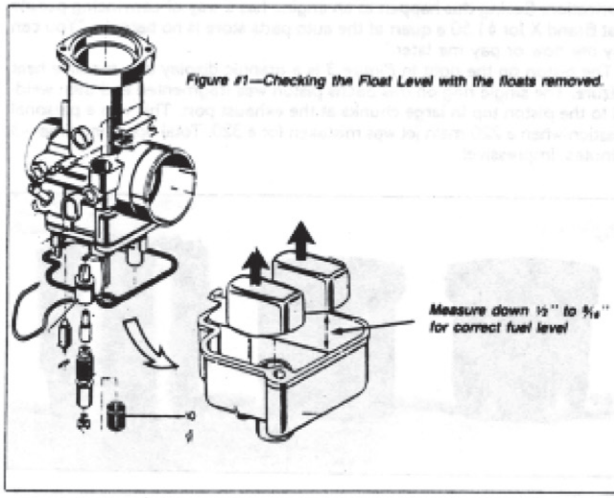

Figure #1—Checking the Float Level with the floats removed.

What To Do If You Have A Fuel Supply Problem: First don't start messing with the float level. Fuel pumps are simple devices and are often called on by the designer to work miracles. The rise or draw from the tank, location of the pump, fuel filter, and primer bulb location, if not carefully designed can just be too much for an impulse operated pump. Test the fuel pressure output at the carb. It should be between 2.9 psi and 7.2 psi. Below 2.9 psi the float bowl will starve. Above 7.2 psi the float valve will be overpowered and fuel will start to flow out the vent tubes. Braided fuel line with the reinforcing webbed layer inside is a common failure item. The inner lining can separate and collapse. This will stop an engine cold and is nearly impossible to spot on inspection of the line. A one piece transparent urethane line is plenty tough to do the job, will not be affected by the fuel, and is easy to inspect even on a quick preflight.

Primer Bulbs: Often a pilot wants a "heavy-duty marine" primer bulb. This is not a bad idea except many times these bulbs have heavyweight check valves. The fuel pump may have a hard time lifting it to allow fuel to pass. Use the standard lightweight primer bulbs or route a bypass to relieve this possibility. [*See Figure 2 for circuit.*] This setup will allow the fuel to bypass any kind of primer bulb. Neat! One less thing to worry about.

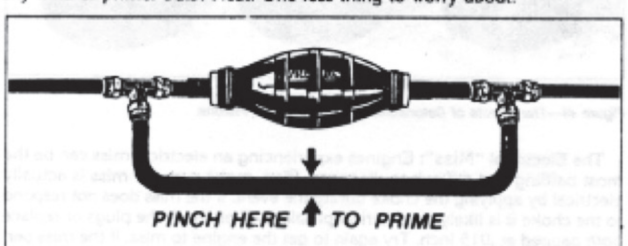

Figure #2—The Primer Bulb Safety Bypass System

The Float Bowl Screen: The screen that surrounds the mixing tube in the lower float bowl is designed to only stabilize fuel as it enters the main jet circuit. This is not a fuel filter. It is common for an operator to reinstall this part in such a way as to break a small piece off this delicate screen. This piece will be drawn up into the main jet where it will cause blockage. The effect is an extremely lean main circuit and massive heat damage to the combustion chamber. *Please be careful with this part.* This screen is illustrated as part 10 in *Figure 1*.

Testing For Spark: If fuel supply seems not to be the problem, next check for spark. First pull *both* spark plugs and look for equality in color. If a single plug is a silver flake color and the other is sooty, direct your attention toward that cylinder. If both plugs look equal, test for spark by grounding against the engine and pull the starter briskly. Spark should be obvious and equal in each side. If both plugs spark boldly then check for a mechanical problem.

Compression Testing: First, with both plugs removed, stick your finger tightly into each cylinder and pull the starter briskly. If you feel vastly unequal compression, the party is over! Remove the heads and/or cylinders and check out the damage first hand. If uncertain, use a compression tester and test for compression. 110 pounds to 140 pounds each side is about right on a Rotax twin. If you suspect a stuck ring, remove the exhaust manifold and view the rings through the exhaust ports. Movement should be seen by the rings between the pistons when subject to up-and-down rocking movement of the prop.

Teardown And Inspection: On close inspection of the removed piston the reason for the failure should become apparent. [*See photo in Figure 3.*] Each piston shown here is a heat-related failure. The center piston shows best the scoring caused by excessive heat. Heat seizures work from the piston top and progress downward. Lubrication failures will extend from the bottom of the piston shirt upward not favoring the top ring area of greatest exhaust heat. The area of least clearance between the piston and wall should be at the bottom or shirt of the piston, thus the area most likely to show the effects of poor lubrication. Seeing this happen to an engine has a way of convincing people that Brand X for $1.50 a quart at the auto parts store is no bargain. "You can pay me now or pay me later."

The piston on the right in *Figure 3* is a graphic display of a massive heat seizure. The single ring on this Sachs piston was fragmented and then welded to the piston top in large chunks at the exhaust port. This was a personal creation when a 220 main jet was mistaken for a 320. Total operating time—3 minutes. Impressive!

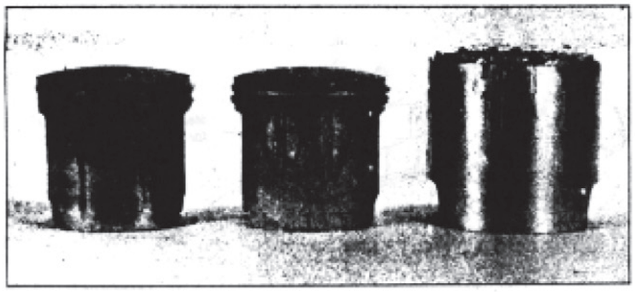

Figure #3—Examples of Heat and Lubrication Failures.

Detonation: The photo in *Figure 4* shows three pistons experiencing detonation in several stages of failure. The piston dome is being bored by the intense and concentrated heat caused by a spark plug firing too far advanced (BTDC). The piston on the right shows a complete penetration of the piston dome by detonation. This is a common result when a pilot "attempts to set" his timing armed with just a gap gauge. [*See "Timing the Rotax Motor," September 1986.*]

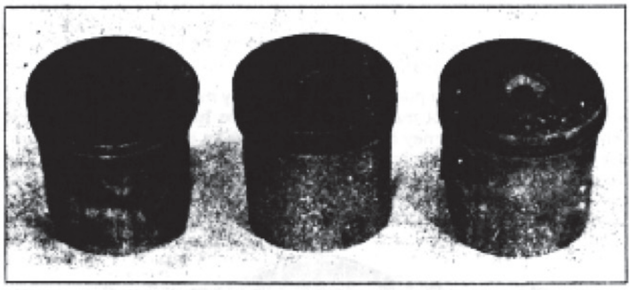

Figure #4—The Effects of Detonation or Preignition on Pistons.

The Electrical "Miss": Engines experiencing an electrical miss can be the most baffling and difficult to diagnose. First, make sure the miss is actually electrical by applying the choke during the event. If the miss does not respond to the choke it is likely an electrical problem. First check the plugs or replace *both* gapped at .015 inch. Try again to get the engine to miss. If the miss persists check the dampening box (Rotax part no. 866-572). Reverse the polarity of the two leads. There should be *no* spark at all. If any spark can be seen, replace the dampening box.

Dampening Box: This box has a very important function. It is simply a resistor and a diode in series connected to an engine ground. If a fouled plug or similar malfunction occurs the 20,000 volts produced by the ignition to fire a plug has to go somewhere! This dampening box takes this voltage and transfers it harmlessly to ground. Without this function the voltage can either transfer to the secondary coils or the plug will fire at the wrong time. At this point detonation, backfiring, and general destruction of expensive engine parts can occur. If you disconnect the dampening box and the miss is eliminated this means the spark finds it easier to pass the resistance of the dampening box rather than to fire the plugs at the exact moment needed. This box is *not* to be removed for obvious reasons. Fouled plugs, incorrectly gapped plugs, broken or bad plug wires, or more commonly, excessive use of "radio noise suppression parts" are the cause of the miss. [*See Figure 5* for the wiring diagram of the Rotax engine illustrating the dampening box and its function in the circuit.]

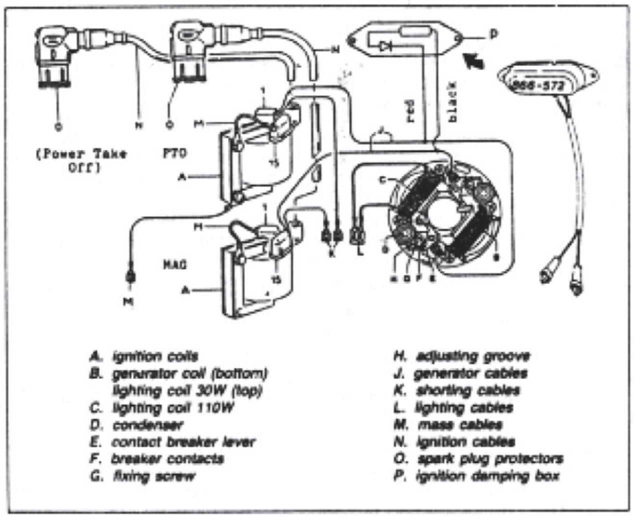

Figure #5—The Schematic Wiring of a Rotax Twin Cylinder Engine with Dampening Box.

Flooded Engine: I hate to be controversial or knock any aircraft design but an inverted or upside-down engine installation sucks! The plugs are at the bottom (gravity) of the combustion chamber. As soon as an operator puts too much fuel to an engine on starting, the plugs are hard pressed to fire submerged in fuel. The lubrication of the crankcase parts on an inverted engine is also marginal at best. Failures in the crankcase run at a 4-to-1 ratio in my engine shop. Many times an operator will continue to flood an engine even more by not recognizing the problem when starting becomes difficult. A badly flooded engine usually has a crankcase (not combustion chamber) full of fuel. This amount of fuel depends on how many times you pulled the starter without getting a spark. Change or clean the plugs. If this does not work your crankcase is likely flooded. You have three choices. First, wait for evaporation of the fuel to clear the crankcase. Second, remove the float bowl and spark plugs and stroke the starter to force the crankcase to clear mechanically by passing the fuel out the exhaust without making the flood worse. Thirdly, and I say this only as a last resort, remove the prop. Just about anything will run without a load if it's going to run at all. A *low* idle should purge the engine back to a normal chance of starting in a short time. I suggest this procedure *only* if you are stuck on a cross-country, you're late for a date, it's getting dark or you are real desperate.

Only try a no-load operation on a fan-cooled, liquid-cooled or an engine with at least a little load of some kind. Why? I once owned a free-air Sachs engine that was acting up. I started the engine without a prop (no load). The warm engine at a low throttle setting went immediately to full rpm, running wild! Hitting the kill switch did nothing. Removing the spark plug wire did nothing. Honest! I finally removed the fuel line. Deciding there was nothing left to do, I sought refuge across the street and waited for the parts to fly. A lack of fuel finally defused the bomb. Few people ever believed my story, but be careful, it *is* possible.

Non-Fouling Plugs: Gold palladium-tipped plugs or NGK B8EV rather than B8ES plugs can help prevent fouling especially in an inverted engine setup. They are expensive (about $3.50 each) but are supposed to fire when standard plugs will foul. Give them a try if flooding or fouling is common on your design.

Professional Help: If none of this helps prevent a failure or if you can't isolate the trouble, contact an authorized Rotax service center for assistance. All Rotax engines are guaranteed for one year from the date of delivery to the manufacturer for the replacement of parts only. No labor. While this may seem slim next to Chrysler's 5/50 protection plan, it is the best in the business. This is compared to other brands that provide the basic 20 feet or 20 seconds—whichever-comes-first guarantee.

Most important is Rotax's commitment to up-to-date engineering and products supplied especially for the light aircraft market. The quality of the product and the professional research and development people backed by Rotax are your assurances that your Rotax powerplant is the best available. Rotax appears to be around for the long term, supplying a wide range of power to a unique and growing marketplace.