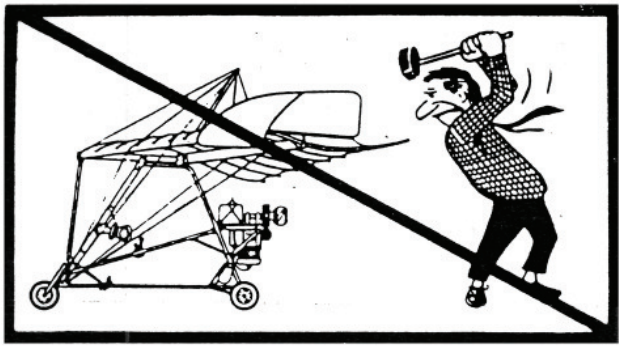
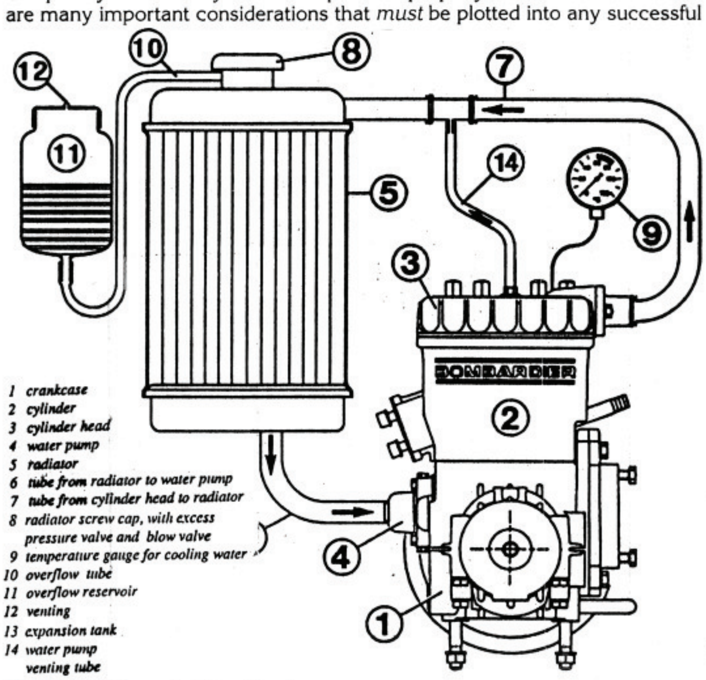


The Proper Care & Feeding of the Rotax Motor - Part 21

How to Set Up a Liquid Cooling System that Works

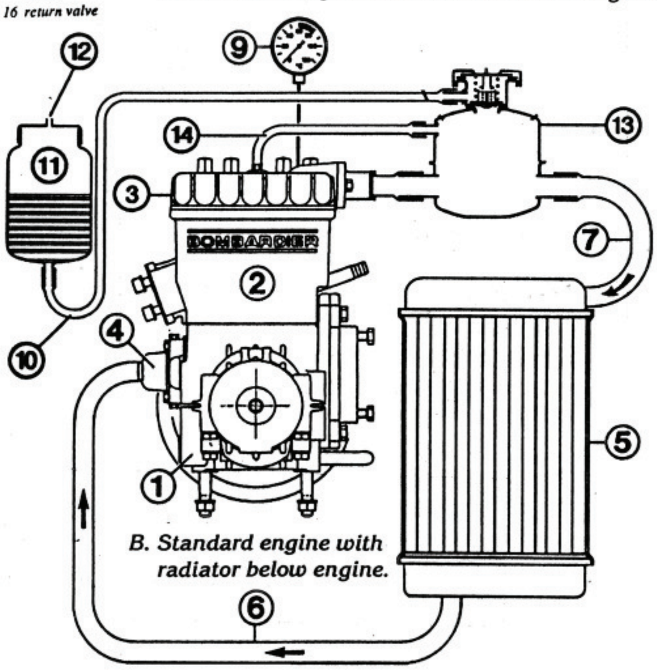
by Mike Stratman

It is commonly acknowledged that what you gain in reliability in liquid-cooled 2-cycle engines is offset by a certain amount of expense and complexity. Radiator systems that perform properly are no accident! There are many important considerations that *must* be plotted into any successful cooling design. Some of these features are not completely obvious to the first-time installer. This month we'll take a close look at what's available in components; deciding on the proper placement of your choice of components; the common pitfalls of systems that don't perform adequately; and troubleshooting common problems.



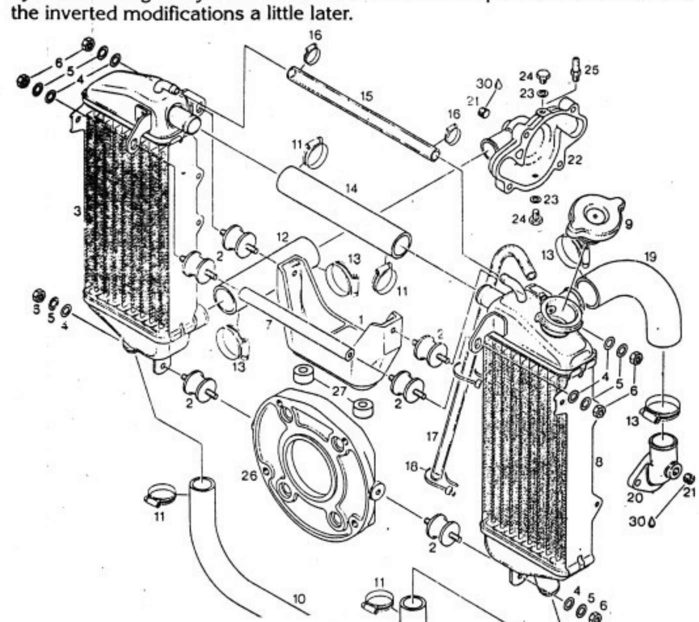
1 crankcase
2 cylinder
3 cylinder head
4 water pump
5 radiator
6 tube from radiator to water pump
7 tube from cylinder head to radiator
8 radiator screw cap, with excess pressure valve and blow valve
9 temperature gauge for cooling water
10 overflow tube
11 overflow reservoir
12 venting
13 expansion tank
14 water pump venting tube
15 excess pressure valve
16 return valve

A. Standard engine with radiator above engine.



B. Standard engine with radiator below engine.

Engine Placement: Standard or inverted? For purposes of clarity we will refer to spark plugs up as a standard installation and spark plugs down as an inverted engine. This is your first consideration when deciding on your particular application. If at all possible, run your engine in the standard or plugs up configuration. While I have been personally chastised for making negative comments concerning inverted engine designs in the past, I still strongly recommend a plugs-up engine. While the engine will run in either position with nearly equal performance, you can do away with several major modifications when you stay in the standard position. Remember that your gear box is always reversible. The prop shaft can be offset a full 3 inches in either direction; behind the rear cylinder or away from the rear cylinder. This gives you a multitude of thrust line options. We will discuss the inverted modifications a little later.



C. Rotax factory cooling system.

Radiator Placement: Where you mount the radiator is an important design consideration. Planting a small size radiator behind a seat or inside a cowling is asking for overheating problems. It is entirely too often that I hear complaints about radiators not doing the job and all too often it is the lack of air flow that is the real problem. A good air flow should be around 1000 cubic feet per minute. Imagine your car without a fan or with the grill covered. Overheating is inevitable! The size of the radiator is not the key. Good air flow is.

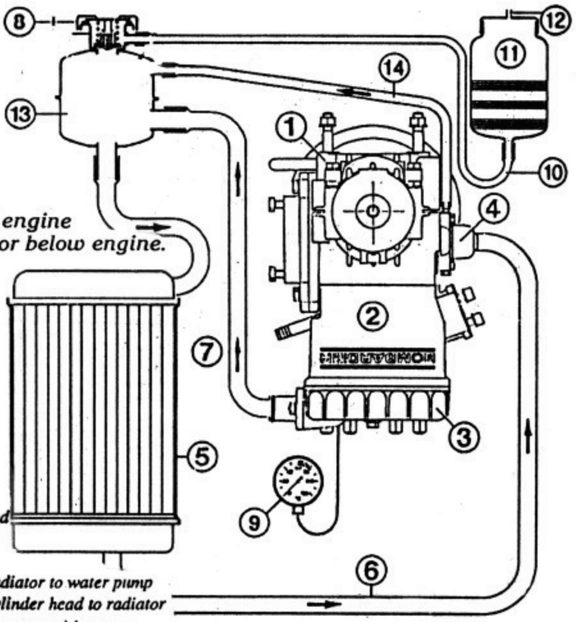
Yet, on the other hand, radiators are not known for their aerodynamic styling. This is a compromise you will have to make if you are doing your own design work. Here's where experience is the best teacher.

Typically small foreign car radiators of approximately 24 inches by 12 inches by 3 inches will do the job when allowed a steady air flow. Smaller units are often used with good results when mounted in full flight air flow.

If your radiator must be located below any part of the engine, you will be required to use a remote mounted filler tank. This tank must be the high point of the entire system. If you use a radiator with a built-in upper reservoir and top mounted pressure cap, this reservoir must be higher than any part of the engine for obvious reasons. This is where the only air in your system should collect. See diagrams for illustrations. If your engine is mounted inverted, a different set of plans is used. We will look at this a little later.

The Rotax Radiator System: Rotax offers a very clean, very intricately finished cooling system. This system mounts to the gear box end of the engine and is complete with trick vibration isolation bumpers and all connecting hoses. The dual split radiators straddle both sides of the gear box mounting. This setup can only be used on a standard plugs-up motor. This package will also set you back nearly $500, but you can count on some very clean engineering by the factory. See diagram C for illustration. Part #26 is the gear box mounting plate to give you an idea of how this relates to the rest of the powerplant. On newer production engines, the mounting is part of the gear box itself.

Steam Vent Line: All new production Rotax 532 or 582 engines are equipped with a special vent line or steam return system. When a hot engine is shut down, the cooling water of course ceases to flow. The heat of the surrounding parts can cause the water to superheat, creating steam. As the system cools down, you can now have air pockets in vital areas. Air pockets are bad news! In the water pump area they will cause cavitation. In layman's terms, this means your coolant circulation is greatly reduced or cut off completely because the water pump impeller may be surrounded by air. These air pockets must have a way to be relieved.



F. Inverted engine with radiator below engine.

1 crankcase
2 cylinder
3 cylinder head
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8 radiator screw cap, with excess pressure valve and blow valve
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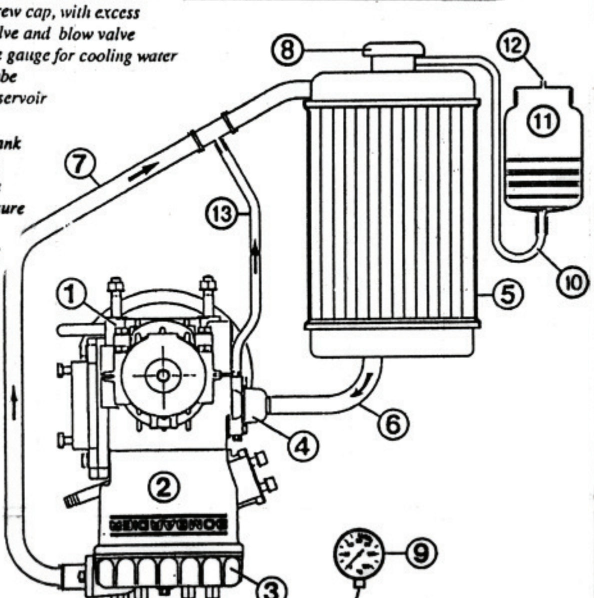
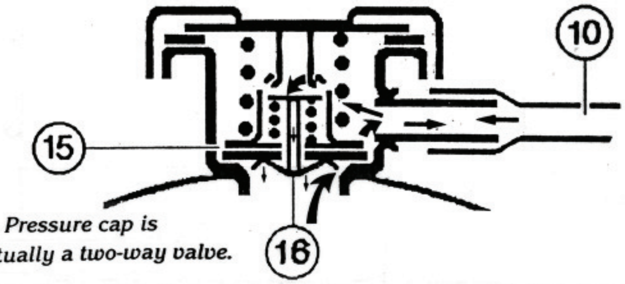


E. Inverted engine with radiator above engine.

This vent line is routed from the high point of the cooling system within the engine block. With a standard engine this is vented by a nipple fitting on each end of the cylinder head (whichever end is higher during flight). There are threaded openings on either end.

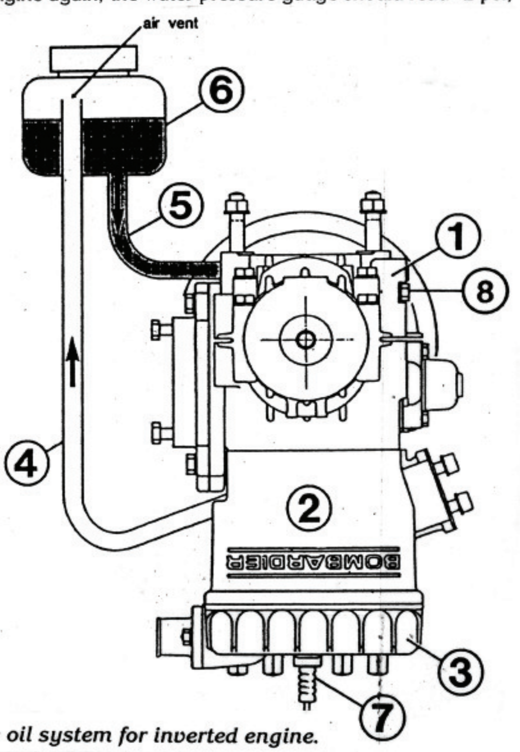
On inverted engines, this nipple is installed at the water pump housing as shown, this now being the high point of the engine. The vent line must connect to the reservoir or fill tank chamber *below* the pressure cap. You most likely will have to braze a fitting into the reservoir to connect the line. You can also use a line tee as shown at a high point near the reservoir.



D. Pressure cap is actually a two-way valve.

Monitoring With Gauges: Any liquid-cooled motor will likely have a water temp gauge. Knowing water temp is a good idea but is *not* necessarily your only option or even the best method of monitoring your system. What will tell the tale of system operation is a water pressure gauge. This gauge must read -15 psi to +15 psi. What will this reading tell you? A lot! First, when a cold engine is started, the water pump will create 2 to 5psi (depending on rpm and probe placement) which will show on your gauge, assuring you the pump is functioning without cavitation. As your system warms up the pressure will build due to heat expansion. This pressure will level off at 8 psi *or* the rating of your pressure cap and stay there. If your cap is functioning properly, all excess pressure will be vented to the recovery bottle at 8 psi. A buildup of pressure would indicate a faulty pressure cap. When the engine is shut down, the pressure should remain at 8 psi indicating conclusively you have no air leaks in your system. As the engine cools to room temperature, the pressure gauge will not only return to zero but actually go negative! Why? Because the system, if properly sealed, will now show a vacuum caused by the fact that pressure has been vented. You cannot remove water or air from a sealed system without creating a vacuum when temperature is returned to a starting point. Here is where a properly functioning pressure cap does its thing. The cap is a two-way valve handled by two separate valves. Study the drawing of the pressure cap (diagram D) carefully: Note the two springs—one heavy spring controlling the 8 psi relief valve #15, and one light spring controlling the return valve #16. As vacuum increases to 2 psi, the return valve opens drawing in *water only* from the recovery bottle, refilling the system to its original starting level. When you go to start up a cold engine again, the water pressure gauge should read -2 psi,

1 crankcase
2 cylinder
3 cylinder head
4 inlet tube
5 return line
6 oil tank
7 spark plug
8 vent plug



G. Rotary valve oil system for inverted engine.

the pressure at which the return valve closed.

Systems that function properly will show these readings and will not leak water, contain air in the lines (it has been purged), or make you wonder if things are working correctly. While I am not suggesting you don't need a water *temp* gauge, doing without a water *pressure* gauge is waiting for problems to surface without warning. A good investment in preventive maintenance.

Most water temp gauges require a 12-volt D/C power source. If you have an electric start system, you have a 12-volt D/C. Inexpensive adapters are available that turn A/C lighting coil voltage into 12 volts D/C.

Inverted Engines: Hanging an engine with plugs down requires rerouting the oil system for the rotary valve and water pump drive. The reservoir that is neatly bracketed on the standard engine must be removed and mounted *above* the engine. Install reservoir on the firewall or suitable elevated position. Fittings must be rotated to point upward to accept lines. Make sure the lines are installed as shown with the air vent to the lower fitting.

As we mentioned in the beginning, cooling systems that perform properly are no accident. Hopefully the information provided here will help you design a cooling system that will provide years of trouble-free flight.