Phillip Lockwood

Reaching Smooth Idle

Synchronizing the 912's Bing Carburetor

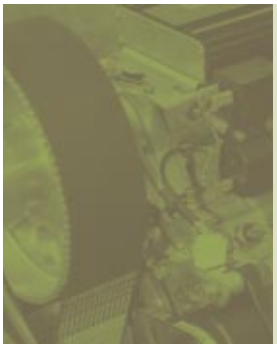
Synchronizing the carburetors on a new engine is a two-step process involving mechanical and pneumatic synchronization. This month we'll discuss why synchronization is important, and describe how to adjust the linkage and mechanically synchronize the carburetors. Next month, we'll take an in-depth look at pneumatic synchronization.

The four-cylinder Rotax 912, 912S and 914 engines owe much of their high power-to-weight-and-size ratio to their dual Bing 64 carburetors. For the 912S and 912ULS to produce 100 hp from just 1,352 cc of displacement at only 5,800 rpm, a separate carburetor for each bank of two cylinders was required. (The 912ULS is the uncertificated version most of us use on our ultralight and homebuilt aircraft; the 912S is the certificated version of the engine, but the procedure for synchronizing the carbs is the same.)

Most engines that produce more power per displacement, without forced air induction, do it at much higher rpm. It is not uncommon for modern, small displacement automobile engines to achieve maximum horsepower at more than 6000 rpm, and some must spin at more than 8000 rpm to achieve their maximum horsepower output. The best Formula 1 racecar engines turn more than 18,000 rpm on race day. So how did Rotax achieve 100 hp at a relatively low rpm with a lightweight, two-valve-per-cylinder valve train and no fuel injection? A big part of the answer lies in its effective dual-carb intake system.

About now people are dying to ask, "Why didn't Rotax use electronic fuel injection and save us all the trouble of having to synchronize the carburetors?"

The answer won't help you synchronize your carburetors, but it might make you feel better about having to do it. Rotax offers the 9-series engines in both certificated and non-certificated versions so that only those who need the advantages of certification pay for the extra cost. However, because its production volume is small, and for the sake of safety, the cost of development, and production efficiency, all versions are substantially the same. Currently, certificating an aircraft engine with electronic fuel injection is difficult and expensive. This is why most aircraft engines with modern electronic fuel injection (EFI) are experimental only. Besides, for liability reasons, most manufacturers of EFI systems won't allow their equip-



Each month, Power ON will address a Rotax engine maintenance or operation issue for either its two- or four-cycle engines. **Phillip Lockwood**, president of Lockwood Aviation Repair, will provide the information based on common repair and maintenance problems.

In addition, readers are invited to send their questions about various alternative engines to our panel of engine "answer men" or to editorial@eaa.org.

- For 1/2 VW engines, write **Bill Bronson**, onehalfvwguy@worldnet.att.net.
- For Corvair engines, write **William Wynne**, WilliamTCA,@aol.com.
- For Subaru engines, write **Don Bouchard**, dbouchard@earthlink.net.
- For Hirth engines, write **Matt Dandar**, rpe@bpsom.com.

We'll reprint questions and answers of interest in upcoming Power ON columns.

ment to be used on aircraft that fly in the United States, let alone assist Rotax on certification.

Perhaps we should be thankful for what we have. After all, I have found the Bing 64 carburetors work quite well. They are reliable and relatively easy to maintain.

Why do we need to pneumatically synchronize the carburetors? What will happen if we don't? Consider the 9-series aircraft engines as two separate, twin cylinder, engines joined by one crankcase and crankshaft. One "engine" is controlled by one carburetor, the other by the second carb. The two carbs must be adjusted as closely as possible to each other so the power pulses from each side are equal. If not, the unequal power strokes can create excessive torsional vibration, which is the rapid slowing down and speeding up of the crankshaft rotational speed. Excessive torsional vibration will increase gearbox wear, increase engine vibration, and make starting difficult.

Adjusting the Linkage

Owners can adjust the throttle linkage in two places. You can make rough adjustments where the throttle cables attach to the throttle valve levers on each carb (see No. 45 on Figure 1). If you have not yet put the throttle cables through the 5 mm Allen screw (No. 46), you should first trim the cable with a special cable cutter, like the one pictured in Photo 1. This will yield a clean cut without which it will be almost impossible to thread the cable through the Allen screw. Using any other type of cutter will likely frazzle the cable end and your nerves.

Cut the cable long and then trim off the excess once you have completed the synchronization. Remember, you can take more off later but you can't make a cable longer. It is easiest to thread the cable through the No. 46 Allen screw with it removed from the throttle arm. Before putting the cable connection assembly back together, lubricate both sides of the throttle arm end with engine oil in between the

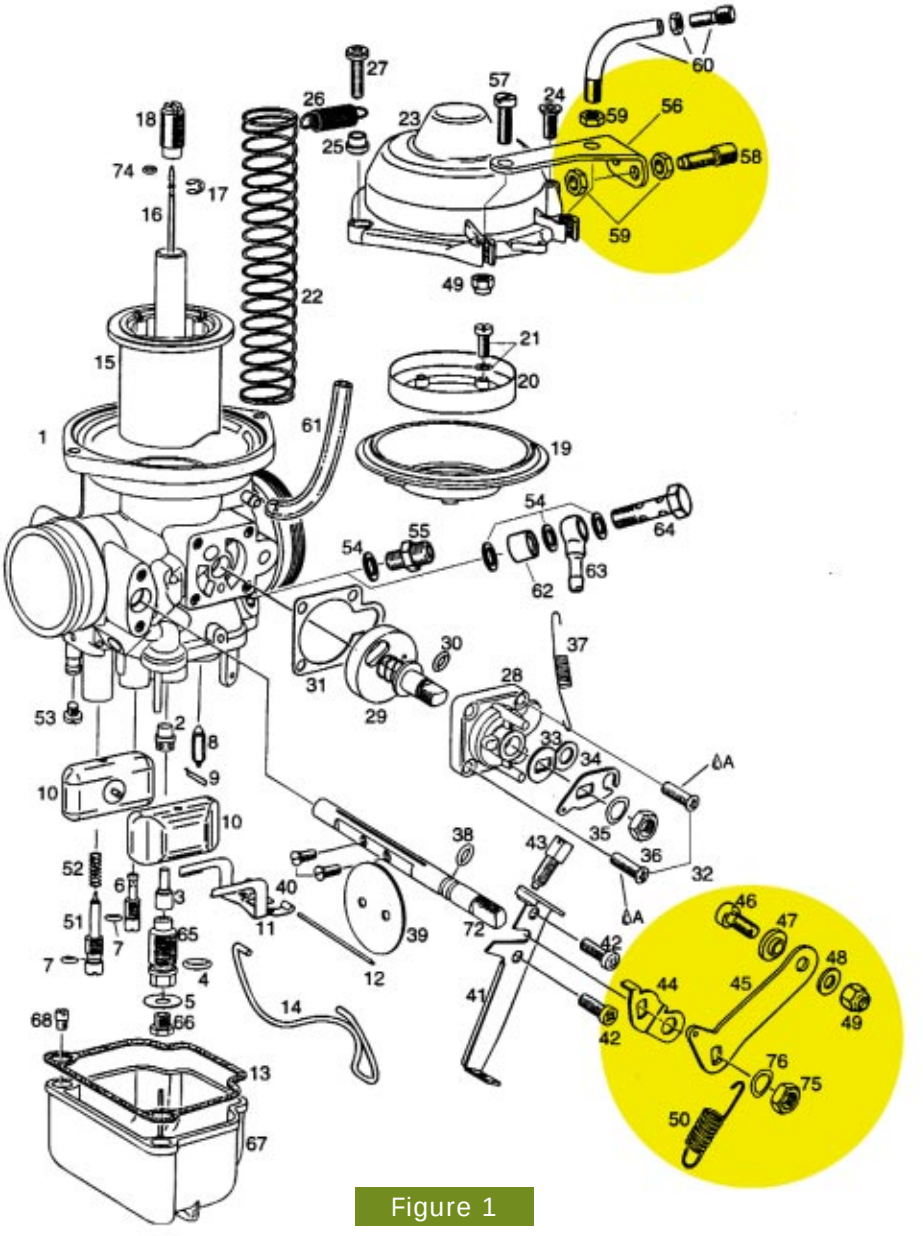


Figure 1

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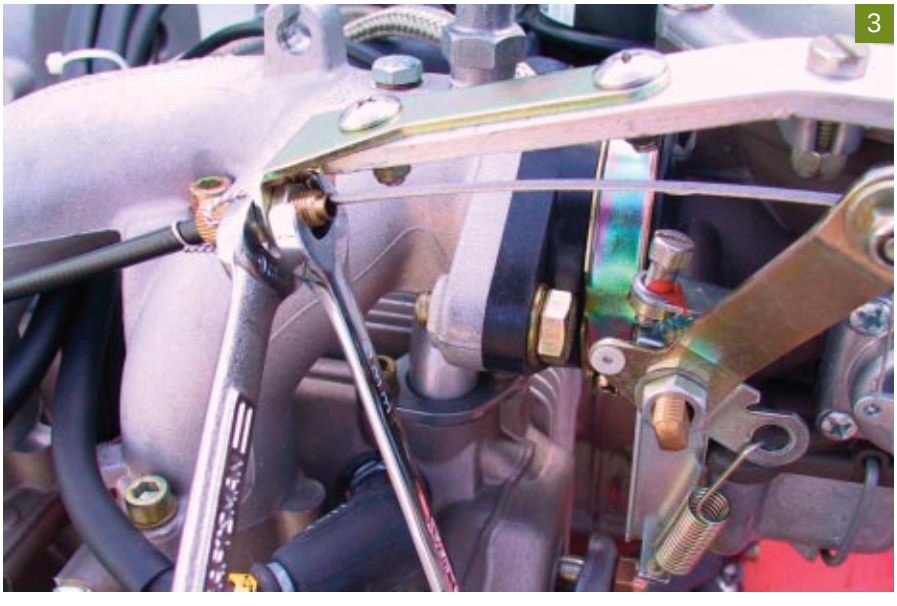
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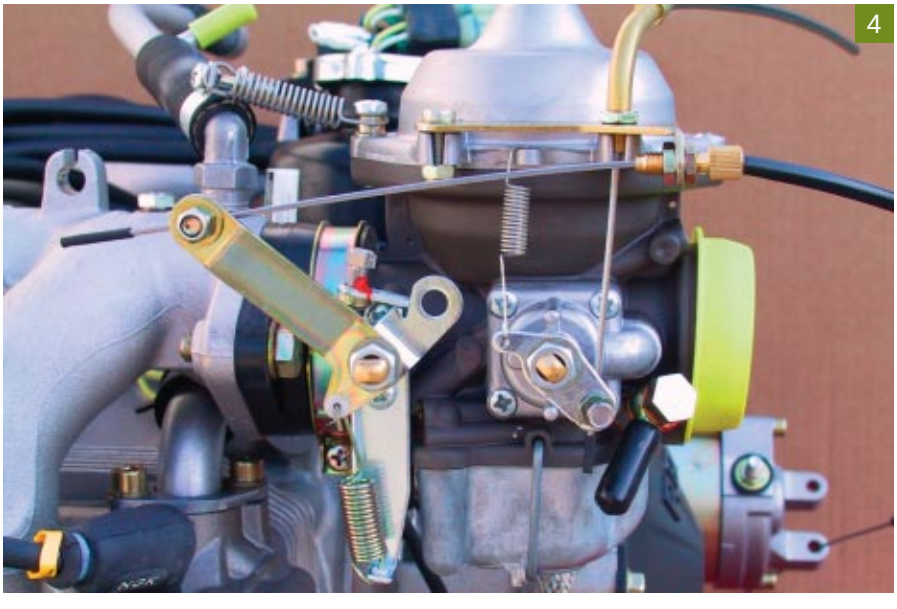
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No. 47 graduated sleeve and the No. 48 washer as depicted in Photo 2.

When putting this assembly back together *do not over tighten the 5 mm locknut shown at No. 49!* Overtightening is a common mistake and will deform the graduated sleeve (No. 47) causing the Allen screw (No. 46) to bind on the throttle arm. If the tightened Allen screw does not swivel freely on the throttle arm, proper synchronization will be impossible. If your graduated sleeves have been crushed, replace the bushing (Part No. 847740) and the washer (Part No. 827800). These parts are soft so they are kinder to the cable than a harder alloy. If the graduated sleeve has cut into the 5 mm washer, turning over the washer may increase the clearance enough to allow the tightened assembly to swivel freely. If you have had the 5 mm locknut on and off several times, the nylon locking feature will wear out. If so, replace it—(Part Number 842030).

You can fine tune the linkage with the cable housing (conduit) adjuster (No. 58). Photo 3 shows this adjustment being made using two 9 mm wrenches to loosen and tighten the two 6 mm hex nuts (No. 59). When you begin pneumatic synchronization, do so with this fine cable housing adjustment screw in the middle of its travel. Note: Photo 3 shows a non-standard throttle linkage, where the throttle valve lever is sprung to idle, which is common on many installations.

In the standard Rotax factory set up, shown in Photo 4, the carburetor throttle valve lever is advanced to full throttle by the spring (No. 50) and must be pulled back to idle by the throttle cable. The carb in Photo 4 is at full throttle. Warning! (They love to say that in the Rotax manuals.) When you receive a new 9-series Rotax engine, the carburetors are in the full throttle position. If you start a new engine before hooking up the throttle linkages and pulling the throttle valve levers back to idle, you will scare yourself silly when your engine roars to life at full throttle with no way to reduce power. Don't do it!

If the prop is *not* mounted on the engine, a 912 with its lightweight flywheel, will rev to kablooey in the blink of an eye. (Don't bother asking for a warranty repair because Rotax is on to this one.) The idea behind springing the throttles to full is this: Should the linkage fail in flight, the engine would go to full power instead of idle, allowing you to fly to an appropriate area (airport) before shutting off the engine and gliding to a safe landing. Of course, you should always fly within gliding distance of a landing area any way, right?

> Consider the 9-series aircraft engines as two separate, twin cylinder, engines joined by one crankcase and crankshaft.

Mechanical Synchronization

Over the years I have tried mechanical synchronization many times and, although it is better than nothing, it does not yield the same results as pneumatic synchronization provides. Mechanical synchronization involves adjusting the carburetor throttle linkages so that at any given throttle setting the throttle valve (butterfly) in each carburetor is in exactly the same position.

Because the engine must be running to perform pneumatic synchronization, you must perform a basic mechanical synchronization prior to first start up. If the linkages are adjusted properly, both throttle valve levers will move off idle at the same time. Get a friend to sit in the cockpit and move the throttle while you look at the carbs. Have your helper advance the throttle, a little at a time, until one of the throttle valve levers move just off the idle stop. Then look at the other carb and make sure that the throttle valve lever is the same distance from the idle stop. If not, adjust the linkages to make them the same.

Note: Rotax calls the idle stop screw the throttle valve stop screw. If you have messed around with the idle screws, even them up or advance the throttle to just shy of the full throttle stop, and measure from the full throttle stop to the throttle valve lever. Again, make the gap the same on both carbs. As long as you are going to follow with pneumatic synchronization, don't spend a lifetime on the mechanical adjustment, as you will end up changing it again anyway.

Next month, we'll discuss the actual pneumatic synchronization process and reprint some reader questions and answers on various engines.