Phillip Lockwood

Reaching Smooth Idle

Synchronizing the 912's Bing Carburetor Part 2

In April we discussed why it's important to synchronize the Rotax 912's dual carburetors and described how to adjust the linkage and mechanically synchronize the carburetors. This month, we'll finish the job by taking an in-depth look at pneumatic synchronization.

Why do we need to pneumatically synchronize the carburetors? What will happen if we don't? Consider the 9-series Rotax aircraft engines (912, 912S, and 914) as two separate, twin-cylinder engines, each with its own carburetor, joined by one crankcase and crankshaft. The two carbs must be adjusted as closely as possible to each other so the power pulses from each side are equal. Unequal power strokes are bad because they 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.

Because the engine must be running to perform pneumatic synchronization, you must perform a basic mechanical synchronization, as described in the April issue, prior to first start up.

Now, let's get started with the actual pneumatic synchronization process.

Tools & Safety Considerations

A number of aviation supply houses offer carburetor-synchronizing kits, including the vacuum gauges and tools required for the process.

Warning! Avoid any chance of contact with the spinning propeller by making all connections and adjustments with the engine shut off.

Disconnect the compensating tube from one side of the intake manifold by loosening the clamp at the angle fitting, as shown in **Photo 1**. Connect the two vacuum gauges, one to each manifold, as shown in **Photo 2**, noting which carburetor each vacuum gauge is connected to. Route the hoses to the cockpit or a safe location well clear of the prop where you can safely view the dual vacuum gauges while running the engine. Be certain the hoses are secured so they cannot contact the turning prop.

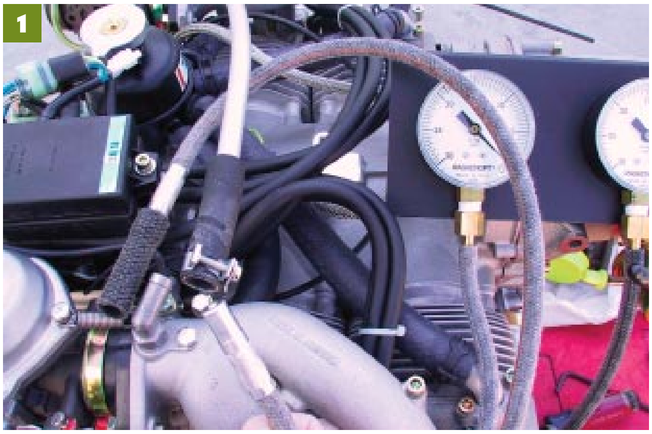
Next, tie down and chock the aircraft so it cannot move. Point the aircraft into the wind, if possible, to enhance engine cooling and reduce vibration. Direct the prop blast away from open hangars and/or objects that could be damaged by the prop wash, and regularly check the cylinder head temperature (CHT). Some installations, especially engines mounted in the pusher configuration, will tend to overheat during prolonged ground runs. If the CHT hits 250°F., shut down the engine and let it cool.

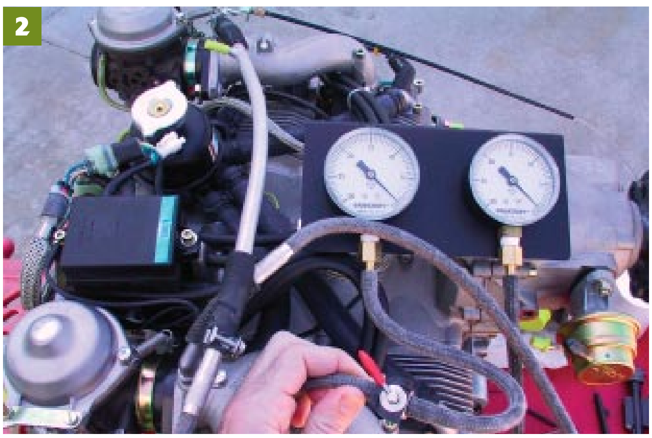
Adjusting Standard Rotax Throttle Linkages

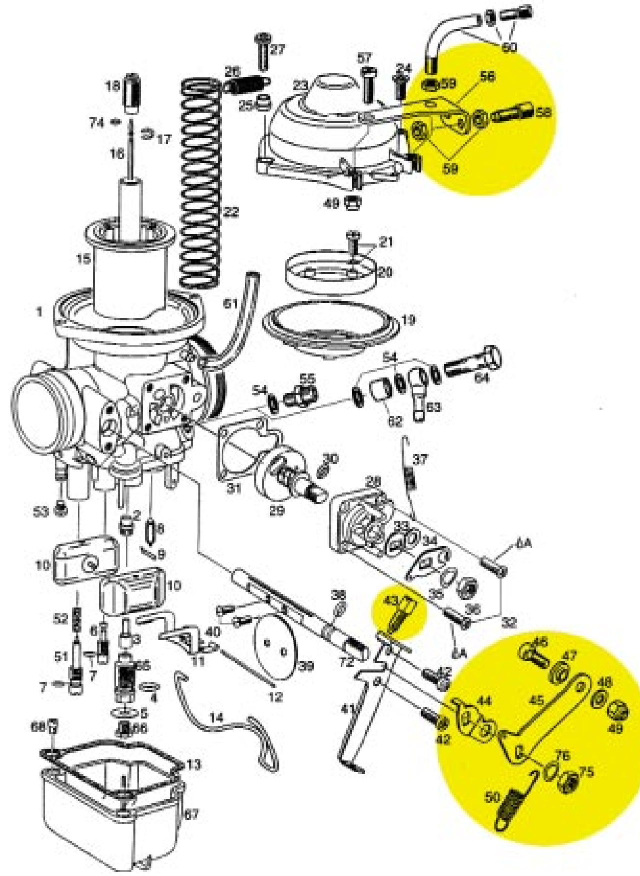
For engines equipped with the *stock Rotax throttle configuration*, in which the throttle lever is advanced by the spring (No. 50) and pulled back to idle by the throttle cable, follow this procedure:

If you have the standard Rotax throttle set up sprung to full power, as shown in **Photo 3**, do not use the idle stop screw, (idle adjustment screw No. 43) as your idle stop during the calibration process. You must hit a positive stop on your cockpit throttle control first. If your cockpit throttle control does not have stops, you must add them. Back off the idle stop screws (No. 43) on each carburetor so they do not contact the idle stop. (You will readjust them later.) Have a helper hold the cockpit throttle control all the way back at idle while you inspect the carbs to be sure the throttle valve stop screws (No. 43) are not touching.

If the throttle stop lever (No. 44) contacts the idle stop screw (No. 43) and its support bracket (No. 41) before the cockpit throttle control contacts its stop, it's possible to bend or flex the bracket when pulling back hard on the throttle handle. This could

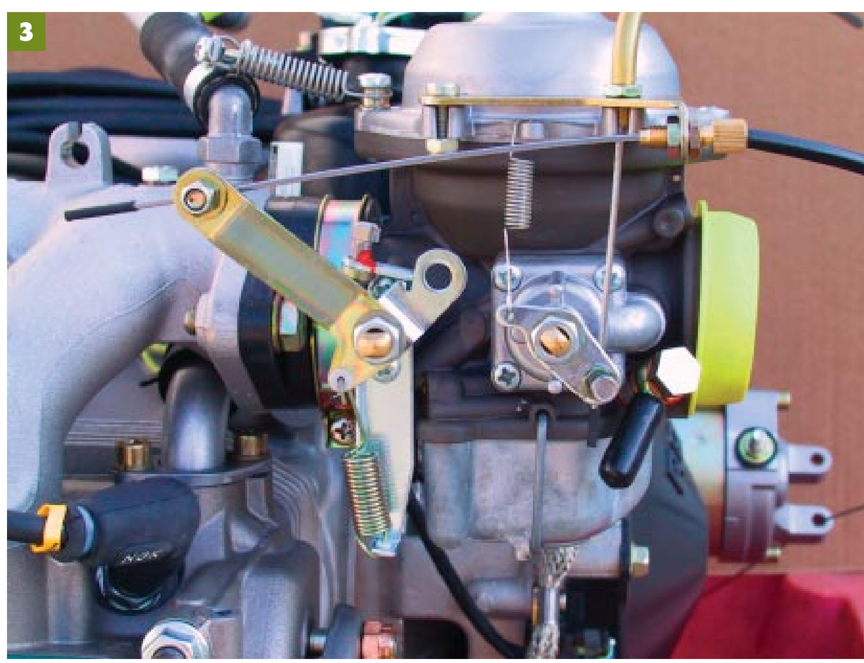






allow the engine idle speed to drop much lower than intended, causing the engine to shake violently and even stop. If this has happened to you on short final, while pulling back on the throttle handle hoping for some magical in-flight braking, now you know the likely cause.

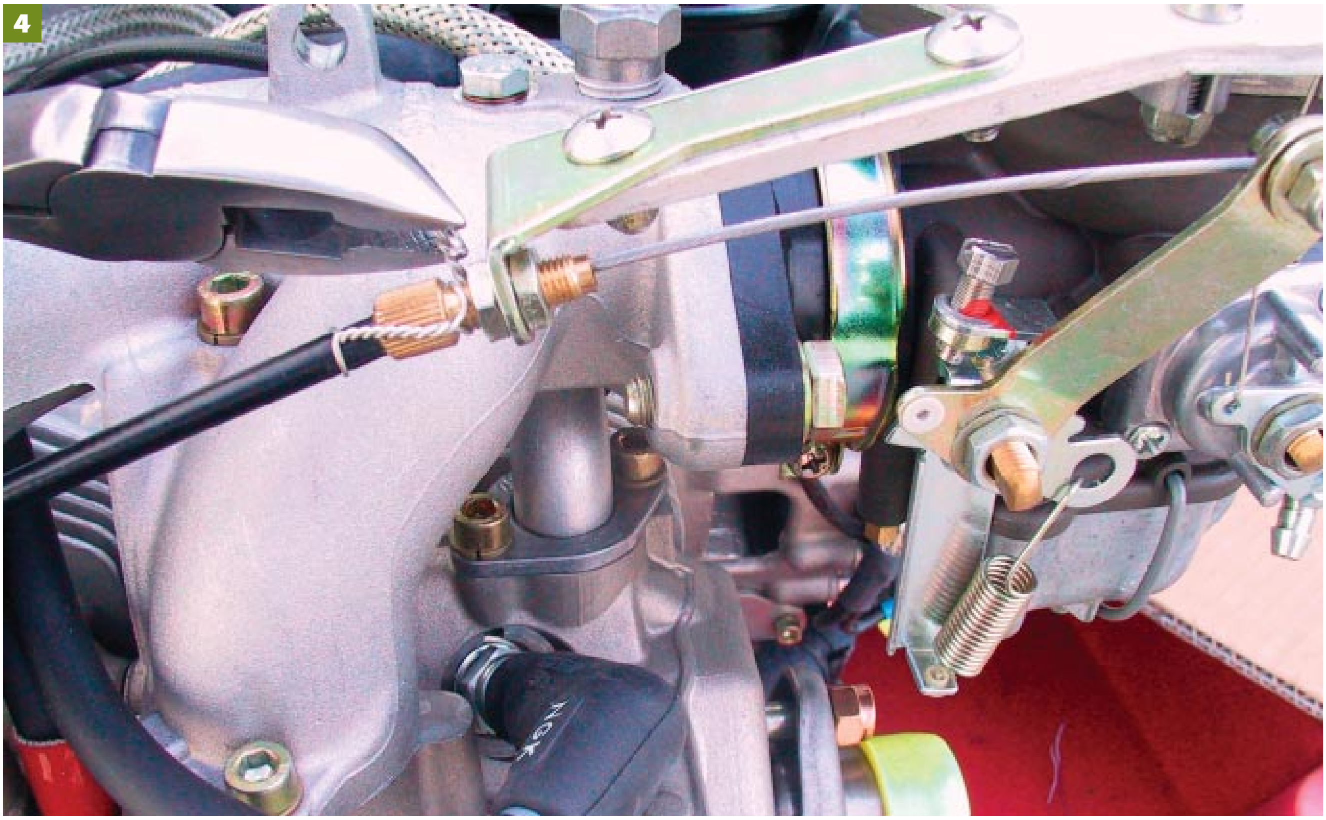
Start the engine and adjust the throttle to produce about 2000 rpm. Never let the idle drop below 1400 rpm while making these adjustments, as the engine will run rough and possibly cause damage to the gearbox. The vacuum gauge needles may oscillate. Adjust the two in-line valves to stabilize the vacuum gauge needles as shown in **Photo 2**. Close the valves just enough to steady the needle and then rev the engine between 2000 and 3000 rpm to make certain the needles still respond. If they do not, you have closed the valves a bit too much. Adjust the throttle linkage at the cable housing adjustment screw (No. 58) to produce equal vacuum on both carbs with the idle at 1800 rpm. Make sure the cockpit throttle control is at its idle stop.



Standard Rotax throttle configuration at full power.

The engine needs to be near normal operating temperature before making final adjustments. It will gain 200 rpm to 300 rpm as it warms up. If you begin this adjustment process when the engine is cold, it will probably be warm by the time you figure out what you're doing.

If the vacuum gauge readings are not equal, the carb with the lower vacuum reading is set at a higher throttle position.



Modified throttle configurations at idle.

If the idle rpm is higher than 1800, retard the carb with the lower vacuum reading.

If the idle rpm is lower than 1800, advance the throttle on the carb with the higher vacuum reading.

Once you have adjusted the carbs to produce equal vacuum with the idle adjusted to 1800 rpm you're nearly finished with the synchronization process. Advance the throttle and watch the vacuum gauges. If you have a sound throttle linkage the two gauges should remain close to each other. Then adjust the idle stop screw (No. 43) using a thin shim (approximately .002 inch) to just touch the throttle stop at idle. Again, make sure the cockpit throttle control is hard against its idle stop when you make this last adjustment. Reconnect the compensating tube and you're ready to go flying.

Adjusting Modified Throttle Linkages

For engines with *modified throttle linkages* where the carb throttle valve lever is advanced by the throttle cable and returned to idle by the spring, as shown in **Photo 4**, follow this procedure.

This set up can make full use of the idle stops and has the potential advantage of providing a smooth idle even if the throttle linkage goes out of adjustment. That's good because keeping the carbs synchronized at low rpm is most important. Idling below 1800 rpm and/or with the carbs out of synchronization is what causes most gearbox wear. Before beginning, have a small amount of slack in the throttle cables at the idle throttle position. Start by setting your idle to 1800 rpm with the engine near normal operating temperature. Make adjustments to the idle stop screw (No. 43). If you are reducing the rpm, check that you still have some slack in the throttle cable at idle.

Install the vacuum gauges as described previously. Start the engine and adjust the throttle to produce about 2000 rpm. Never let the idle drop below 1400 rpm while making these adjustments, as the engine will run rough and possibly cause damage to the gearbox. The vacuum gauge needles may oscillate. Adjust the two in-line valves to stabilize the vacuum gauge needles as shown in **Photo 2**. Close the valves just enough to steady the needle and then rev the engine between 2000 and 3000 rpm to make certain the needles still respond. If they do not, you have closed the valves a bit too much.

With the engine at operating temperature, adjust the idle rpm to 1800. If the gauges are not equal, the carb with the lower vacuum reading is set at a higher throttle position.

If the idle rpm is higher than 1800, retard the carb with the lower vacuum indication.

If the idle rpm is lower than 1800, advance the throttle on the carb with the higher vacuum indication.

After you have adjusted the idle stop screws to produce equal vacuum readings with the idle adjusted to 1800 rpm, adjust the throttle linkage above idle, using the cable housing adjustment screw (No. 58 and 59) to balance the carbs. This task can be performed at about 2500 rpm. Adjust the linkages to produce equal vacuum readings. Once this adjustment has been completed, the carbs should have the same vacuum at all power settings, if your throttle linkage is sound. But remember, it's more critical to have the same vacuum readings at lower rpm.

After you have achieved synchronization at above idle settings, make sure you still have a small amount of slack in both throttle cables at idle. Then, with the engine off, advance the cockpit throttle control to the full position and confirm that the cockpit control hits its stop before or at the same time as the carburetor throttle valve lever (No. 45) hits the carb-mounted full throttle stop. It's acceptable if the throttle valve lever falls 1/16-inch or so shy of hitting the full throttle stop on the carburetor. Remove the vacuum lines from your carb balancing equipment and reconnect the compensation tube that runs between the two manifolds.

Post-Adjustment Tasks

When you've completed the pneumatic synchronization process, trim the excess throttle cable where it attaches to the carb throttle valve lever on each carb. Use specially designed cable cutters to achieve a clean cut. Leave about 1 inch of cable beyond the final point of attachment and seal the end with a 5/8-inch long piece of 1/8-inch diameter heat-shrink material.

Use safety wire to lock the cable housing to the adjuster as shown in **Photo 4**. This is important for the non-standard throttle setups as there will be a small amount of slack in the cable at idle, which could allow the cable housing to unseat from the cable housing adjustment screw (No. 58).

Dab a drop of engine oil from your dipstick on the cable pivot point where it attaches to the throttle valve lever. Make a habit of doing this whenever you check your oil level to prevent the pivot point from sticking.

Now, let's go flying.

Alternative Engine Q&As

Redrive Re-Thoughts

I feel the need to correct some misinformation in the February *Experimenter*.

I have been flying a VW-powered Kolb Mark III for about six years, the first four years with a 2180 cc direct-drive VW engine. I have since changed the engine to a reduction-drive VW of the same size.

With the direct-drive VW I had a reliable engine package, but I lacked the thrust to function as a two-passenger airplane. When I switched to a Valley Engineering reduction-drive VW, I found I had twice the thrust of the direct-drive engine. I now have a plane that performs as well as the same model with an 80-hp Rotax 912. My 2180 cc VW is configured for a 3200 rpm cruise and a 3500 rpm climb.

The biggest problem I've had since switching to the reduction drive is keeping the engine warm! I have over 100 hours on the engine as now configured and have flown from my home in Michigan to EAA AirVenture Oshkosh and back—approximately 1,000 miles round trip—with no problems other than low oil temps.

The climb rate for a redrive-equipped VW is at least as good as the benchmark 80-hp Rotax 912. If you didn't see my plane fly at Oshkosh or Gene Smith fly his reduction-drive VWs at Oshkosh over the last several years, I can understand the comment about VWs having a poor climb rate, but it just isn't correct.

Also, [your] recommendation of installing a reduction drive with a jackshaft to cancel resonance is totally wrong. Molt Taylor and many others have found that a long shaft will amplify resonance between an engine and the prop.

Valley Engineering [see the "Classified Ads" in this magazine] sells lightweight, reliable reduction drives that have been around for almost 10 years.

Rick Neilsen
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A. I can make mistakes with the best of them. The best thing about this forum is that it makes the best thinking available for readers.

My notions about reduction drives are biased by my thinking that if a builder is attempting to imitate a successful design, he or she must copy it verbatim. Designs like Valley's, which have withstood the test of time, are not what I attempted to criticize.

I do find the notion of a properly tuned counter shaft to be a time-honored way to deal with resonance vibrations of the crankshaft that cannot be dealt with by normal balancing protocols.

I sincerely apologize for any misstatement.

Bill Bronson

Each month in Power ON, **Phillip Lockwood**, president of Lockwood Aviation Repair, will address common Rotax engine maintenance or operation issues. 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, or

- 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.