

The Proper Care and Feeding of the Rotax Motor—Part 10

by Mike Stratman

Tuning the Bing Carburetor

Summer has started; the air is warm and still, and blizzards of winter are just bad memories. Your gorgeous new girl has been wondering why you read these weird magazines and talk about "getting some air." You pull your wing out of the hangar and fire it up. Aimed down the runway you firewall the throttle. As you roll by your foxy new friend, you realize the engine is acting like a dog. As you work the throttle furiously, the trees at the end of the strip begin to dominate your attention. You've been meaning to find out why your engine doesn't always run right.

It could be there's nothing wrong with your motor that a little carburetor tuning wouldn't cure.

The importance of the proper air/fuel mixture is the life blood of any 2-cycle engine. The demand for precise fuel metering is essential and governed solely by the carburetor. One of my most common requests for technical help comes from pilots wanting to

understand carb theory. Rather than just telling someone what to do, it's more effective to explain why to do it. This month we'll get into the guts of the Bing slide carburetor, show how it works, and how to make educated adjustments on it.

Factory Recommended Jetting: Fortunately the Rotax factory has done a lot of testing and puts out a completed listing for every application of a Bing carb on a Rotax engine. This takes nearly all the guesswork out of carb tuning. [See Figure 2 for the most current recommendations available. These figures are calculated at sea level at 60 degrees F or 15 degrees C.]

If you don't understand what these numbers mean, don't worry. They will be addressed individually so as to make complete sense when it is all brought together.

FIGURE #2
RECOMMENDED FACTORY
JETTING FOR BING CARBURETORS

	277(A)	277(B)	377(A)	377(B)	447(A)	447(B)	503(A)	503(B)	503DC	503DC	532DC	532DC	532DC
MAIN JET	148	140	165	155	165	155	180	158	158	148	165	155	205
IDLER JET	45	45	45	45	45	45	45	45	45	45	55	55	55
NEEDLE JET	2.72	2.72	2.70	2.70	2.70	2.70	2.74	2.74	2.74	2.74	2.72	2.72	2.94
JET NEEDLE	8L2	8L2	802	802	15K2	15K2	8G2	6H2	8L2	8L2	11G2	11G2	11G2
POSITION	2	2	2	2	2	2	3	3	1	1	3	3	3
IDLER SCREW (turns out)	1	1	.5	.5	.5	.5	.5	.5	.5	.5	1	1	1

ALL ABOVE WITH WINDOW IN BOTTOM OF PISTON 2303B ENGINE SIDE (4.4 mm wide x 3.8 mm high)
(A) WITH K&N AIR CLEANER (RC1200/SP2100), WITHOUT ROTAX AIR INTAKE SILENCER, WITH OR WITHOUT ROTAX AFTER MUFFLER KIT.
(B) WITH ROTAX AIR INTAKE SILENCER, WITH K&N CM3000 AIR CLEANER, WITH OR WITHOUT ROTAX AFTER MUFFLER KIT.

Main Jet Correction Chart: Because not everyone lives at sea level, and because the temperature and humidity can also vary radically, a main jet correction may be necessary. Figure 3 shows the Main Jet Correction Chart.

FIGURE #3
MAIN JET CORRECTION CHART **EXAMPLE: 160 x .89 = 142 MAIN JET**

Altitude - METERS FEET	0	500 1500'	1000 3000'	1500 4500'	2000 6000'	2500 7500'	3000 9000'	3500 10500'	4000 12000'
TEMPERATURE °F °C									
-22° -30°	1.04	1.03	1.01	1.00	.98	.97	.95	.94	.93
-4° -20°	1.03	1.02	1.00	.99	.97	.96	.95	.93	.92
14° -10°	1.02	1.01	.99	.98	.96	.95	.94	.92	.91
32° 0°	1.01	1.00	.98	.97	.95	.94	.93	.91	.90
50° 10°	1.00	.99	.97	.96	.95	.93	.92	.91	.89
59° 15°	1.00	.99	.97	.96	.94	.93	.92	.90	.89
68° 20°	1.00	.98	.97	.95	.94	.93	.91	.90	.88
86° 30°	.99	.97	.96	.94	.93	.92	.90	.89	.88
104° 40°	.98	.96	.95	.94	.92	.91	.90	.88	.87
123° 50°	.97	.96	.94	.93	.92	.90	.89	.88	.86

NOTE: Before operating the engine again at low altitude, reinstallation of the original jet is necessary. Engine damage may otherwise occur.

How To Use The Main Jet Correction Chart

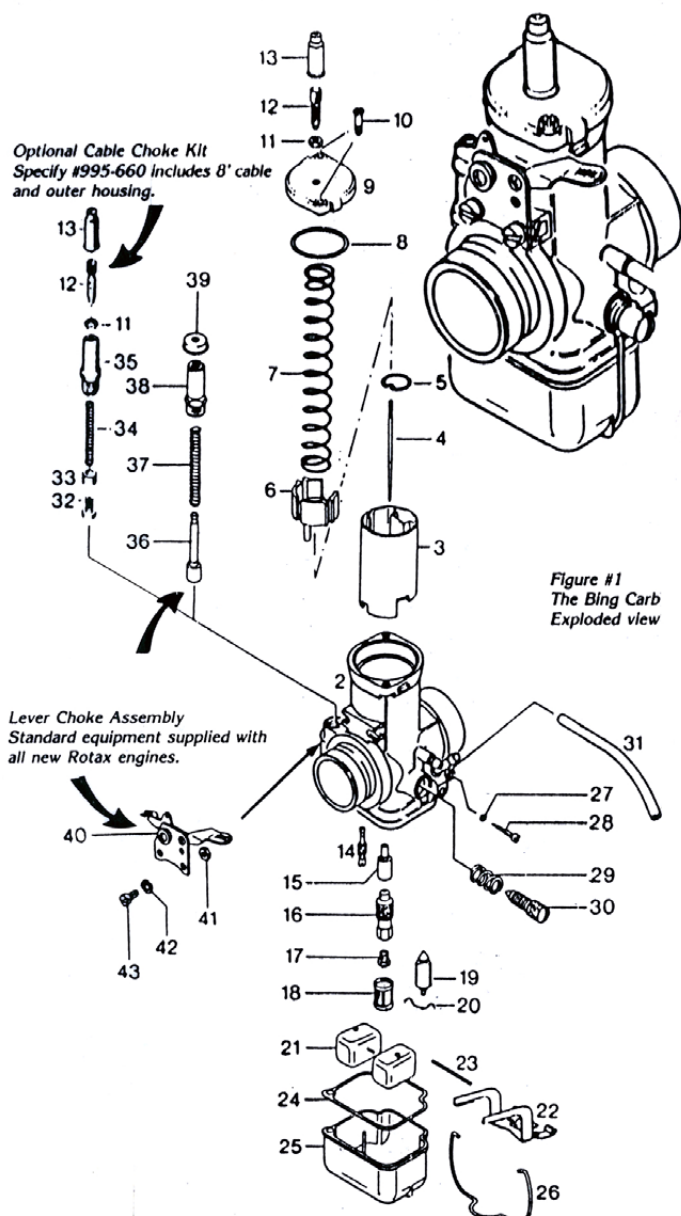
Step 1. Assume nothing! Disassemble and check your carburetor to verify that the recommended jetting, shown in the chart, is installed in your carb. This is the most up-to-date information available at the time of this publication.

Step 2. Because air density varies with temperature and altitude changes, a main jet correction may be necessary. The chart was calculated at sea level with an air temperature of 60 degrees F or 15 degrees C.

Step 3. Apply the multiplication factor to the recommended main jet size to correct your particular operating situation. [See example above chart: 160 x .89 = 142 main jet.]

Step 4. Your operating conditions will vary with the change of seasons. If your EGT temperatures vary, and your engine experiences performance difficulties, a review of your jetting may be necessary. Return to step 2.

Step 5. Humidity is also a variable in determining air density. A high humidity means a lower density of air to be consumed by combustion. Because we are generally not equipped with a way of easily reading the percentage of humidity present, this can be read into the chart by adding altitude on high humidity days and subtracting altitude in very dry climates. An EGT gauge should illustrate changes in these conditions under full throttle readings.

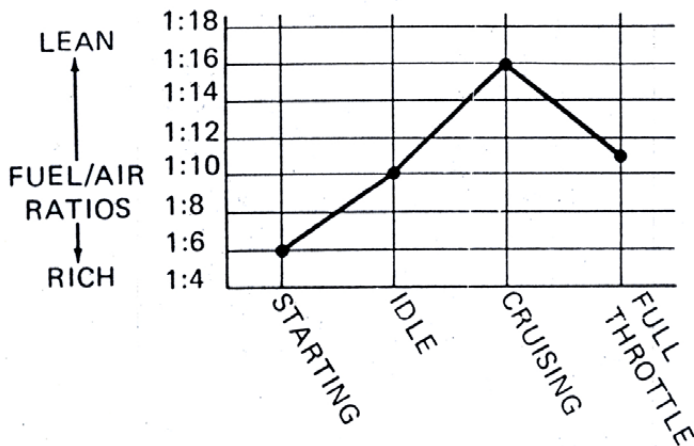


Using the information illustrated above, a vast majority of carb tuning should be unnecessary. The Rotax factory people also say these recommendations are what you need. From here on out, the information I have been able to gather is not easily found, unlike the vast technical info available for the Mikuni carb. The similarities of the Bing and Mikuni carbs are nearly identical in principal. Examining each circuit is the best way to understand your carb completely.

As most of you probably know, too lean an air/fuel ratio will cause severe overheating of the engine and some costly repairs. A rich mixture protects the engine and your investment. Too rich a mixture will cause the engine to load up, run rough, and lose power. I might also add that it is difficult to overheat an engine at half throttle or lower settings. The real danger is at full throttle. Remember, the smart thing to do when tuning is to start rich, too rich, and slowly lean things out.

Understanding Carb Theory: The precise fuel/air mixture necessary at any given speed is the carb's function. This ratio varies radically at different throttle openings. Figure 4 illustrates the typical demands of a 2-cycle engine. At very slow engine speeds, the fuel is broken up into small droplets. If the engine is cold, these droplets of fuel will not vaporize as they would in a warm engine. It is necessary to provide a very rich mixture to ensure that some of the fuel will be burned. When warmed up, the engine speed at idle is low, and air flow through the carb is so low that the incomplete atomization of the fuel occurs. The mixture at idle is rich, about 1:10. Under hard acceleration, when maximum power is being developed, the mixture ratio might be 1:12. The actual amounts of fuel and air are much greater for high power operations. What is important to realize is, slide valve carbs have the ability to meter fuel precisely under demanding conditions. Butterfly-type carbs do not have these exacting fuel metering qualities, and will likely turn your 2-cycle into an incredible gas hog.

Figure #4



Illustrates the typical fuel demands of a two-cycle engine.

The Float System: The float system is designed to regulate the incoming fuel. The fuel level in the float bowl is controlled by the two floats and a needle valve. Figure 5 shows the parts responsible for controlling the reservoir. A clogged or worn valve seat (#19) causes fuel to overflow out the vent lines (#31). Changing the float level should not be attempted to correct delivery problems. Remove and inspect parts for wear.

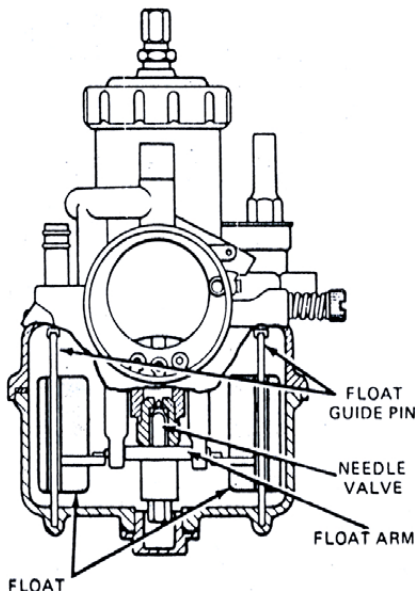


Figure #5—The float system governing the intake of fuel into the reservoir.

The Pilot System: The pilot or idler jet (#14) controls the air/fuel mixture mainly from closed to 1/4 throttle. Figure 6 illustrates the pilot system. Idler jet comes in sizes 35 to 60 at 5-unit increments.

The lower the number, the smaller the jet opening and the leaner the mixture. This is also a bypass system that works at all throttle positions. You should also note that all Rotax engines but the 532 use the same 45 idler. [See Figure 2.] Care should be taken not to quickly blame a rough idling engine on this system. A gear box modification is necessary. [See "The Proper Care and Feeding Of The Rotax Engine-Part 4," July 1987.]

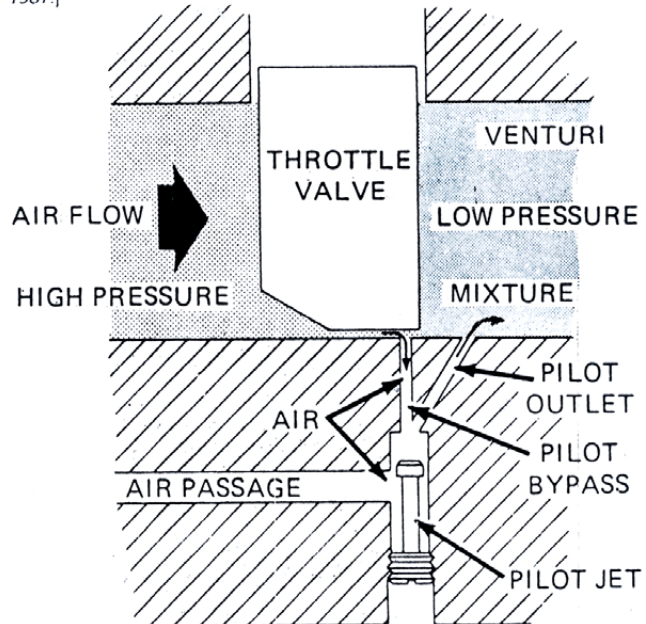


Figure #6

The Choke or Enricher Circuit: This circuit allows for a rich, nearly raw blast of fuel to be delivered to the engine on demand at any throttle setting. This circuit is very important to understand. It is invaluable in diagnosing carburetion problems. Study the diagram in Figure 7 carefully. Applying the choke opens the passage for a rich blast of fuel at any throttle setting. The key here is, this is a bypass circuit that works at any point in the throttle opening. If you experience a problem in 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 that throttle opening. If applying the choke does nothing, it is likely an electrical problem. Following this procedure should be one of your first steps in determining the origin of an engine problem.

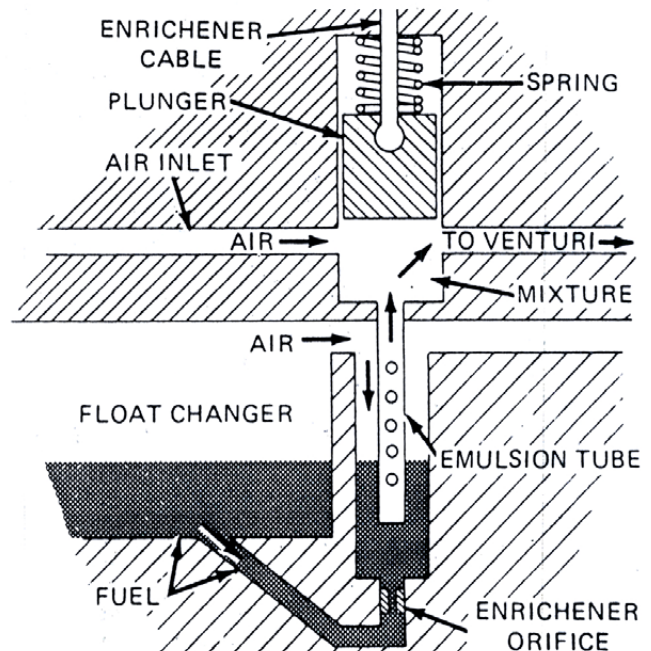
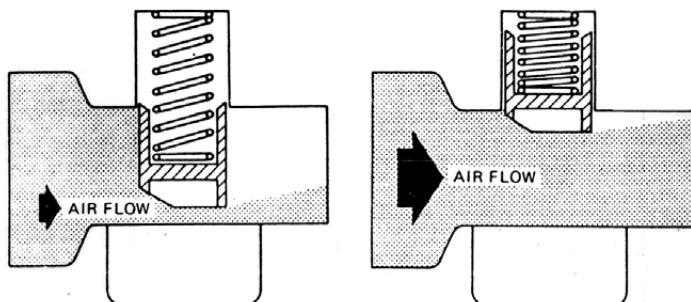


Figure #7—The inner workings of the choke or enricher system.

The Throttle Valve: The round cylinder that rides inside the main carb body is the throttle valve #3. This part is rarely changed in tuning and the same style is used on all Rotax engines. Figure 8 illustrates how the throttle valve governs the flow of air through the venturi. These valves do come in different cut-away configurations which changes the angle of the diagonally cut surface, but they are expensive to change and hard to find. It's best not to worry about this item as a tuning component.

Figure #8



The throttle valve controls the air intake.

The Needle Jet Circuit: This circuit is actually two tuning pieces working in conjunction with each other. The needle jet (#15) is the cylindrical brass passage located directly above the main jet (#17). This part is available in sizes 268, 270, 272, 274, 276 and 278. The smaller the number, the smaller the diameter of the inner passage and the leaner the condition. The jet needle #4 is the pin that rides inside the throttle valve and out the bottom of this slide into the needle jet passage. The relationship between these two parts is well illustrated in Figure 9.

The clearance between the tapered pin and the passage determines how much fuel can pass at a given throttle setting. This system controls the fuel mixture between 1/4 and 3/4 throttle.

The real tough part for most people to understand is the configurations of the jet needle (#4) available. This part is tapered at varying degrees through its effective length. In spite of a considerable amount of prodding, phone calling, digging, researching and exploring, I have yet to find a lot of precise information on the actual dimensions of a jet needle. Mikuni lays this out for you in an exacting 6-interval pin diameter chart. While this may be more than most people can handle, it is a wealth of information for anyone wanting to compare the characteristics of one jet needle to the next. Unfortunately, due to a lack of this kind of information, Bing carbs are often seen as inferior, or even replaced by the nearly identical Mikuni slide carb, simply because the tuning specs on it are not easy to come by. Please, if this information is available, will somebody tell me where to find it? I'll do my best to share it with all the people who keep asking for it.

Figure #9—The jet needle and needle jet form a fuel passage by creating a variable clearance.

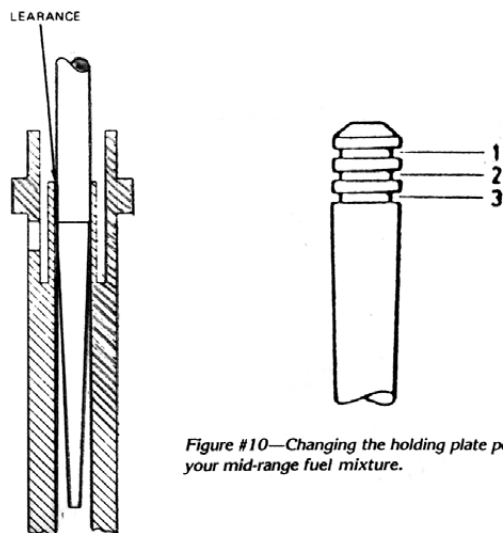


Figure #10—Changing the holding plate position will change your mid-range fuel mixture.

The Jet Needle: This part is available in 6H2, 802, 8G2, 8L2, 15K2 and 11G2. There may be a lot more available, but it's a well-kept secret, at least in this sport. A general rule of thumb to apply is, needles with a "High Number Code" produce richer mixtures above half-throttle. Example: 8L2 instead of 6L2. Needles with a "High Letter Code" produce richer mixtures below half-throttle. Example: 6P2 instead of 6D2.

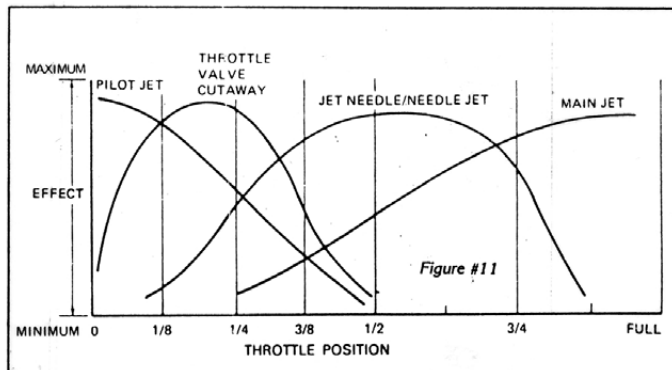
My recommendation is, if you have a mid-range throttle problem, change the needle jet #15, because this part will consistently affect the entire range from 1/4 to 3/4. Or you may want to experiment with your jet needle position.

The Jet Needle Position: This position is determined by which location the holding plate (#5) is installed on the jet needle. Figure 10 shows the three positions available on the jet needle (#4) or pin. This position affects the timing of the jet needle versus the throttle side (#3) and the needle jet (#15). This relationship requires some thinking. It may even require you to read this section several times, but once you understand what's going on, you can make educated changes rather than random experiments.

Moving the holding plate (#5) to position #1 will delay the timing between the jet needle and needle jet clearance versus the air intake supplied by the opening of the throttle valve. This will produce a leaner 1/4 to 3/4 throttle opening, because there will be more air passing into the engine than fuel allowed. Moving the holding plate to position #3 will accelerate the timing between the jet needle and the needle jet clearance versus the opening of the throttle valve. This will produce a richer mixture from 1/4 to 3/4 throttle opening. Don't expect miracles! While this change will make a difference, it may not cure your problem.

A common complaint is that an engine will not operate at a given rpm. The engine will either drop or gain rpm without a throttle change. This gap can be as much as 1,000 rpms and can often occur in the cruise range. Very annoying! A lot of people attach the holding plate position and then, in frustration, go after the needle jet/jet needle circuit. This condition, more often than not, is a result of the tuned exhaust system not wanting to hold that rpm. [See "The Proper Care And Feeding Of The Rotax Motor-Part 8," April 1988.] There is a chance that a mid-range modification may take care of this problem, but in many cases, you are stuck with it.

The Main Jet: This part (#7) is easy to understand. It is simply a hole of an exacting size drilled in a hex-sided piece of brass. This passage controls all the fuel leaving the float bowl with the exception of the bypass circuits discussed previously. The main jet is available from 125 to 195 in 5-unit increments, with a few mid-sizes available, such as 146, 158 and 162. The smaller the number, the smaller the opening, and the leaner the condition. This part controls the fuel mixture mainly from 3/4 to full throttle. The proper fuel mixture is critical in this range. The majority of engine seizures and meltdowns occur in this 3/4 to full throttle range. Paying close attention to your main jet selection is obviously imperative. Consulting the Recommended Jetting Chart (Figure 2), and the Main Jet Correction Chart (Figure 3), will generally put you on close course with the proper main jet.



Bringing It All Together: Now that you understand how each circuit works, all you have to do is apply it. Figure 11 illustrates the approximate working range of each part.

It is clear from Figure 11 that there are overlapping areas where two or more circuits are working together. First, determine precisely at which throttle opening you are experiencing the difficulty. Secondly, consult the chart to see which circuit will be most effective at that point. Make an educated change in jetting, and look for a favorable response.

Taking the time to understand the entire picture in carb tuning can make all the difference in engine reliability and your flying fun.



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