

101 Quad Tuning

Performance tips from leading pros in the ATV industry

Let's face it, a lot of us out there in quadland only ride our quads a few times a year and really don't understand a lot of the tuning lingo that is thrown around the campfires at night. You could be talking to someone about their motor and listening to their advice, only to discover that they're riding a two stroke motor, and you have a four stroke motor. One thing that I have learned over the years is that it's best to keep your comments to yourself and be thought a fool, rather than open your mouth and remove all doubt.

The goal of this article is to give our readers enough accurate information to diagnose an engine problem, and know if it's serious or just needs a new spark plug. To make sure that we are passing on the correct information, we contacted Duncan Racing International, located in Santee, California. They have over 40 years of factory tuning to their credit in both two stroke and four stroke motor applications.

Loren Duncan is their head tuner and was happy to sit down and give us a quick course in recognizing common problems that occur. But first, let's touch on some of the basic mechanicals for both types of engines.

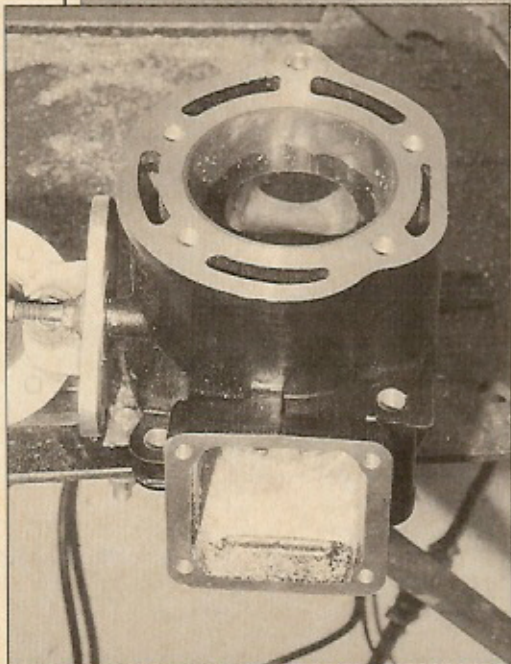
TWO STROKE BASICS

Two stroke engines are usually the engines of choice for most of the high performance ATV owners. They are lighter in weight and have less moving parts than their four stroke cousins. As the name implies, they make all their power in two strokes of piston travel inside the cylinder. The fuel is drawn through the carburetor where it is mixed with air. This is where we hear the terms "lean" and "rich."

A lean mixture means that there is not enough fuel in the air/fuel charge, which in turn causes intense heat to be created and generally will result in a seized piston. This means that the piston got way too hot and

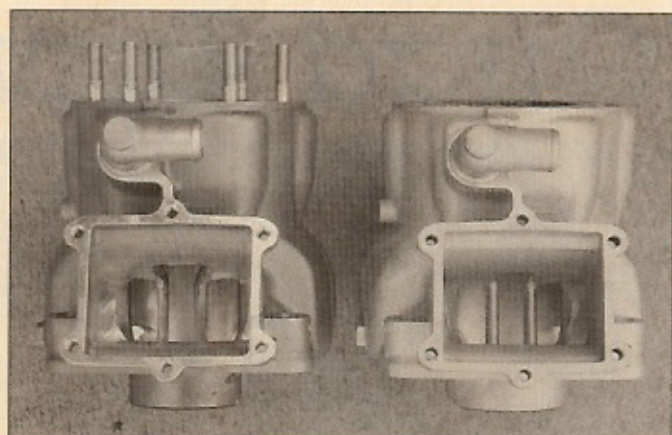
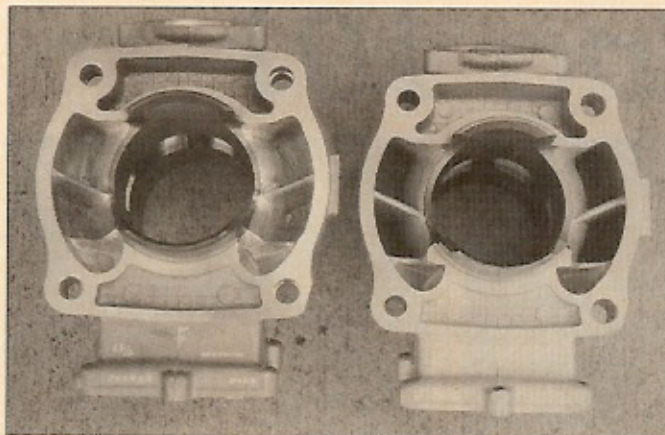


ABOVE, this is where Loren Duncan has made his name in the industry, at the porting bench. The porting tool that he uses is like a Dremel tool, or a dentists drill, with a rotary cutting wheel on it, to smooth and remove excess material in the intake, exhaust, and transfer ports on the two stroke engines. LEFT, here is the intake track of a 2-stroke cylinder. By removing material and opening up the intake track and transfer ports, the engine is able to perform much better and obtain maximum efficiency.

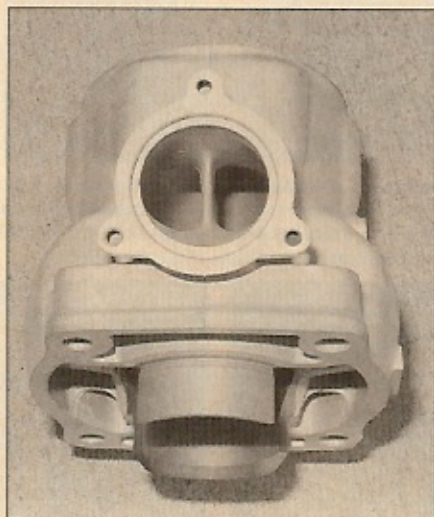
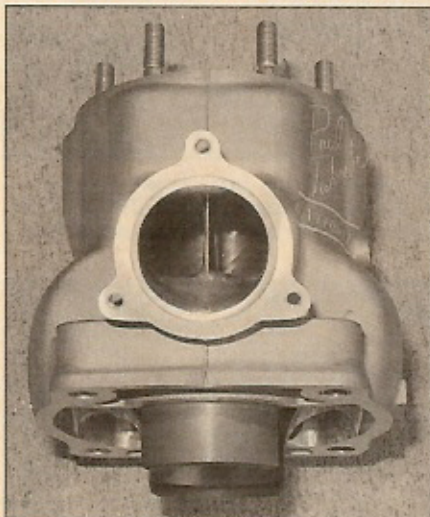


expanded inside the cylinder creating an interference problem with the piston-to-cylinder tolerance, possibly welding the piston skirt to the cylinder wall, if the piston generated enough heat. One sign to listen for that may indicate a lean mixture is that the engine doesn't want to idle back down to a low rpm. Another sign of being lean is

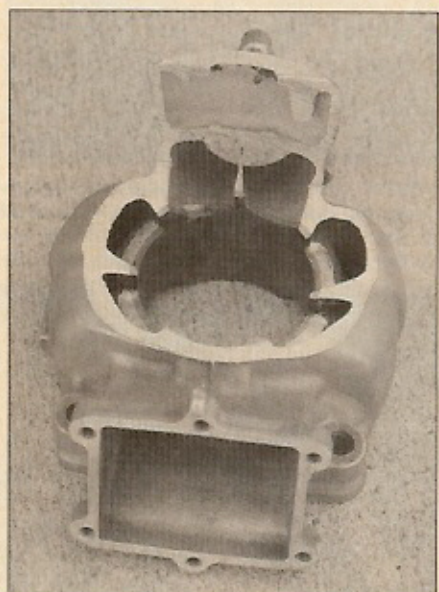
BY WALLY CAHILL, DANNY DUNCAN & LOREN DUNCAN of Duncan Racing International



ABOVE LEFT, this photo shows a comparison of a modified cylinder, left, as compared to its stock counterpart which has yet to be ported. The modified cylinder's transfer port provides a less restrictive route for the air/fuel mixture. **ABOVE RIGHT**, here's a view showing two cylinders, the one on the left is ported so that the transfer ports are much larger which increases the air/fuel mixture into the crankcase, and the cylinder on the right is still in stock condition. Porting in this area allows the fuel to have a straight shot into the crankcase versus the more restrictive stock configuration.



ABOVE LEFT, here, we're looking at the exhaust port for a modified two stroke engine. The bridge, or material in the center, is to support the piston rings so they won't get hooked on the exhaust port. Some tuners remove this material but it usually becomes a trouble spot if they do. **ABOVE RIGHT**, this is the same side of an unmodified cylinder. Note how much rougher and unfinished it looks compared to the modified exhaust port.



ABOVE, here's a cutaway view of a two stroke that shows the intake track as well as the transfer ports that allow the fuel mixture to reach the intake ports where it enters the cylinder.

the power falling off at about 3/4 of the way through the powerband.

A rich mixture means that there is too much fuel in the mixture and, while it won't do any damage like a lean mixture will, it could leave you walking out of the dunes just as quick. If your mixture is rich, the engine will never reach its full potential for power. Spark plugs are usually the victims of this condition as they are flooded with raw fuel and basically get drowned out of existence. One of the most visible clues to this condition is a heavy plume of blue smoke coming from the silencer. If you see this tell-tale sign, look and see if there is a thick goo or oily residue inside of the silencer. If there is, check to make sure that the air filter is not clogged with dirt which could choke your engine by not letting enough air through the filter, creating the rich condition. If that's not the problem, look at the spark plug. If it looks wet and oily, replace it. It's a good rule of thumb to replace your spark plug before each week-

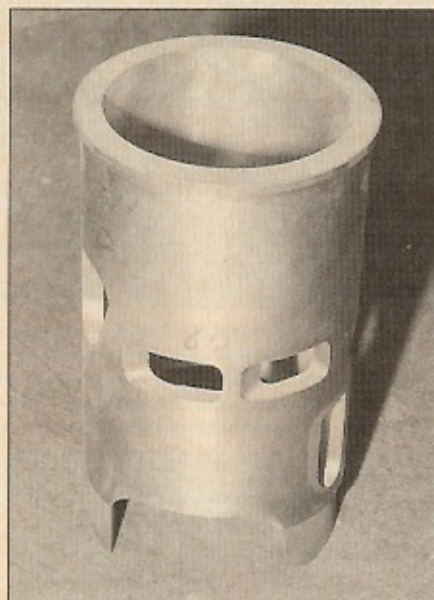
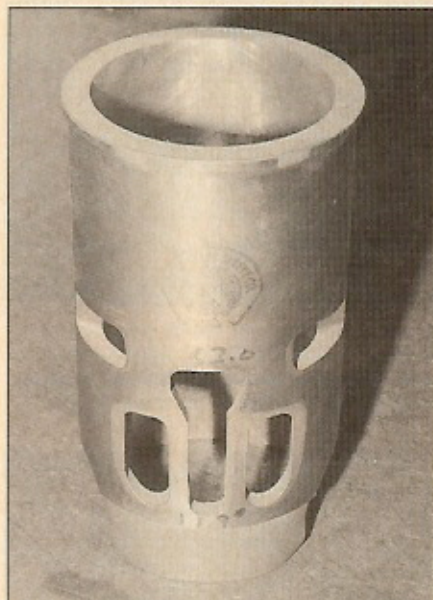
end riding trip. It doesn't cost a lot and it's cheap insurance that may save you a long walk back to camp.

Now that you understand these conditions, let's look and see what happens to the air/fuel mixture after it leaves the carburetor. (The first key to understanding how the 2-stroke engine operates is to remember that there are always at least two parts of the power cycle going on at once — one above the piston, others below it). The piston is going up which causes the air/fuel mixture to be sucked past the reed valve. These are simply one-way trap doors that swing open to let the fuel mixture into the inlet track, and then slam shut so the mixture can't get back out through the carb. After the air/fuel mixture passes the reeds, it goes into the crankcase and as the piston is coming down it causes the mixture to be moved through the transfer ports. Transfer ports are like little tunnels that lead from the crankcase up to the cylinder. The area where the tunnels join the cylinder wall is called the "ports."

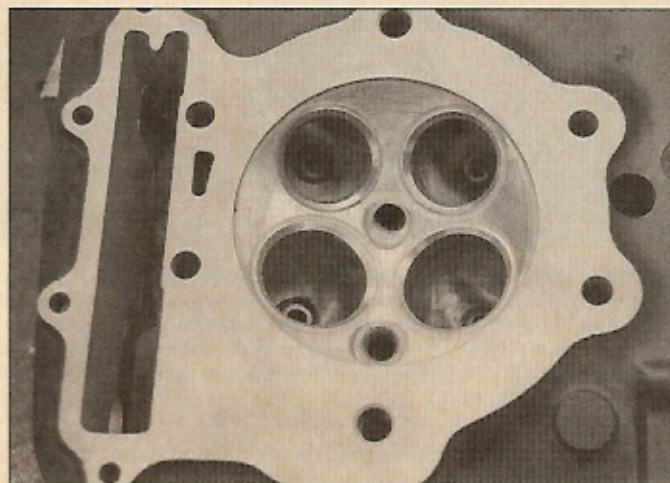
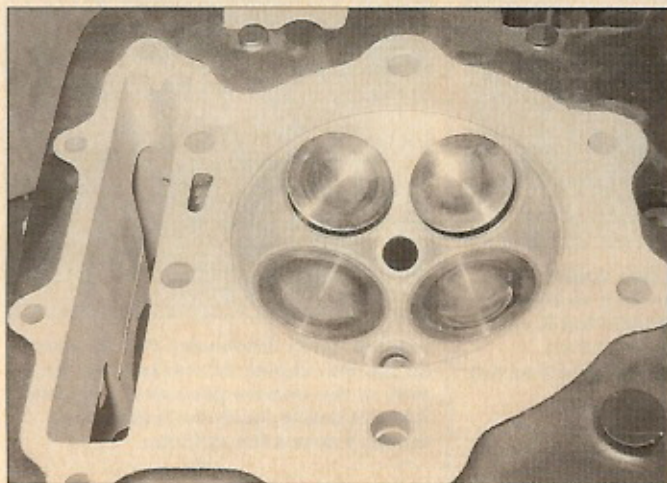
The normal up and down movement of the piston will open up or close off the ports at the proper times. We now get back to the mixture, which has been transferred to the top of the piston which is now on its way up compressing the charge. Then, just before top dead center we have ignition. As the spark plug fires and the air/fuel mixture burns, its force is transferred into a downward force on the piston and creates the power that makes the quad move. As the piston is driven down, it uncovers the exhaust port that lets the burnt fuel through the expansion chamber and creates a suction at the same time in the inlet side of the engine that draws the air/fuel mixture past the reed valve, as explained before.

So, basically, the engine is just an air pump, that when you add fuel, compression and spark at the right time, it creates its own power.

Quad Tuning 101



ABOVE LEFT, this is a cylinder sleeve. This is what you would need to have installed in your cylinder if you damage one severely. Note the three rectangular ports. These allow the fuel mix to be evenly distributed through the transfer ports. **ABOVE CENTER**, this is the exhaust side of the same sleeve, showing the exhaust port design. **ABOVE RIGHT**, here's the view of the transfer ports. This is the place where the fuel enters the cylinder that comes up from the crankcase.



FOUR STROKE BASICS

A four-stroke engine operates similar to the two-stroke, in that the pistons move up and down, but that's where the similarity ends. The reason it's called a four stroke is simply because it takes four strokes of the piston to complete one power cycle. Intake-compression-ignition-exhaust.

Again, starting at the carburetor, the air/fuel mixture is drawn through an inlet track to the inlet valve. The valve inlet and exhaust are opened by a camshaft that looks like a roll of quarters with bumps, or "lobes," on it. A small chain comes up inside of the engine from the crankshaft and turns the camshaft at 1/2 of the crankshaft's speed, and the lobes on the camshaft push open the valves. The valves are controlled by dual springs, which are used to control the motion of the valve and its associated

ABOVE LEFT, this is a four stroke head as the piston sees it. On this Honda head, there are two intake valves (the small ones), and two exhaust valves (the large ones), to ensure a high volume or flow of the intake and exhaust gases. **ABOVE RIGHT**, this is a bare four stroke head. The valves are out so you can see the intake and exhaust ports that are polished to decrease any resistance that may slow down the exhaust flow or make the fuel puddle on the intake side. The hole in the center is for the spark plug. This is what is called a hemispherical or "hemi" head.

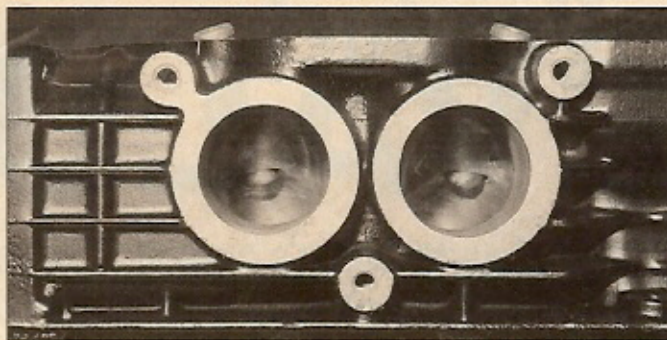
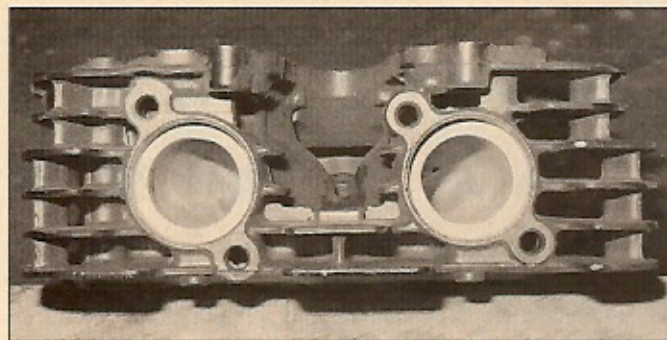
valve train, so that it follows the profile of the cam lobes to return the valve to its closed position. Once the fuel mixture is sealed in the cylinder, as the piston comes up towards top dead center (TDC), the spark plug fires just before TDC. This explosion drives the piston back down the cylinder and, as the piston is coming back up inside the cylinder, the exhaust valves are opened by the camshaft lobes and the burnt fuel is pushed out of the cylinder past the exhaust valve and out the exhaust pipe.

This is an over simplified explanation of the basic four stroke theory. If you are going

to do any trouble shooting or performance work on your ATV, it would help you to understand how things operate inside the engine.

LET'S ASK THE PROS

We asked Loren Duncan to tell us what the most commonly asked questions are when people call their shop for advice. And, here's what he had to say, as well as telling us the answers to these questions.



ABOVE LEFT, here we see the exhaust ports on the front side of the engine, these ports lead directly to the exhaust valves. Their surface can be enlarged and smoothed out to increase the flow of exhaust from the engine resulting in a higher exhaust flow. ABOVE RIGHT, these are the intake ports that lead directly to the intake valves. These ports are also enlarged and smoothed out to insure mass quantities of fuel can reach the cylinder to create more power. LEFT, this picture shows a two stroke engine with a degree wheel attached to the crankshaft. This wheel is used to measure the intake and exhaust port height. The port height allows a tuner to create an engine that creates more torque, or more rpm, depending on the type of riding that the owner does.



1. What is two stroke porting? Two stroke porting is a way of altering the port timing by changing the width, height and angle of the ports.

2. How is two stroke porting performed? Two stroke porting is accomplished by cutting the metal with a dremel tool, of which there are several different sizes and shapes. Before the cutting, or porting work, is started, the cylinder is degreed in a special fixture, and lines are marked on the cylinder to show where it will be cut.

3. How does two stroke porting alter your engine's power curve? You, and the person that is going to do the porting, decide where you want the emphasis of power — more low end, increased mid-range, better top end performance. Also, the cylinder you are working with has a lot to do with what can be done.

4. What does a two stroke cylinder head modification consist of? This entails setting the squish angle and clearance, modifying the combustion chamber for better burn quality and control, and changing the compression ratio.

5. Do you need a cylinder head modification if your cylinder is ported? Yes, porting changes the compression and one of the head modifications is to adjust the compression ratio.



6. Who should port my two stroke cylinder? A trained professional in two stroke porting, that has the ability to do the complete job. By that, we mean that they can tell you what their porting will do with different exhaust systems, what head modifications are needed, what carbs work the best with your porting. We suggest that you check around and, when you decide what you want to have done, have it all done by one person or company. That way, if there are any questions or problems they can take care of them for you.

ABOVE, here we see the master (Danny Duncan) CCing a two stroke head. Danny has been tuning race motors for many years and is the driving force that instilled the high work ethics in both of his sons. LEFT, this is what we call CCing a head. Fluid is used to measure the available space in a cylinder head which controls the compression ratio as well as the flame travel during combustion of the fuel. A flat piece of plexi-glass is used to seal the combustion chamber as fluid is leaked from a measuring vial to give the exact cc displacement.

7. How will a professionally done two stroke cylinder port job affect the reliability of my ATV? With the correct fuel, jetting, and maintenance, reliability may drop as much as 10-15%. Most of that is due to the fact that you have more power, and you're using it more often.

8. How important is porting and head modifications to the overall performance picture of my two stroke ATV? They are the second most vital option for improved performance, with the exhaust system being number one. ●