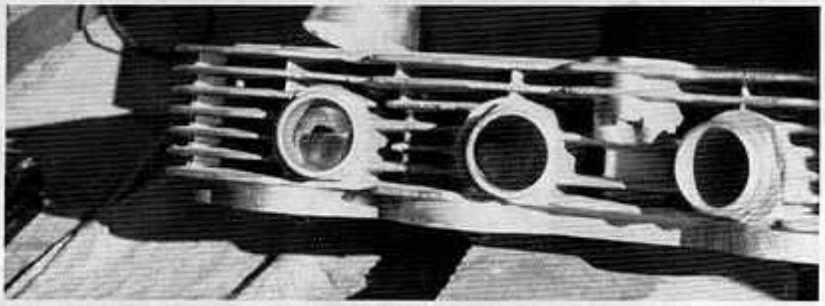
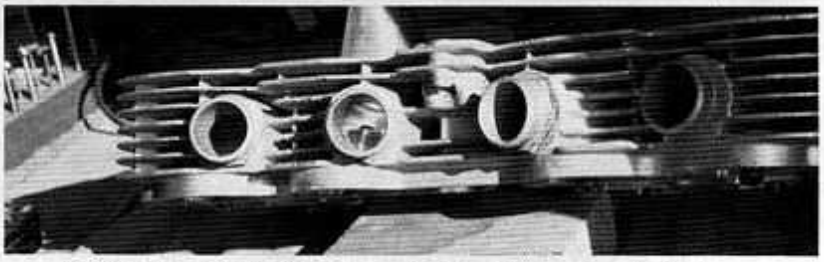
Flow Bench Porting

Here's one bench session that can net you horsepower.

by Steve Stillwell

BELOW—Late model motorcycle engines actually have very good parts made from good castings. But perfection is lost in mass production as shown in roughness around this port.





The #2 port on this Honda head was polished without porting. On the flow bench, the port actually flowed 2 cfm's less than a stocker!

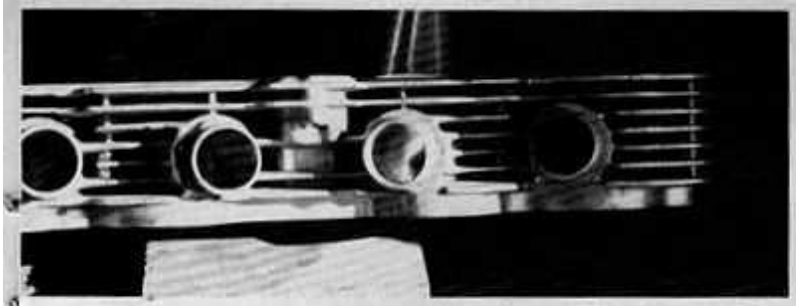
Porting is probably one of the best ways to improve the performance and operation of your bike without infringing upon reliability. Most of us are already familiar with the term porting, because the automotive guys have always used the term *porting and polishing*. In almost every article you've read in a "rodding" book dealing with intakes and heads, someone always seems to get around to P & P'ing the head and/or intake.

On motorcycles, porting and polishing is really a whole different ball game. In the automotive industry, shops port the heads and intake to make them larger in almost every instance, because the engine designers have undersized the intake and exhaust passages. This isn't the case in the motorcycle engine, though. Porting on a late model motorcycle engine is simply refining the intake and exhaust ports to the original engineering specifications which are lost in mass production. Surprisingly enough, today's motorcycle engines, especially the Japanese made fours, flow quite well which is one of the reasons these engines pump out over one horsepower per cubic inch. Remember, a 750 Honda is really only 736cc's, which amounts to a little more than 45 cubic inches. The "green meanie" Kawasaki 900 is really a whopping 903 cc's which puts it at a little over 55 cubic inches. That's not much, considering the average American sedan has an engine with a 350 cubic inch engine!

Before you get into the porting of a motorcycle head, the first thing you find out is that there are more wrong ways to port than right. This is especially true of the delicate balance which must be maintained between the cylinders of a multi-pistoned engine such as the fours. The next thing you are going to figure out is home porting is almost impossible since this balance has to be maintained. Cut too much metal out of the wrong place and you will run into jetting problems as well as creating that imbalance which will give you a lugging cylinder.

Talking with Steve of JBS, the normal home porting job usually has too much metal removed from the venturi area at the valve seat and also too much removed where the manifold meets the head. The two most critical areas which are more often ported wrong are the streamline area and the radius of the port. Since you are probably totally lost in these terms, the streamline area is the port or tunnel leading from where the manifold connects to where the radius in the port begins. In laymen's terms, it's where the fuel/air mixture blasts through the port!

The radius is where the tunnel turns to direct the fuel/air mixture down onto the valve. Cutting this radius will redirect the flow of the mixture onto the top of the valve. Obviously, the most



The #3 port actually shows the type of porting Steve likes to do. This port was ported and then glass beaded for quite an improvement. On the right, Steve shows off the various types of tools it takes to get into the smallest radius found in the different ports in motorcycle heads.

The two main heads used in the porting of a Honda head are shown above. These tools are a carbide cutter and a sanding head. The carbide cutter enables him to remove any burrs and rough casting left in the port. This is done through the intake port shown in photo at right.

preferred cut would direct the fuel/air mixture so it is evenly distributed around the valve seat so 100% of the valve opening can be used. You can't just grab a cutting tool and start hogging out the radius as you are apt to cause more damage than good. Even the best engine builders don't do eyeball work anymore, since a flow bench lets you see the results without having to assemble and test run the engine.

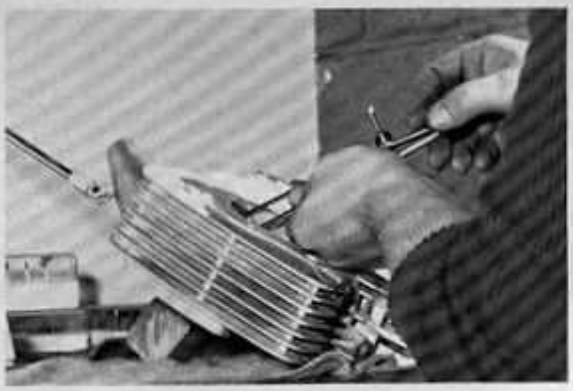
Next question that should be in your head is what is a flow bench? If you have ever heard one in operation, then you already know they are a very sophisticated vacuum cleaner! That's how they sound, but there is a little more to them. In short, a flow bench is a device which simulates the engine's head in operation and measures the mount of air being drawn through the ports.

One of the local shops which has a flow bench is JBS in Stanton, CA. Steve is the bench man at JBS and he and I got to talking about porting using a flow bench. I, like most bikers, thought the best method of porting is to make that passage as big as your fist and the fuel/air mixture would have to flow through the ports fast and efficiently since there would be very little resistance. Unfortunately, that is the most common approach to porting and *very wrong!* Porting has to be directed at improving the velocity of the fuel/air mixture — not volume. Like Steve says, "If you have the velocity, you also have the volume."

The port profile must be maintained for proper flow and performance. Here, the valve is being checked for size.

To get a better idea of what he was talking about, we decided to follow Steve through the process of porting a head. Since a photo is worth a thousand words, take a look at the number one port as it is stock. As you can probably see, the port shows some roughness around the radius area, but by mass production standards, this is pretty good. The next shot is the #2 port. This one was not ported, just polished. The smoothness and mirror finish is impressive, but Steve feels that polishing isn't too important unless your engine is built to the max and you want to pick up that extra hidden couple of horsepower. In short, he doesn't push polishing onto the customer since he feels the money can be better spent. As a matter of fact, the polished but unported cylinder actually dropped 2 CFM when tested on the flow bench!

Since we have shown you two ports which aren't particularly pleasing to



Correct porting is a constant job of cutting with an equal amount of measuring. No large amount of cutting is ever done without first measuring. Largest mistake made by amateurs is removing too much metal by enlarging the ports drastically. That procedure will actually limit the air flow velocity!

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Steve, then we should also show you his preference and flow bench proven method of porting. The #3 port shows you what a port would look like after mild porting and then glass beading. Mind that I didn't say sandblasting, I said glass beading! There is a mile of difference between the two as the glass beaded port is almost as shiney as the polished one!

Before any work begins, the actual amount of porting to be done has to be determined. Although the amount of modifications to the engine will have some effect on the porting style, the major factors considered will be the use of the bike, and the type of cam. The cam has the biggest effect on the porting since the lift and duration of the cam has a direct bearing on the flow of air past the valve. That is one reason why porting should be accompanied by the addition of at least a mild street cam if not more. The best porting job in the world won't help out if the valve only opens a fraction of an inch!

A cam swap would probably net you ten more horsepower and a port job would give you about a 15% increase in power. As you can see, it would be better to get 15% of 75 hp than 15% of 65 hp.

After the porting style is determined, some initial cutting is performed. The major tools used in porting look like something out of a dentist's office. These drills have to be very small in order to reach into even the smallest crevice in the ports. Fortunately, the ports in the Honda Four head are big enough so the larger grinding tools can be used in most instances.

ABOVE—JBS prefers to finish the porting of a head by glass beading. This resists carbon build up among other advantages.

Initial work on the Honda head is done using a spear shaped carbide cutter. The rough work is done quite quickly using this cutter with the sanding head used to smooth things up. A small cut is actually made to clean up the rough parts of the port casting, then the measuring begins. The sizing of this port is really simple. With this particular head job, the port is going to be enlarged to match the intake valve. This means the port will measure the size of the valve less the diameter of the valve stem. Basically this creates a good velocity of the fuel/air mixture as it passes thru the ports. The cutting continues until Steve nears the desired size. A liberal amount of metal must be retained for the smoothing, but even more important for the profiling of the port. The profiling actually means the redirecting of the fuel/air charge to create a faster, less restricted flow of the mixture into the combustion chamber.

Now, the head is taken over to the

ABOVE—The base part of the flow bench is fabricated to duplicate the flow of air into the cylinder through the port. The most important part of installation is alignment.

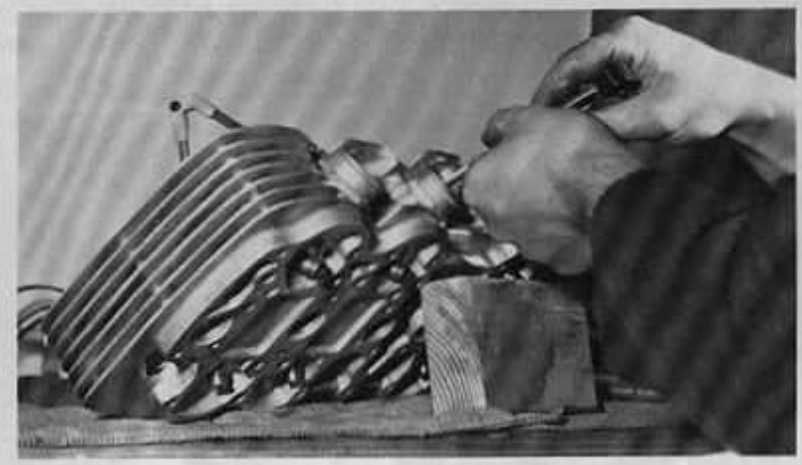
Flow bench operates by measuring amount of air that flows through port. Thus, intake valve has to be in place and depressed as if the engine were running.

LEFT—Watching the gauge, Steve can reach into the port and actually find areas of restriction in the air flow.

RIGHT—With just minor amount of porting, (in right area) Steve acquired 6 cfm increase in air flow thru port.

BELOW—Next, and one of the major steps, is to balance all ports as they all have to flow the same cfm's.

BELOW RIGHT—The only true way to acquire equal flow of air in all the ports is by using the flow bench. This is a must in porting multi-cylinder engines.



glass bead machine. Here, the ports are glass beaded which gives them a smooth finish. Steve has found this a desirable finish as it resists carbon build-up as well as eliminating some port turbulance.

Next, the head has to be bolted onto the mounting fixture of the flow bench. Besides mounting the head, this unit simulates an actual cylinder. With the head secured to the fixture, the unit can then be attached to the flow bench.

The flow bench is a very useful tool, but everything has to be set up properly or the information is useless. The cam profile information is then used to determine the valve travel. This information is used to set the working valve travel for flow bench testing. The valve is set in the full open position, then the bench is turned on. Air is drawn in thru the open intake port past the open valve. Steve is experienced on this machine and it is unique to watch him work.

Using a thin wire with a taped end, he probes into the intake port while the machine is operating. Using this

To complete a trick porting job, the valves are polished to a mirror finish. Results from this are even more surprising.

method, he can find and then rework any restrictive areas. As shown in the photo, this port flow was improved from 40 CFM to 46 CFM with only one cut. An improvement of 6 cubic feet per minute with the valve only open 5mm is quite good, but even better results were attained!

With one port done, meaning modification of the exhaust port, valve seat area, both parts of the venturi and the diameter of the streamline area, this port is finished. Now, the same has to be done to the other ports and they all have to be balanced with equal flow readings. That's not a job for an amateur!

A normal job would also net you a valve polishing job for even better flow. This is accomplished by mounting each valve in a high speed head and polishing it to a chrome like finish.

Average cost to port a head runs about forty dollars a cylinder, but is sure worth the money. Engine modifiers like JBS like to talk more in "percentage figures" but I did get them to state that a good port job would average about a 13 to 15 horsepower increase on a Honda Four with similar results on other makes of bikes.

If you are really interested in talking to one of the guys at JBS, drop them a line a 11064 Mercantile, Dept. SC, Stanton, California 90680, or call 714-897-4101. They can make your bike faster or at least make you a better bench racer in just a short session.