I've been telling myself that I'm going to create "yet another" flathead porting and relieving post. One has to wonder why I'd even waste/take the time . . . given the wealth of knowledge, posts and opinions available. I guess the only reason is that when I first got into flatheads (35 years ago), I read EVERYTHING I could, bought every old DIY mag, studied everything, talked to all the old racers . . . in the end, it is like going to the Fortune Teller -- she tells you all sorts of crap, it is up to you to decide what to take away. I'm not going to claim to have the definitive answer to anything flathead related -- there are more opinions that A$$holes . . . so if this is valuable, cool . . . hope it helps somebody. <u>By Bored & Stroked</u>

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Background: I've read just about every dang article out there, seen all the pictures, read all the articles and hung out with some people who have really made flatheads run -- and learned a LOT along the way. There are MANY ways to port/relieve a flathead -- you need to decide the type of engine you're building, understand your capabilities (with an air grinder) and use your own common sense. The type of port/relief job you do for a very hot street engine is very different than one that is going to Bonneville. In some cases, the type of port/relief jobs I'm going to show would actually make your car run worse (from a stop sign) - especially if it is a heavy car, didn't have the rest of the engine combination (cubic inches), etc.. There is no 'standard port/relief' job that works for everybody . . . it all depends on what you're trying to accomplish, what the rest of the engine is setup to do, your expectations, etc..

Just to let you know, I typically build pretty hot engines . . . bored/stroked, big cams, with light cars, race gears, etc -- the type you'd race back in the day. So -- if you're just looking for a nice polish and port-match article -- this is not it!

Installment #1: Understanding the flathead intake port It is really hard to understand/imagine just how much you have to work with -- unless you've ported a bunch of these . . . 'hit water' once or more, etc.. When I was doing my first heavy port jobs, all I could think about was "I wonder if I'm going to go through and hit water???". Honestly -- it was a lot of trial and error, asshole puckering and being just plain scared about half the time I was working. I only wish I knew what the port actually looked like - to see just how much I had to work with.

Here is a cutaway of a 40's era 59L type block -- showing what the stock port looks like, with dimensions to show what you have to work with. The dimensions on the side walls show you how thick the ports are on the sides -- while the cut-away dimensions show the top, bottom, back of valve pocket, etc.. Take some time to really study this picture -- it is the bible you should live by.

The next picture is one that I've reworked to show you the basic areas that you need to concentrate on - for a race type intake port job. Yes, there are many variations, but this will give you the basic idea as to where you need to rework the port, how you're really trying to rework the short-side flow, etc.. There is not a huge amount to be gained in the bottom of the port - it is the top (short side) that stands to gain the most. Notice that you need to be very careful about how much material you remove in the bottom -- there have been plenty of first-time porters who tried to "remove the hump/raised" area . . . only to hit water (it is only .160 thick at best!).

What this picture can't show is that you'll widen the port as well - taking material out of both sides (starting on the intake manifold end and going the length of the port). Quite a bit of work needs to be done to open up the port and blend it into the bowl area, blend it into the opened up short-side (roof), etc.. You'll need some long carbide cutters, stones and sand-paper rolls to reach to the area from the manifold side all the way to the bowl area.

Installment #2 – Two Sample Port/Relief Jobs - Full Race and Competition . . .

Sample Work: I'll now show an example of a fairly heavy port/relief job for a full race street engine.

1) Application #1 - Street "Full Race" Setup

This term was widely used back in the day - what the hell it exactly means??? . . . who the hell knows. I've categorized it as such in that there was a heavy amount of work put into this block -- roughly 40 or so hours of porting and relieving. The engine belongs to 'RustyBucket' (Chris Daniels) - it is his first flathead and his first port/relief job. We discussed the overall engine package, application, goals, etc -- so I could help him determine a path to go on. I roughed the first port - so he could see about how far to go then said "you get the next 15". One never appreciates the work that a really nice port/relief job requires . . . until you do one yourself! Chris has done an EXCELLENT job . . . check it out . . .

Engine Specifications:

Engine: 42-48 59AB style block.
Bore: 3 5/16
Stroke: 4" Merc crank
Cubic Inches: 276
Rods: 49-53 Frenchies
Heads: New Edelbrock block letters -- didn't measure the CCs, but they are fully machined in the valve pocket area (about .500 deep) - this reduces compression (which came into play on our relief decision).
Intake: Edelbrock Slingshot (new) - dual Stromberg 97's
Cam: Potvin 3/8 (great cam . . . thanks 'Pete1')
Valves: Stainless Pro-Flow style - 1.5" on both
Ignition: Harman-Collins dual coil
Headers: Belond style - 'Reds'
Flywheel: Lightened to 25 or so lbs (can't remember the exact #)
Clutch: 9"
Application: 28 Model A roadster on 32 rails, 39 trans, Halibrand Q.C.

Things to Think About: This is a light car, has a quick change, has a medium weight flywheel, has a 39 transmission. He is running bias ply tires - don't remember the diameter, but they are very tall in the back (probably 32" or so). This car can take a pretty big cam, some fairly heavy porting and still have enough torque to come away from a stop sign really nicely. It may be a bit under carbed - we'll find out, but it can take a pretty big port/relief job and still have enough low-end power. I doubt he'll rev it much past 5500, so total top-end transfer area flow is not a big issue -- it is more important to maintain compression ratio. Also, at 276 cubes - it can take a fairly large port and maintain decent low-speed port velocity.

Relief: Semi Relieved - Nice Blending into the Transfer Area:

Pay attention to the relief style - it is much more of a blend and radius method, than the traditional 1/8" to 3/16" full relief. This was done to preserve compression and still help flow. The edge of the bore was radiused a bit as well.

Rough Porting and Rough Relief:

Ports In-Progress and Finished:

Relief Finished - With Bore Edge Radius:

Installment #3: Competition Port/Relief

The next engine is a 59L block that originated in a Kenz & Leslie streamliner (at least that was the story when my Uncle bought it in Denver and gave it to me as a Xmas present for my 16th birthday). It was already pretty heavily ported (about like the other example) - and had a full traditional relief.

I then put a lot more work into all the ports, the relief, the exhaust passages, etc.. Basically, I reworked everything I could get a long-reach piece of carbide, stones and sandpaper into.

I ran this in with a SCoT blower about 30 years ago, then "mothballed" it until last year or so.

What I show you is ALMOST complete for it's next update -- the ports are done, the relief is done, but I have yet to install the large intake valves (probably 1.65 to 1.7).

Engine Specifications:

Engine: 42-48 59L Block
Bore: 3 5/16 + .020
Crank: Merc crank - 4 1/8" stroke - fully polished, grooved mains, clearance ground
Cubes: 286

Heads: Either Navarro High-Dome or Baron Pop-Ups
Rods: H-beam - reworked to lighten them
Main Girdle and Steel Caps: Doug King
Cam: .450 or so lift and about 270 degrees at .050 lift (big!)
Blower: GMC 4-71
Fuel System: 650 HP - double pumper or 2-port Hilborn
Valves: Titanium intake - 1.7", Severe-duty 1.5" exhaust
Guides: 49-53 - sleeved back to .3125 - bronze liners
Oiling: Aviad pan, scrapers, trap doors, 10 qts
Oil Pump: High-volume (like a Lincoln)
Ignition: MSD 7535 with boost retard
Flywheel: 12 lb aluminum
Clutch: 10" - lightened counterweights

Application Notes: This is a race motor - it will never idle well, has a big blower on it and it is designed for high-end horsepower. The last time I ran it I was running 6800 through the traps (a bit brave at the time!). I'm not yet sure what car/chassis I'm going to put it back in . . . something to race and have run. Given ALL of the above, I'm not worried about low-end torque -- the blower helps this anyway and it is designed with a single purpose in mind - racing and high rpm power. This is why you'll see much bigger ports (from what you can see). I welded in exhaust dividers in the center ports and have done lots of works on the guides to port match them (individually). When I complete the valve work in the future - I'll update these photos.

Here yah go - don't have any real "in-progress" pictures . . .

Installment #4: Valve Guide Work

Once you've ported the heck out of a flathead block, you need to turn your attention and your lathe to the valve guides. If you just run the stock 49-53 guides, you'll find that they stick up into your nice new port - wrecking havoc on the flow. Back in the day, the quick and easy trick was to grab a trusty hack-saw and cut the last 3/16 or so off of the tops . . . a little less guide, no blending . . . crude and partially effective.

What you really need to do is take a lathe and back-cut/reverse-radius the tops of the intake and exhaust guides to match the port floors. Typically the intakes will need more cut-back and radius, the exhausts a little less.

The easiest way to understand how much to cut/blend is to use some die-chem on the guide sides, place them in the port (with the horse shoe clip) and scribe where the port floor intersects the guide side. Once you know approximately how far to cut-back the intake and exhaust, you should be able to use the same dimensions for the rest of them (with the assumption that you were consistent in your porting work)

[B]1) Using a Lathe to Radius/Cut-Back the Guides:[/B

Testing the Guide Fitment in the Port:

Custom Fitting Guides to Individual Ports: This example is on the 59L competition engine - where I wanted to blend the guide into the port shape as close as possible to the port floor. Every guide is individually fitted - and then it is indexed/pinned to keep the orientation. These are prototypes, will probably replace the bronze liner to stick up the full-length when I'm done.

PS: Glob-o-Matic: Barney Navarro and I talked about custom guides and intake port flow -- he mentioned that he has seen guys weld a big glob of brass or even lead to the tops of the guides, then hand blend the port "turn" into this material. The goal was to help the air flow make the turn and not slam into the valve pocket wall! Cool Stuff . . . just wish I had more time to play and try this!

Installment #5: Things to know about valve springs . . . some myths busted in my mind!

Those of us who have built hot flatheads have probably heard about 'Zephyr' springs, Isky 185G single springs and maybe even the "hot setup" for big cams . . . the Isky dual valve springs. How many of you have ever actually tested them on a valve spring compressor or ran them?

1) Engine Style and Spring Pressure: It if very easy to NOT think about how simple the flathead valve train is -- there are very few moving parts . . . no rockers, no pushrods and not much weight (unless you're running those crap SOLID adjustable lifters). Due to this, you really don't need and don't want much spring pressure on the street - even for a .400 lift cam like the Isky 400 Jr., Potvin 3/8, etc.. This is especially true if you're being conservative on your RPM range and not pushing the top-end past 5500 (which very few people do). Also, the flathead only has 3 cam bearings, so putting a bunch of spring pressure puts unnecessary pressure on the cam -- and on a high-lift cam (which has a small shank diameter or base circle), it wants to deflect/flex all the more.

Putting your 'Cam in the Oil Pan': Lastly, the more spring pressure you run on a flat tappet, mushroom or radius cam - the more valve train wear you get. Want to wear that cast iron regrind out really fast??? - put a bunch of spring pressure on it! Roller cams can take much more, but they are made out of 8620 or 9310 billet steel and are heat treated!

So how much is enough? Well . . . as usual, it kind of depends. For MOST even hot street flatheads, you'll probably not need more than 60 - 70 lbs on the seat. For even more radical cams (not really street cams) - like the Potvin 425, you'll probably not need more than 80 - 85 lbs (with the above rpm range). Even on my blown flathead with a very radical .450 lift cam and steep fast opening ramps, I only ran 90 lbs on the seat . . . ran to 6800 RPM and didn't float a valve.

Flatdog with his Crower roller cam only ran about 90 - 100 on the seat . . . with 10 lbs boost in a full drag-race application (.450 lift as well).

2) Testing Installed Heights and Spring Pressure: You can buy a nice hydraulic tester that will work on a drill press or a lathe for somewhere around $80 (I think that is correct - checkout Jegs). It works great:

3) Sample Spring Pressures and Flathead Myths: Here are some numbers to review on spring type, pressure and installed heights. I wanted to check it with a reasonable seat pressure and a "nose" pressure - assuming a Potvin 3/8 cam - .375 or so lift (gross).

a) New Lincoln Zephyr Springs (new) - Reds:

Height: Pounds:
1.950 80
1.575 170

b) Isky 185G (new) - One of my favorite flathead single springs:

Height: Pounds:
1.980 80
1.605 180

c) Isky Dual Springs (new) - What many swear they need on cams like the 404-A, rollers, etc:

Height: Pounds:
1.765 80
1.390 180 lbs

d) Lincoln Zephyr (used) - came out of a 404-A radius cam setup

Height: Pounds:
1.820 80
1.445 150

Here is a picture - with the used Zephyrs on the left, then the new Zephyrs, then the 185G, then the Isky Duals:

So . . . did you notice anything funny in the numbers ?????????????????

How about those trick Isky dual springs? First of all did you notice how SHORT the installed height needed to be to just get 80 lbs? How the heck are you going to end up with a spring height of 1.765? - to do that, you'd need about .200 - .300 of spring shims (unless you ran shortened valves). This is especially true since many of you are using SBC valves in your flatheads . . . everybody is selling them and they are a bit longer than a flathead anyway. Even when you install the dual springs at the necessary height to achieve 80 lbs on the seat . . . they still have the SAME spring pressure as the single 185G springs on the nose. Also, they are a royal pain in the ass to install - as the outer spring will NOT fit through the guide bore . . . so you "assemble" them with the valve/guide in the block . . . now that REALLY sucks! Talk about one big cussing/swearing fest -- and a lot of bloody knuckles . . . (even with the necessary tools).

If you have a fairly stout street engine - run the Zephyrs, if you have a really big cam and/or a blower, run the 185Gs. Use the approximate spring pressures listed above . . . or not, whatever makes you happy

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As my old buddy used to say . . . "Gas, Grass or Ass" - nobody rides for free ! Seemed he was always alone . . .

Installment #6 - Spring Retainers: Okay, so you've read the rest of my boring and lame ass posts . . . might as well give the capper this evening . . .

Installed Spring Height is Key! The numbers that I posted on the previous installment showed that you need to achieve an installed spring height of about 1.950 - 1.980 (depending on which spring you're using and how many lbs you want/need on the seat). If you're running the typical SBC 1.5" pro-flow, better than a Ginzu frigging valves . . . that anybody can buy from anyplace . . . but the flathead web sites sell as if they have a "special part" just for you . . . then you're running a valve that is about 4.910 or so in length. The stock flathead valve (if I remember correctly) is 4.810 in length - so you're already .100 longer . . . which means MORE spring shims.

So lets take a typical combination of SBC 1.5" or 1.6" 4.910 valves, Lincoln Zephyr springs and a desired installation height of say 1.950 or so. Well, without ANY spring shims, running stock retainers . . . you'll have an installed spring height of over 2.1 inches - this is WAY too weak! (I know - depends on your engine, the one I just did was about 2.150). That means you need three .060 shims and one .030 shims . . . lots of them stacked up like a bunch of nickles. If you buy the Zephyr springs and complete valve package from places like Reds . . . they throw in one .060 shim per valve -- not even close . . . (you'd think they'd know the issue . . . guess not!)

Solving the Spring Height/Retainer Problem: Don't just slap the damn valves, springs, retainers together . . . cause you bought the kit and that is all your have to use . . . get off your butt and buy some aftermarket chrome moly retainers (Comp Cams: 743-16) - and turn them down on a lathe to end up with the following:

a) The correct installed height - with probably NO shims
b) A nice chrome moly retainer . . . much better than the stock stuff.
c) A much cleaner valve setup with a nice tight fit between the valve spring and the retainer. The inner valve spring area of these cut-down retainers fits a flathead Zephyr or 185G spring perfectly!

Here are some examples of what I do - using the Comp Camps chrome moly retainers -- part number "743-16"

a) Mount them in a lathe
b) Turn the OD down to match the OD of your Zephyr or 185G springs
c) The spring will have a tight fit on the inner spring location of the retainer.
d) Put a valve, guide, spring, retainer, lock assembly together.
e) Install it in your block and measure the installed height - adjust as necessary. The thicker retainer will be equal to 2 - 3 thick shims . . . you may still need some, just depends on the lbs you want on the seat!
f) Tip: It is nice to have a weak 'test spring' - that you can just compress by hand during the 'fit up' stage . . . makes life easier.

Here are some pictures:

Here are pictures of a stock, modified and Comp-Cams moly retainer - see how they've been turned down:

Here is the complete assembly - ready to go . . . nice and clean. I still needed one thick shim .060 and one .015 shim . . . better than 5!

Intake Manifolds and Porting

That was a very good question! You do need to pay attention to the intake manifold that you are planning on running! Certain manifolds do not have much material for porting - others do.

There are a couple things to note:

1) Use Blue Die-Chem around all the ports (intake side) before you start to port anything.

2) Place the manifold on the block and scribe around the manifold so you have a visual mark as to the perimeter.

3) You may find that you can't open up the ports as much as you'd like.

4) Porting Template: If you're new to all of this, you may want to make a 'porting template' out of plastic or something thin, but strong (even a piece of sheet steel. Finish/smooth it out and use it to scribe the same port outlines on all the intake ports -- might help you keep things consistently shaped. It is quite hard to do that by eye when you're learning - once you've done it quite a bit, you can do pretty well by eye.

5) Technique for Consistency - Find One and Stick to It: I've found that I settle in to a consistent method of doing the major "hog out" work. I always start in the same area of the port, using the same methods, same tools/cutters and repeat everything on all ports. I also spend about the same amount of time on each one.

It really helps if you do things the same -- port to port . . . to get them as close to each other as possible. Consider doing the SAME operation to all ports in a row - then switch over to the next operation. This also saves time on tool changes (cutters to stones, stones to cartridge rolls, etc). The natural tendency is to do one port at a time, but you'll be more consistent if you do one operation at a time (especially during the "hog out" stage!) and you'll get done much faster.

6) Welding up the intake: On my SCoT blower manifold for the competition ported block, I had to have the intake manifold (aluminum) welded up around most of the ports -- to give me more material to work with. Yes, it was a pain to do, but I wanted the big ports and it was the only manifold I had - needed to "fix" it.

7) Intake Gaskets: You used to be able to buy big-port intake gaskets . . . don't know if you still can? What I would do is buy some bulk gasket material and use an Xacto knife and make my own - that way you'll get an exact fit around both the manifold and ports. It is what most of us do who port the blocks out like this.

8) Intake Porting Template - the Gasket: Since I always port the block first, I cut the gasket to match the block - then use it as the template to scribe the port shapes onto the manifold. Again, use machinist's blue die-chem on the manifold surface.

Thank you Bored & Stroke....!

Return to Home Index