Note. Major changes and/or additions are in bold face font. Contributions by web members are underlined with dots and credit given when known. Minor changes, usually just wording, are not drawn attention to by any special font.

************** HEADS **************

Revised April 30, 2009

TORQUE SPECIFICATIONS ARE LISTED IN THE SPECIFICATION SECTION.

TORQUING HEADS: Use #8 hardness flat washers with oil on both sides when installing aluminum heads to protect the heads as well as increasing torque accuracy. I use them on cast iron head also.

On cap screws, coat threads with a thread sealant (like **Permatex Thread Sealant #5925)** to prevent coolant from seeping up the threads and to deter future seizing. Lightly oil the underside of the heads of the cap screws to increase torque accuracy.

On studs, lightly oil the fine threads and the underside of the head nuts as well as the washers. This will increase torque accuracy.

Initial installation of heads should be torqued in 3 incremental stages (20 ft/lbs, 40 ft/lbs, and final torque). Follow the torque sequence as shown below on 24 stud heads **and 21 stud heads.**

First time engine start up: run engine to operating temp. Shut down and allow to cool to room temp. (Tip: Remove the radiator cap to increase cooling rate) Retorque the heads after it's cool to the touch. I usually let them set overnight.

Then warm engine a second time and repeat the heating, cool off, and retorque drill. (I like to do this three times, but I'm some kind of nut.... at least Billy says I am!)

Run the engine 200 miles and retorque them again after it cools.

Re-torque at 200 mile intervals until they take a set (none are less than the torque value).

Thereafter, re-torque at 6 month intervals.

HEAD TORQUE SEQUENCE ON 24 STUD ENGINES:

20 11 3 4 12 21
19 1 22
10 13
18 2 23
9 14
17 8 7 6 5 15 16 24

HEAD TORQUE SEQUENCE ON 21 STUD ENGINES:

18 14 4 5 15 19
12 6 2 7 13
16 8 1 9 17
20 10 3 11 21

COMBUSTION CHAMBER CAPACITY. Ford made some pairs of heads with different combustion chamber volumes specifically for the left and right banks. This is also true for some, but not all, brands of after-market heads. IMO this was done to compensate for the different distances between the valves and pistons on the two banks.

This is the result of the angles of the center line of the valves in relationship to the center of the camshaft and block (the two banks of valves are

located 49½ and 52 degrees from the center of the cam and block and the 52 degrees is on the left side. [[[[[The center line of the crankshaft is offset to the right side 0.265" from the center of the engine. However, the center line of the camshaft is in line with the center of the engine. This all boils down to different measurements between the valves and pistons on each bank. This positions the valves a little closer to the cylinders on the left bank).]]]]]
Keep in mind Ford tried many different head configurations on production engines over the years. Measuring is the only sure way to determine what volume your particular heads have.

The 81T heads (24 stud) were cast iron and have right and left heads. They were rated at 5.9:1 compression ratio (C/R). Their combustion chambers have 83cc in the right head (part #6049) and 85cc in the left head (part #6050).

The 81AS heads (24 stud) were cast iron and have right and left heads. They were rated at 7.5:1 C/R. Their combustion chambers have 60cc in the right head (part #6049) and 62cc in the left head (part #6050).

The 81A heads (24 stud) came in either aluminum or cast iron. Both were rated the same at 6.2:1 C/R. Both have right and left heads. The aluminum heads have combustion chambers of 82cc for the right head (part #6049) and 84cc for the left head (part #6050). The cast iron heads have combustion chambers of 79cc for the right head (part #6049) and 81cc for the left head (part #6050). Interesting.... same C/R with different cc's.... wonder if flat top versus semi-dome pistons account for the variation?

99AS heads (24 stud) were cast iron and have right and left heads. They were rated at 7.1:1 C/R. The right head (part #6049) had a combustion chamber volume of 65cc and the left head (part #6050) had 67cc.

99T heads (24 stud) were cast iron and have right and left heads. They were rated at 5.5:1 C/R. The right head (part #6049) had a combustion chamber volume of 90cc and the left head (part #6050) had 92cc.

The 59 series heads (24 stud) do not have different heads for right and left banks as far as I know. The spec's I've seen show only one cc measurement..... one size fits all?
Stock heads are usually marked 6050 (or L) for the left head and 6049 (or R) for the right head. But I've seen heads with neither numbers nor letters. The sure fire method is to measure the volume of the combustion chambers in both heads. A quickie method I use (I'm lazy) is to simply compare the depth of the recession for an intake valve in both heads. They'll be different if there is a right and left head. The head with the deepest measurement will have the larger cc combustion chamber and is the driver's side or left head.

One added opinion. There are those who don't use finned aluminum heads saying stock heads will outperform them. If this is true, then my question is why have over 99% of all records set by flatheads over the years used finned aluminum heads? Surely the owners didn't spend their hard earned money to go slower. Just one of my dumb thoughts.

OFFENHAUSER #425 AND EDELBROCK HEADS: I've tried both on my present 59 series flathead. I prefer the Edelbrocks..... even though the majority of go-fasters prefer Offenhauser. The set of Offy #425 heads I had on my flathead had the same combustion chamber capacity in both heads..... no right or left head as far as I could ever determine. But my Edelbrock heads came with unequal capacities (like many stock Ford heads). I checked them over thoroughly but never found any mark to indicate which bank the head's were designed for. There wasn't any literature in either shipping box either. I checked the combustion chamber volume in both Edelbrock heads and then measured the depth of the recession for an intake valve in both heads. As expected, the head that measures approximately 0.030" deeper had the larger cc combustion chamber. The larger cc head is for the left side of the engine (driver's side). Both brands of heads had identical plug thread depth (9/16"). I recessed the plug seats 0.072" on both brands of heads to get 1/2" reach plugs flush with the bottom plug thread. This lowered the plug's ground electrode down into the combustion chambers. The ground electrodes of 1/2" reach plugs would be smashed whenever the engine was twisted tighter than 4000 rpm (this may be mostly due to the block surfaces being decked and milling the heads to get everything as flat as possible). This was true with both the Offy's and Edelbrocks. Eventually, I went back to 7/16" reach plugs to keep from shutting down the plug gaps and/or destroying plugs (interesting.... both brands of heads recommend Champion H-10 plugs with a 7/16" reach despite their plug hole depth of about 9/16".... go figure). The 7/16" reach plugs left two threads in the heads (don't forget I had spot faced them 0.072") exposed to combustion flames and heat. I ground these two threads away to prevent possible hot spots for pre-ignition. The Edelbrock's were purchased new a few years ago and came with heli-coils in all spark plug holes. The Offy heads didn't have spark plug heli-coils**.... (From rodnut on 1/30/03.... He says all Edelbrock heads he sees do not have factory heli-coils in the plugs.** Both brands of heads had the same C/R from the factory. Neither came with smooth or polished combustion chambers.

REWORKING COMBUSTION CHAMBERS: Going through some antiquated notes from early flathead racing days, I came across the reasoning, dimensions, etc. we used to alter combustion chambers for our souped up engines. There were two sets of dimensions and figures..... one for street and one for track. This was done on street engines to lower the compression ratio (C/R) to run other than premium gas (at the time, leaded premium was $0.24 per gallon and leaded regular was $0.22 a gallon!) and to decrease engine heat. But it was primarily done for because it made a noticeable change in performance. I altered my present Edelbrock's using the old notes with a couple of slight modifications. This was done mainly to lower my engine's compression ratio (C/R) from 10.4:1 down to a reasonable level. However, I hoped to increase low-end response and increase upper rpm performance along the way. Quite an order. On my present engine.... boring to 3-3/8", stroking to 4", decking the block 0.006", and milling 0.025" off the Edelbrock heads raised the C/R to 10.4:1. With premium gasoline it would ping hard under even moderate loads at any elevation. I had to add considerable octane boost to each tank of premium no-lead gas and retard the timing even at 5000'. At sea level, I had to double the octane boost additive (expensive) and still had to back the timing off to 1 degree BTDC to keep the mill from cratering itself.

I use a carbide cutter and a die grinder. The grooves in the cutter are dug into a wax candle frequently to keep aluminum grindings from clogging the cutters. It's no fun picking out the tightly packed aluminum that's been forced into the cutting grooves. I laid a used head gasket on the head surface (notice the gasket extends over into the combustion chamber and forms a "cave" back under the gasket when bolted down) to outline each combustion chamber using a felt tip pen. Removing all felt tip pen ink lines defines the limits of grinding to be done. By grinding to these limits I will eliminate the existing pocket that's formed between the head and the block and going back to the edge of the recessed gasket **. This will, hopefully, increase combustion chamber capacity and improve intake and exhaust flow. I want a smooth combustion chamber and to eliminate anything that could possibly lead to pre-ignition or detonation. After grinding all of the areas back to, and including, the felt tip pen lines, the edges of the gasket will be exactly even with the combustion chamber (getting rid of the “cave”)...... which should improve combustion efficiency in addition to lowering the C/R.

****From rodnut on 1/30/03. and I quote... “I don’t necessarily agree with this. If you study a Ford head, especially the low C/R heads, this area is left, and this transfer passage is deepened where it enters the cylinder area. The “neck” formed by the sides of the transfer passage creates turbulence. To lower C/R and improve breathing, just continue this transfer passage into the cylinder area. Ford knew what they were doing.”**

I start grinding at the top of the valve pockets to un-shroud them and improve intake and exhaust flow. I grind away the aluminum head material over the valves through the felt tip pen markings (in the range of 0.040" width). Continued grinding away material down the sides of the valve pockets to the mid-point of the side of the valve. At this point I taper the grinding outward to the existing edge (at the “step”) of the combustion chamber. The amount needed to be ground outward around the valve areas varies according to whether it’s on the intake valve side or the exhaust valve side. In case your interested, past records show grinding the intake side is 0.120" and the exhaust side is 0.065".

The “step” up to the slight dome machined in the head is next to be ground on. My old notes say to eliminate the sharp vertical step (many think this reduced turbulence and flow) by grinding it to a gentle slope whose beginning edge of the slope is closer to the center of the dome. Measure 0.200" from the edge of the step and lay a straight edge across the head. Scribe a line across the four combustion chambers. This line marks the limits of grinding. Beginning at this line I grind towards the edge of the step. I grind progressively deeper as I get closer to the edge of the step to form the desired gentle ramp. This completely eliminates the sharp vertical step.

All that’s left is to smooth any rough grind markings and polish the combustion chamber. The polishing helps reduce carbon build-up and is done with a small diameter scotch bright disc on a die grinder. Then I cc all the combustion chambers (using a chemical type burette) in one head and do additional grinding to make all the combustion chambers in the one head EXACTLY the same. Then the same is done for the other head. Remember the right head combustion chambers are to have less cc’s (3 cc) than the left head. After grinding, they were 66.0 cc in the left head and 63.0 cc in the right head. As stated earlier, the C/R in my engine was 10.4:1 before grinding. After grinding it’s 9.4:1 as near as I can tell (the semi-dome pistons complicate calculating the new C/R by my simple geezer mind). I think this is about the maximum for today’s premium fuel and permits normal spark advances. It eliminated the need for octane boosters. Time to do this in aluminum heads is about 6-7 hours which includes cc’ing the heads.

RESULTS: This increased low end response a lot more than I remembered or hoped for. The engine wants to run and turns easier and quicker throughout its entire rpm range. The peak rpm increased some. Gas mileage was not affected as near as I can tell. The performance changes alone were worth every bit of work as far as I’m concerned.

Since then, I’ve done three other sets of aluminum heads. All of the owners say they’re very impressed with the increased low end and mid- range response as well as overall increased performance. **ADDITIONAL NOTE: Red Hamilton, of Red’s Headers, recommends increasing the space around the top and sides of the valves.**

especially the intake, to improve breathing. He also says removing 0.025" from around the tops of the valves and down the sides to the step will lower the C/R 0.6 points.

PREVENTING HEADS FROM STICKING TO STUDS: Heads sticking to studs is common and is one reason many will not use studs. This discussion talks about aluminum heads, but the same applies to cast iron heads. Aluminum heads seem to be the biggest problem. Both studs and cap screws go through thousands of heat/cool cycles which may cause them to warp. The studs come into contact with the sides of the bolt holes in the heads. Over time they seize to the head which makes it extremely difficult, if not impossible, to remove an aluminum head without destroying it. IMPORTANT: Aluminum heads are soft and will squish under the nuts (or bolts) and be squeezed against the stud. Many use ordinary flat washers to prevent this. But, the ordinary flat washers are so soft they'll squish in to the studs. These are a real bear to remove because they become threaded to the stud's threads and shank and are almost impossible to remove. Solution is to use either #8 or #9 hardness flat washers.

Something I do to reduce head/stud (or bolt) sticking is drill each head bolt hole 1/64" larger in diameter. I've never had any problem with heads sticking to studs since I began this practice. For those who don't want to drill their heads: Try wiping some anti-seize on both on the stud shoulders and inside the head's bolt holes. This gives fairly good results.

HEAD GASKETS: Stock head gaskets can be used for bores up to and including 3-5/16". Anything bigger should use "big-bore" gaskets since the edges of a stock gasket overlap into the bigger bore cylinder area (not a good idea since they shore don't seem to compress wuf a hoot). Stock gaskets are normally fiber with a ring of metal crimped around the cooling holes and cylinders. Big-bore gaskets are **now available in both graphite and copper. I use only copper/asbestos sandwich type gaskets on flatheads no matter what the bore is.** Copper crush gaskets have a crushed thickness of 0.050".

BLOWN HEAD GASKETS: If you're having problems blowing head gaskets, you might want to try something the stock car guys do. They coat both sides of the head gaskets with Permatex Ultra-Blue Silicon. The Ultra-Blue has more silicon than regular blue gasket maker. This permits head movement during the frequent expansion and contraction of the head and block. Just smear a thin skim over both sides of the gasket. Install the head as soon as possible... don't wait for the stuff to "skim". I do this to the copper head gaskets on my flathead as a matter of course. The stock car guys also do this when re-using a head gasket. I've tried re-using head gaskets (copper big-bore head gaskets cost about $35 each!) a few times with Ultra-Blue with good results.

ANTI-SEIZE COMPOUND: Always put anti-seize compound on any spark plug or fitting that threads into aluminum, copper, or brass. Especially true when using cad plated spark plugs (Champion for instance) in aluminum heads. These will seize very quickly without anti-seize (cad plating and aluminum are dissimilar metals and form electrolysis). It doesn't take very long until the plug and the aluminum head becomes one piece... or seem to. Then when you remove the plug, the plug threads come out with the plugs..... and you get to show your heli-coil installation skills. Simpler to use anti-seize to prevent problems and prolong the life of the heads considerably. This stuff is available from any parts store for a couple of bucks.

INSTALLING GENERATOR MOUNTS & OIL FILTERS ON FINNED HEADS: These can be a real chore to install without ruining or grinding off some fins. I use coupling nuts and studs. If you're running cap screws instead of studs, I recommend using studs where the generator or oil filter will sit.

Let's assume there are 3 mounting holes on the generator mounting bracket or oil filter. Replace the three cap screws with three studs. These don't have to be turned down much..... just snug will do just fine. Most times you can locate 3 old FH studs which have about two inches of fine threads. Cut the studs to used just the threaded ends. If you can't find long enough threads, use studs and extend the fine threads by using a die on them. Place a grade 8 flat washer on each stud to protect the aluminum head. Install 3 coupling type nuts (they're over twice as deep as a head nut) and torque them down. Install the cut studs in the top of coupling nuts. Put on grade 8 flat washers followed by the generator mount and then follow with grade 8 flat washers. Install 11/16" head nuts and tighten down. The 11/16" head nuts don't have to be torqued down. The coupling nuts tolerate 60 ft/lbs of torque even though they're only a grade 5. They take a 5/8" socket so there is plenty of room between the nuts and the fins. Makes for a neat and simple installation.

DETERMINING COMPRESSION RATIO: The method I've used is a formula using cubic centimeters (cc):

$$\text{Comp. Ratio} = \frac{V_1 + V_2}{V_2}$$

Where V_1 is the displacement of one cylinder in cc's.
And V_2 is the space in the combustion chamber in cc's.
And one cubic inch equals 16.387 cc
(Note: The dome on the top of a semi-dome piston has a volume of 5.66cc. This is a stock bore and semi-dome.)

COMPRESSION RATIOS: For non-relieved blocks. The following is from Offenhauser and are their head identification numbers. These identification numbers indicate the depth of the valve recessions in the heads combustion chamber.

BORE	STROKE	DISPLACEMENT	#425	#400	#375	#350	#325
3-1/16	3-3/4	220.92	7.1	7.6	7.9	8.5	9.2
3-1/16	3-7/8	228.28	7.2	7.7	8.2	8.8	9.5
3/1/16	4	235.648	7.4	7.9	8.4	9.0	9.8
3-3/16	3-3/4	239.312	7.4	7.9	8.5	9.2	9.9
3-3/16	3-7/8	247.288	7.7	8.2	8.8	9.4	10.2
3-3/16	4	255.272	8.0	8.5	9.0	9.7	10.5
3-3/16	4-1/8	263.24	8.2	8.7	9.3	9.9	10.8
3-5/16	3-3/4	258.48	8.1	8.6	9.1	9.8	10.6
3-5/16	3-7/8	267.096	8.3	8.8	9.4	10.1	10.9
3-5/16	4	275.712	8.6	9.1	9.7	10.4	11.3
3-5/16	4-1/8	284.328	8.8	9.3	9.9	10.7	11.6
3-3/8	3-3/4	268.376	8.3	8.8	9.4	10.1	10.9
3-3/8	3-7/8	277.328	8.6	9.1	9.7	10.4	11.3
3-3/8	4	286.272	8.9	9.4	10.0	10.7	11.6
3-3/8	4-1/8	295.20	9.1	9.6	10.3	11.1	11.9

HEAD FLOW RATES:

HEAD MFG.	DEPTH OF VALVE POCKET	FLOW RATE
**stock Ford	?	86.6
Offy #375	0.375"	84.0
Offy #425	0.425"	86.0
Edelbrock	0.375"	80.3
Navarro	0.450"	88.2
Kong	?	81.9
Baron Street	0.500"	90.3
Sharp	0.420"	82.9
Motor City	0.570"	92.4

**Stock heads after engine modifications of: 0.375" cam lift, 1.72" diameter intakes valves, 1.5" diameter exhaust valves, race “D” ports, 1/8" relieved, but with no pop-up or high-domed pistons. (I don’t know what number heads were used.)

COMPRESSION RATIO CHANGE WHEN RELIEVING BLOCK: Edelbrock literature says factory relief decreases compression ratio ½ point.

COMPRESSION INCREASE WHEN STROKING CRANKSHAFTS: Edelbrock literature states the compression ratio on a flathead increases 0.3 of a point per 1/8" stroke increase.

Return to Home Index