What to look for in a good Aluminum Cylinder Head Repair

Repair and reconditioning of aluminum cylinder heads is a rapidly growing business. They are the "hot spot" of auto engine repair at the moment—in more ways than one.

Many fine articles have been written recently, telling machine shops the ins and outs of aluminum cylinder head work. This article is not meant to replace that more detailed information.

The point of this article is to better inform you about things you can do on your own to diagnose the reasons for a failure, and to measure any secondary damage that may have been caused. It may help you write estimates, and keep you from wasting your time and the customer's money.

You don't have to know everything the machine shop knows to make some very important decisions about the correct repair needed; or whether repair, as opposed to replacement, is even a good idea.

Do you just send that head down the street and hope for the best? Does every head need the deluxe treatment? Are you sure about how much you and the customer will have to spend?

An inspection may just convince both you and the customer that the head has gone its last mile and ought to just be replaced.

You may want to purchase some of the tools and equipment shown to help you make those decisions. The decision to buy them will be based on the amount of cylinder head repair you do in your shop, as well as your relationship with your local machinist.

At the very least, you should know what you want, know what to ask for, and be able to recognize a quality repair.

The bottom line is that you're the one standing behind the job. Irate customers find their way to your doorstep, not the machinist's.

Six Pack

There are six good questions to ask about a car with a suspected cylinder head problem before the head is torn from the car and sent to the local machine shop.

1) What shape is the cooling system in? Has the engine ever overheated? Has the cooling system ever been flushed?
2) If there is a cylinder head and/or head gasket failure, what caused it?
3) Is anything else other than the head damaged?
4) Does the head need to be repaired? If so, how much should be done? Is it worth the time, effort, and money to do an iffy repair?
5) What should you expect from your machinist in terms of equipment, proper procedures, and workmanship?
6) What can you do to make the repair a lasting one?

Time spent before and during teardown finding answers to these questions will be small change com-

pared to the cost of a comeback.

Taking the Heat

HEAT. That's right, heat. It's the bad guy for these smaller engines and aluminum heads. You've heard it all before, over and over again, but unless you want that cylinder head job to act like a homing pigeon for the next month, you don't dare forget it.

These engines run hot in tiny engine compartments under sleek, sloping hoods that do little to catch a passing breeze. They're asked to power automatic transmissions, power steering pumps, and air conditioners; haul six screaming little leaguers to practice; and occasionally tow a small boat trailer. Throw in a good dose of America's favorite pastime—vehicle neglect—stir lightly, and you have a recipe for HEAT.

As a result, checking that cooling system and including the cost of making it right on the first estimate are essential for covering one's seat, so to speak. Belts, radiator caps, hoses, electric cooling fans, etc. etc., should all be checked before the repair. Nuff said.

On-The-Car Cooling System Checks

Assuming that there isn't a gaping hole in the cooling system, you can do some cooling system tests *before* teardown. Run the engine, pressure cap off, and check for bubbles in the coolant that may indicate a leak between the cooling system and the combustion chamber.

Pressure test the system. If pressure drops, start with the obvious and check for external leaks. Check the oil for contamination. No engine compartment leaks? Check below the heater core in the car for wet carpeting.

Still nothing? Check the spark plugs for a plug or plugs that look steam cleaned. This may indicate that coolant is entering the combustion chamber and disappearing out the tailpipe.

Also check along the edges of the engine block just below the head gasket for tell-tale signs of a coolant leak that's burning off before it runs on the floor. Now is the time to make as complete an estimate as possible.

Causes?

Aside from the cooling system, there are other reasons for overheated engines that don't involve antifreeze or hoses. Anything that makes the engine work harder or less efficiently has to be considered. Add up the effects of four semi-flat tires, improper ignition timing or fuel mixture, a vacuum leak, dragging brakes, extremely contaminated oil, a bug-plugged air conditioner condenser, and then add a trailer hitch for good measure. Now stack these monsters against the limitations of even properly functioning cooling systems, and you'll see there isn't much room for error. These conditions may not be as obvious, but are very important and should be looked at and corrected.

Combustion Chamber Tests

On-the-car pressure testing of combustion chambers will vary depending on personal preference and the availability of equipment.

- A traditional compression test will point out major compression leaks.
- Air checking of cylinders with a leak-down checker (differential leak tester) is more accurate and will isolate borderline compression leaks.
- The use of block-check or an emission sniffer can also be helpful for detecting exhaust gases in the coolant.

Our thanks to machine shop instructor Roger Borer at Perfect Circle's Ottawa Lake, Michigan training center for his and Perfect Circle's help in preparing this article.

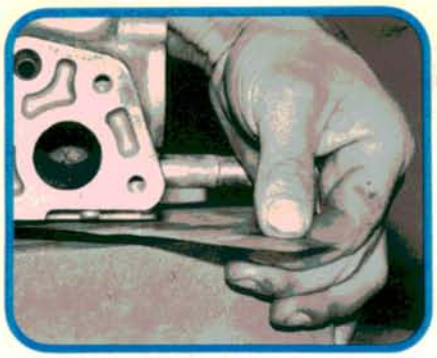
—By Ralph Birnbaum

1

With the head removed and head gasket cleaned away, check the head for distortion using a machinist's quality straightedge and feeler gauges. Distortion shouldn't exceed factory specs over any six-inch span. Distortion greater than .015 inch (0.38 mm) may require straightening of the head before machining.

2

Before sending the head for resurfacing, check to see that the head is thick enough for machining. (Some manufacturers don't allow for *any* cutting.) Mic the head and compare the reading to minimum allowable specs. The head may have been machined once before and may already be too thin.

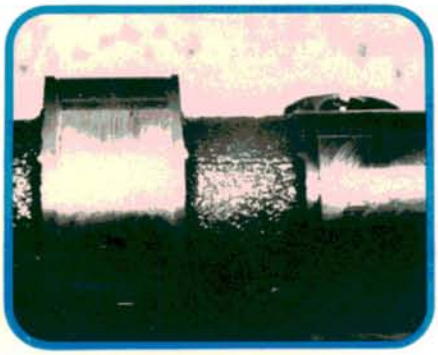


3

If a good used head is not available for a rare application, or if the cost of a new head is sky high, you may choose to have the head straightened. Your machinist will need a heavy straightening jig like the one shown. First, he'll shim the head to 50-80 percent of the total distortion, as shown.

4

Now he'll tighten two bolts through the center of the head to 25-30 ft/lbs (34-41 Nm) to tension the warp against the shims and bake the head at 550° F for about 5½ hours. When the head is cool, bolt the cam in place without followers and check that it turns freely to re-check journal alignment.



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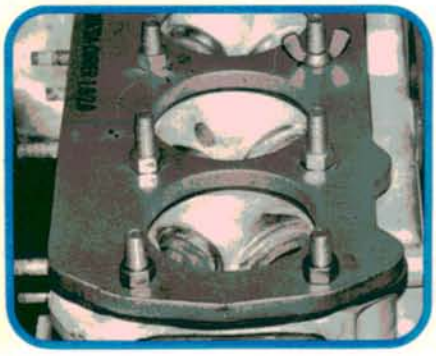
As long as you have the camshaft handy, take a moment to check for a trashed lobe, or lobes, like the one shown. Heat and lack of lubrication caused this. It's scrap and shouldn't be reused unless your kid needs it to make a lamp in shop class.

6

If the cam looks that rough, you'd better check the cam journals for excessive wear. The cam followers and valve adjusting screws are also likely to be in the same sad state. The heads on these adjustment screws will be hard to adjust, may not hold an adjustment, and will probably be noisy.



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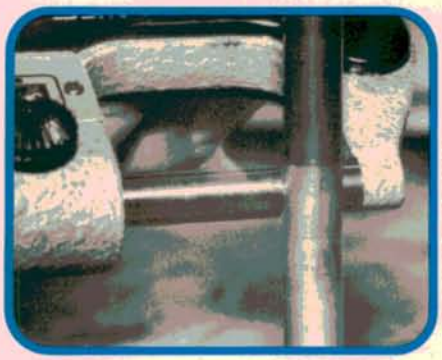
These rubber-backed plates are for pressure testing cooling jackets for leaks, *always* a good idea since porosity and hairline cracks in the head may be too small to see. These plates come in different configurations to fit most heads, and eliminate the need to cover individual coolant passage openings.

8

One plate has an air line fitting. Connect it to a pressure-controlled air line and pressurize to 50-60 PSI. Submerge the head in water for 3-4 minutes. Bubbles indicate a leak which is a lot easier to handle now than it will be after the head is installed and leaks coolant.

9

How about those valves? It doesn't take long to pop them out and run some quick checks on valve face and stem condition, guide wear, and seat condition. These checks are especially helpful if you bought a used head and want to inspect it. Start by checking for valve stem wear. Mic the end of the valve that rides above the guide.



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Now close the mic .001 inch (0.025 mm) and try to fit the mic over the area of the valve stem that rides up and down in the guide. If the stems are good, the mic should *not* fit around the stem. Also check the valve keepers and keeper grooves for excessive wear. Keeper replacement is always a good idea.

11

Valve guides. Repair or knurl? Knurling can be a valid repair technique under the right conditions, but don't just check the center of the guide with this dial type indicator and assume there's enough metal left to knurl. Guides wear the most at the ends—a condition called bell-mouth.

12

Check for bell-mouth as follows. Open the micrometer to the diameter of the valve stem plus an additional amount equal to the original valve stem-to-guide clearance. Now add .007 inch (0.18 mm)—the maximum most knurlers will pull—to the opening and lock the micrometer. Use the mic to set a ball gauge.

13

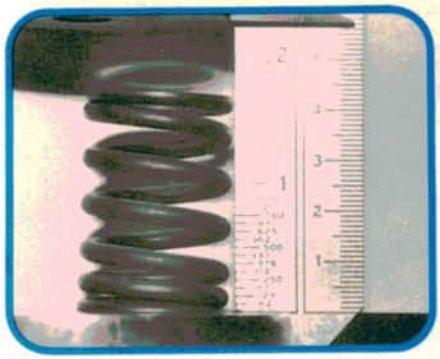
Try the ball gauge in both ends of the guide. If the gauge starts into the guide at the ends, the bell-mouth is bad enough that knurling won't work. Knurling doesn't add metal, it only displaces existing metal. Ignoring bell-mouth will cause knurled guides to wear and fail prematurely.

14

Valve springs are one of the most commonly neglected parts of any cylinder head repair. Using a valve spring checker like this one, compress the spring to its installed height (that is, in the head, on the valve, keepers installed, valve closed) and take a reading. This one reads 40 PSI.

15

The chart says that this head takes a spring with a 50 PSI spec, not 40. This new spring, compressed to installed height shows the correct reading. Shimming valve springs to obtain correct installed height is okay. Shimming to increase spring tension on a worn spring is a no-no. Replace the weak ones.



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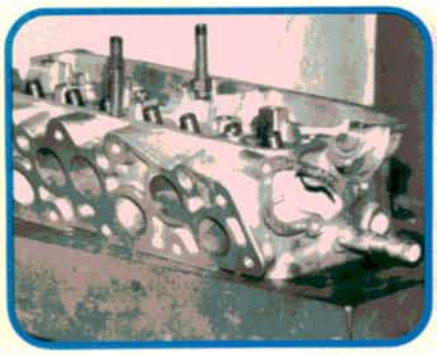
Spring distortion can also decrease valve action efficiency. With the spring on a flat surface check the edge of the coil to make sure it's square with the base. This one isn't. If you can fit a .060-inch (1.5 mm) feeler gauge between the edge of the spring coil and that ruler, replace the spring.

17

Can your machinist replace valve seats? Why trash a head if all that's wrong with it is one bad seat? This machine cuts out the old seat and enlarges the hole to allow installation of a new oversize OD seat. Cast iron seats are okay for intakes, but ask for chrome or nickel alloy seats on exhausts.

18

A jet-spray hot wash (180° F) cleans aluminum without destroying it. If glass beading is suggested, be careful to protect bearing surfaces. Also cover all coolant and oil passages so small amounts of moisture don't trap beads which may wash loose later and act as an abrasive on critical surfaces.



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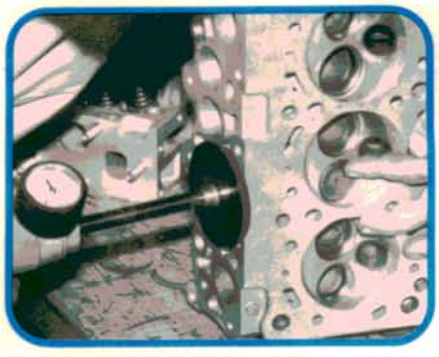
Baking the head is another way to remove that oily layer of crud. Oil film and grease turn to an easily removed, flaky residue. A final blasting with crushed nut shells is less destructive than bead blasting, and any trapped shell residue will dissolve without harming critical surfaces.



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Look at the valve-to-head fit after a valve grind. Valves should not ride too low in the seats, nor should they ride too high—all should be relatively even. This Sioux checker is a fast way to make sure the valves are sealing properly. Pull the trigger, read the gauge, and know how much vacuum that port will hold.