THE RIGHT WAY TO BETTER VALVE JOBS

A LITTLE EXTRA CARE ON THOSE VALVE JOBS CAN MEAN THE DIFFERENCE BETWEEN WINNING AND LOSING!

By Jim McFarland

Remember a few years back when your mode of transportation had only two wheels, and one or the other all too frequently had to be disassembled because a nail had found its way into the innertube? If you recall the situation, you'll also remember that trying to inflate a hole-infested tube is a frustrating experience; air is leaving at the same time you're trying to bring pressure up to a given level. What's all that got to do with automotive valve functioning? Not much, we'll agree, but you *can* visualize the effect on compression when combustion pressures escape through poorly seating valves; and this situation can also be quite frustrating. Follow along as we work our way through a first-class valve job; hopefully, it'll remove some of the frustration and give you some pointers on performing valve work and some worthwhile maintenance tips.

You're probably familiar with a valve's functions, so we'll just review them briefly: a valve permits entry of fresh fuel into the combustion chamber and exit of spent fuel mixture after the combustion process. It also seals the chamber so that pressures can build up and provide the "push" to the wheels. This sounds simple enough, but there are complicating factors——such as heat.

Exhaust valve heads are subjected to greater temperatures than any other engine component: in the neighborhood of 1400 degrees F. It's not just a hot seat, however. Incoming fuel provides chilly blasts, and pressures reach tremendous levels. Piston loads reach greater than 6000 pounds during high rpm, full-throttle operation.

With these operating conditions, is it any wonder valves require attention from time to time? Determining just when a valve job is needed is the easy part; a compression check of each cylinder will indicate pressure-holding capabilities. If pressures vary more than 10-12 psi between high and low readings, get out your coveralls and tools, and let's tackle the job at hand.

As the head is disassembled, valves should be arranged in the order in which they were installed. When new valve guides are going to be installed as part of the total valve job, it isn't necessary to make sure valves are returned to their original places; however, it's good practice to keep up with which valve goes where. A valve-holding board can be constructed quite easily to help keep the valves in their proper arrangement: drill a series of holes in a piece of board 2½-feet x 3¼-inches x ¼-inch and insert the valves as you remove them from the head.

Put the head (or block if that's where valves are positioned on the engine in question) in a suitable solvent or hot tank for soaking. Meanwhile, valve components should be *carefully* inspected for unusually pounded faces (1/32-inch valve head

margin is required for proper functioning), scratched or bent stems; and cracked, warped or burned valve heads. Any valves having chipped stems or enlarged spring-retainer lock grooves should be made into carbon-removal tools—or wastebasketed. Don't plan to reinstall them, at any rate.

Carbon will accumulate on the underside of intake valve heads when excessive oil has been allowed to flow past valve guides (an indication of guide wear). Valves with such deposits should be soaked in a solvent to remove oil and varnish, then subjected to a wire-wheel treatment to remove carbon deposits. If you have access to a bench-mounted wire wheel and use it for this purpose, be sure to protect your hands, eyes and face during the cleaning process. Return the valves to the solvent bath after carbon-removal and check again for tiny flaws that may have been overlooked earlier.

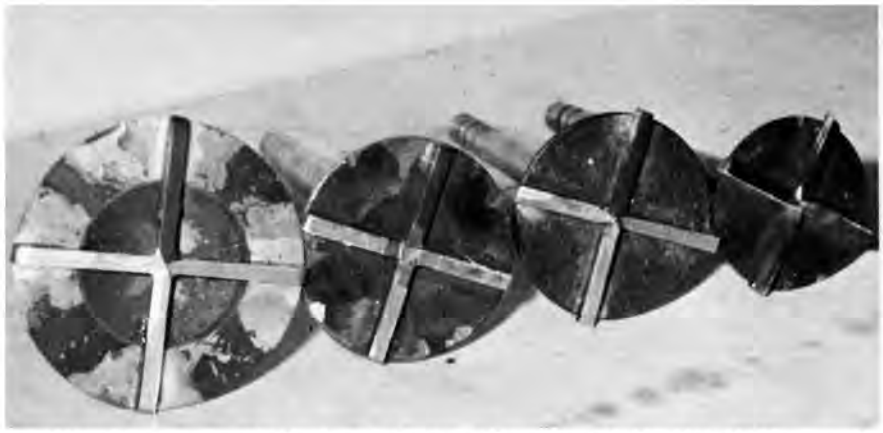
The valve-facing operation is next, and we recommend that you avail yourself of the services of a professional grinder for this procedure. Special equipment, stone grit, coolant and know-how are required for a suitable face-cut; otherwise, warped valve heads, improper face finish, and poorly sealing valves can result. A "pro" can also spot any overlooked bent valve stems as he works on the valve faces. So you'll be ahead in the long run to see a local machinist for the face-cutting process.

While the valves are getting the attention of the grinder, let's give the head or block some attention. The solvent bath has started the procedure. Now it's time to remove pieces of gasket or other foreign substances from the surface of the head or block with a flat file or some coarse-grit sandpaper attached to a block of wood. After the surface has been thoroughly cleaned and smoothed, it's time for a trueness check.

A level bar or comparable tool should be placed in a length-wise direction on the surface of the head or block. Use a .004-inch strip gauge to test clearance. Variations up to this limit will be taken care of by head torquing, but any greater deviations will call for mill cutting or surface grinding. Trueness should also be checked at three other positions: at two diagonal locations and crosswise on the head or block surface. Remove any etchings on the surface which have been created by corroded steel head gaskets.

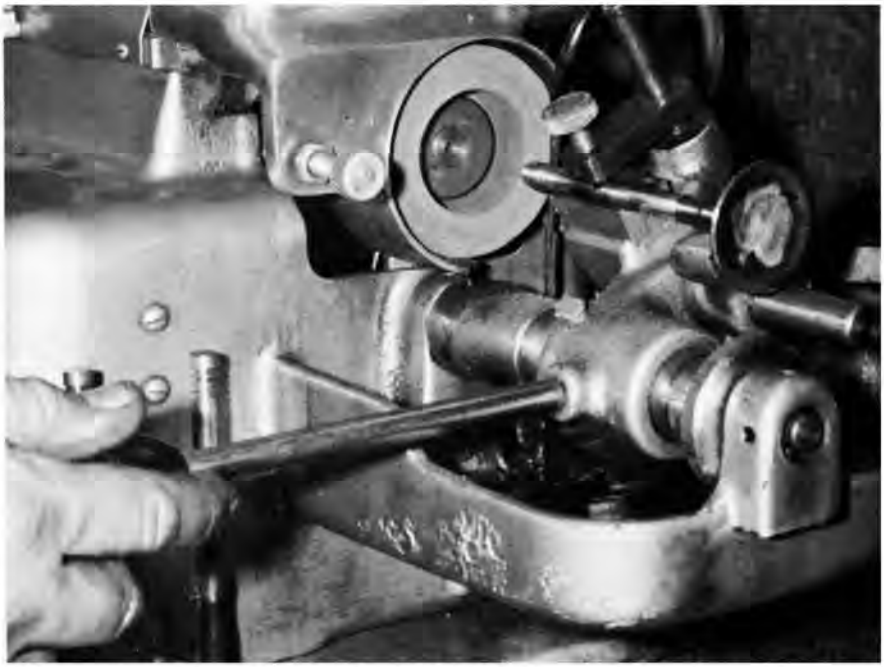
Crack-detection is next, and there are a number of suitable methods of finding those "invisible" cracks, including Magnafluxing and spray-on metal products. The point to remember is to be sure to check for cracks "scientifically". Don't just look over the head or block for obvious cracks.

The valve guides come up for inspection next. They may be stationary or removable; in either case, knurling can be utilized to restore proper specs.



Additional piston top/valve head clearance is easily obtained with home-made "cutters" installed in an electric drill and used through a valve guide. Depth of cut can be measured on valve stem relative to top of valve guide boss.

Position of performance type valve seats is normally at extreme edge of valve and is usually of a width ranging from a hair-line out to .030-.040-inch (depending upon whether the seat is an intake or an exhaust).



Facing of rocker-end of valve stem is desirable. Just make certain that any metal smear here is removed (by light filing or chamfering of stem tip) before valve is removed from the head. Valve guide bore damage is the unhappy result if a smeared valve stem is hammered out of a head. Stem material is far harder than stock guide material.

Machinists differ in opinion about the advisability of the knurling process for this purpose, but extremely costly racing engines have utilized knurling very effectively with clearance as low as .001-inch being adequate.

Valve guides should also get the solvent treatment to remove carbon and/or other deposits. Then comes the wobble check. The valve should be raised to near-maximum camshaft lift. Rocker-arm scrub causes wear, and the amount of this wear is what we're checking. The wobble limit is .005-.006-inch. If you find a greater amount, oversize valve stems, knurling or guide replacement is required. Worn guides and the attending wobble can result in "wandering" valves, warped heads and pounding of seat metal to the extent that seats connot be reconditioned. So check carefully and take any remedial action called for.

Assuming wobble has not exceeded the tolerance limit, the next procedure once again utilizes your neighborhood machinist: valve seat reconditioning. In spite of the fact that recutting tools of various types are available over-the-counter, we advise professional assistance for the valve seat work. The valve/valve seat fit is crucial for efficient valve functioning. If the seat's too wide, carbon deposits will form in valve pockets. If the seat's too narrow, valve head heat won't dissipate properly. So it's best to be *sure* and have this step taken care of at a machine shop.

When removable valve seats are part of the setup, badly damaged seats can be replaced quite easily. Slight breaks

Performance valve springs can be of either or a combination of these two shown. Flat steel coil is a harmonic surge damper (springs have resonate frequency points in their cycling range) which adds very little spring load; other spring incorporates counter-wound inner spring for additional spring pressure. Some super-duty springs incorporate both harmonic damper and inner spring.

Valve guides (especially intake valve guides) should be fitted with some sort of seal (Perfect Circle, etc.) to retard oil drain-down and lack of guide/stem seal during use of high lift (high valve-scrub) camshafts.

One necessary spring check is for "cock". On a level surface, spring should stand "square" (perpendicular) with base. Variations here make a spring subject to scraping, since it operates with less than its designed pressure.

Spring "stack" (installed spring height, valve seated) is fundamental to correct valve performance. Use of snap-gauge on installed spring retainer will indicate shim material (if any) needed for proper spring height.

in the metal don't necessarily require replacement; a number of crack-repair methods and materials are available which can restore a seat to performance-worthiness. Consideration must be given to the location and size of the crack and stresses and pressures to be encountered if the seat is repaired and returned to service.

Replacement seats may screw in or be pressed or shrunk into place. The point is that it's vitally important that insert seats fill all the way to the bottom of the respective receptacle. Air space below an inserted seat will interfere with heat dissipation and cause too much heat buildup. By the way, pressed-fit insert seats can be installed more easily if you chill them first in the freezing compartment of your family's refrigerator. The shrinkage which results will facilitate slipping the inserts into place. Dry ice can also be used for this purpose. Care must be taken in handling the chilled pieces, for breakage is more likely under these conditions.

The concentricity of valve guide bore axes and corresponding valve seats should be checked with a dial indicator mounted on a valve guide pilot shaft. The tolerance limit is .001-inch.

Thus far we've paid no attention to one of the vital components of the valve setup--the springs. Ultimate valve life and proper cylinder-pressure maintenance are dependent on the valve springs, so it's imperative that they be in suitable condition. Rusted, etched, cracked or otherwise damaged springs (including any with flaked-off paint spots) should be added to your collection of "things to make something out of someday".

The springs must undergo some "scientific" testing, too. Each spring should be checked for "cock" (perpendicularity, or amount of deviation from a straight up and down line), by using a straightedge and the block side of the head or some other level surface. If variance at the top of the spring next to the straightedge is no more than 1/16-inch, you're home free. Otherwise, don't use the spring when reassembly time comes.

Free length of spring and compressed spring tension must also be checked and compared with manufacturer's specs. If this seems like a lot of to-do for such a simple piece of equipment, consider what will result if a spring collapses during operation and allows the valve to join the piston's travels. It has happened more times than we'd care to recall, and considering the fact that in an eight-cylinder mill the valve springs open and close about 630,000 times per hour at an engine speed of 30 mph, it's understandable that springs deserve special treatment.

One final area of discussion, and we'll start puttin' things back together. A word is in order about the valve-lapping process. This involves putting an abrasive coating between valve and seat surfaces and rotating the valve. The "for's" maintain that this procedure will reveal any bad valve/seat fits which can logically result from any machining operation, by compensating for irregularities and insuring conformity of seats and valves. The "anti-lappers" are against the practice because lapping compounds become permanently embedded in the pores of valve/seat metals. They advocate, instead, use of Prussian blue paste or a similar fit-checking substance which is removable once it's performed its function. Regardless of the method you choose, it is important to make sure the grinding operation has produced a seat throughout the full width and circumference of the valve.

With all the bits and pieces cleaned,

Wobble check of valve in guide will indicate need for installation of oversized valves (stems) or reconditioning (knurling, inserting, etc.) of guide bores.

Installation of valve guide seals is accompanied by mill-cut of guide tops. Reduction of guide boss o.d. facilitates placement of seal over guide.

Head warpage check (during valve job) can cure possible pressure leakage problems later after job is complete. Surfacing or slight head cut is needed only to remove gasket etch or to correct excessive air gap (in excess of 0.008-0.010-inch) measured with strip gauge between head surface and straightedge.

Assortment of spring shim material is available and should be used for accurate spring height on assembled head. Snap gauge is well worth the money.

Spring pressure reading can be correlated with recommended height of installed spring. Exact seat pressures can be determined and spring pressure uniformity checked (with low or high springs being discarded).

inspected and reworked, we're ready to start reassembling. We'll continue to check for any foreign particles or for any flaws which could render the valve job so much wasted effort. Even at this stage it's better to catch an unsuitable valve component than to find out an hour or so from now when compression is checked again.

Look at spring seating surfaces to see if there are nicks or burrs; check spring retainers and keepers for cracks and wear spots. Coat valve guide bores with a dab of oil. Don't forget to put those valves back where they came from originally. If springs have one end with a closed coil, that end goes next to cylinder head or block. Secondary valve springs (or anti-surge coils) also deserve inspection and testing. The valve/spring assembly is installed with the help of a spring-compression tool. Be sure to use new valve stem or guide oil seals——and watch your fingers; that 160-pound spring can wake you up fast.

Check the valve contact point of rocker arms and the pushrod side of rocker arms for smeared metal spots. They could lead to trouble.

Shims are frequently needed to restore proper height and tension to valve springs which are installed on ground valve seats. Measure the springs after installation and add the shims if necessary. Serrated-surface shims can be used to compensate for metal set or "torsion relax" that accompanies spring flexing and heat during new-spring break-in. Place the smooth side of the serrated shim toward the valve spring (not the head).

A new head gasket and proper sealer should be used during reinstallation of the head, and torque patterns should follow the manufacturer's recommendations.

In the category of general tips and pointers, consideration might be given to the following. Valve guides located near the front of an engine run cooler and are apt to wear faster. Filing the tips of valve stems in advance will prevent valve guide damage when valve-removal time occurs. If you insist on performing the cutting and grinding yourself, be sure not to let any oil get on valve seats during the cutting. We'll also mention that the metal in insert seats is usually hard, and special stones are required.

We recommend the installation of P. C. valve seals to prevent oil from accumulating and running down a valve stem, past the valve guide and into the combustion chamber of an OHV engine. P. C. seals are doughnut-shaped and are installed after counterboring guides to make them large enough in diameter to take the seals. A less costly (and less suitable) method is to taper the tops of valve guides with a suitable tool.

If you've committed the foregoing procedures to memory, you'll find that restoring compression by performing a valve job isn't such a grind after all!