The Early Valiant Barracuda Club
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Valve Adjustments 101

extracted from our email list
a teaching by Erik Ievins

Question #1 - Which engines need its valves adjusted?
Question #2 - When do you need to adjust the valves?
Question #3 - What is a suitable step-by-step procedure?
Question #4 - Why is it necessary, anyway?
(How does this make the engine perform better, what happens when you neglect valve adjustment)

Although initially confident that such a common procedure would be well-documented, perhaps in many places, to my astonishment I found no mention whatsoever in my 1964 Plymouth factory service manual of any sort of valve lash adjustment technique, on ANY Plymouth engine. And after searching online for a half hour, I found very little in print.

First of all, understanding stuff like this requires some ability to visualize what's going on inside an engine. If you're interested, here are some cool articles and pictures:
www.howstuffworks.com/camshaft.htm
www.keveney.com/otto.html
www.innerauto.com/main.html (click on Animations, then V8 engine)

But even with all that, it still doesn't help much in answering all your questions. So I guess it must be my turn to put on the Teacher's Hat. Strap yourselves in, and hang on...

There are several ways to adjust valve lash. But let's start with the basic premise of what it means. First of all, it would help us to realize that a valve is pushed open by mechanical linkage, and is closed by a spring. Those are the only two forces at work, along the line of direction of valve movement. When we speak of an overhead-valve (OHV) engine, each camshaft lobe is buried down in the middle of the engine, and pushes a lifter and pushrod *up*. The rocker arm is used as a pivot and pushes the valve stem *down*, thus opening the valve into the cylinder head. (Typical total valve opening movement is only 3/8 to 1/2 inch... yes, that's the "lift" specification of a camshaft.) So what we end up with is a little "tug-of-war" going on... actually a "push-of-war." The valve spring is trying to keep the valve closed, and the cam lobe is trying to push it open, through the linkage of the pushrod and rocker arm. As the camshaft turns, the high point of the lobe pushes the linkage, until the valve is at its maximum opening. As the cam continues to turn, the high point of the lobe disappears out of the way, and (thanks partly to gravity but mostly to the valve spring) the lifter rides back down to the "base circle" of the cam lobe, thus letting the valve spring win the argument for the remainder of that revolution.

In an ideal world, that's all we would need. But in practice, if any of those many linkage parts start wearing, the dimensions change. And if the valve surfaces hammer themselves into the seat, the dimensions change in the other direction. Either way, it becomes tricky to make sure that the most important goal is accomplished: the cam needs to relax the linkage enough to make sure that the valve is allowed to close ALL the way. A valve stuck open even as much as 0.001" will not seal combustion pressure, so you'll lose power out the valves which would otherwise propel the car. But even worse, the valves (especially the exhaust) get pretty hot in a combustion chamber, and need to contact the head for heatsink purposes. When someone refers to a burned valve (obviously, metal doesn't burn as if paper), they're referring to one which has a melted and/or oxidized seating surface (face) which will no longer effectively seal against the cylinder head surface even when it "looks" closed. And once that starts happening, the valve can no longer cool off, so the problem gets worse and worse, more and more quickly.

One common way to make sure the valves close is to build a little bit of slop into the linkage, usually seen at the rocker arm because gravity is pulling the other parts away from it. Let's say if the lifter drops far enough to close the valve, and then another few thousandths of an inch, we can then be certain that the valve will truly always close (barring other problems like valve float at high RPMs, that is.) So why not design it for even more slop, like an eighth of an inch? Well, first of all, you want the camshaft to be able to lift the valve open as far as it can, to allow the most efficient breathing of air in and out of the engine. But perhaps more important, when the pushrod comes up and hits the rocker arm, then the other side of the rocker arm hits the tip of the valve stem, you get a wonderful hammering action. Not only does that wear out parts, but you can hear it... this is often referred to as valve clatter.

Now for a definition: Valve lash is the measurement of air space between the rocker arm and the tip of the valve stem during that portion of cam revolution where the lifter is riding on the base circle, the valvetrain is relaxed, and the valve spring is holding the valve fully closed. It is usually a pretty small gap, enough to be measurable with a thin metal feeler gauge between 10 and 20 thousandths of an inch (0.010-0.020). The lash can be changed by adjusting a screw on the end of each rocker arm, to bring it closer to or farther away from the valve stem.

The actual valve lash specification (for each engine family) is carefully chosen by the manufacturer, to allow for satisfactory operation with either a cold or warm engine (expansion of linkage parts and valve stem lengths change the lash a little), and to allow room for gradual wear between adjustments. The trick is to strike an appropriate balance between opening the valve as far as possible and making sure it closes securely. Racers often find reasons to deviate from the manufacturer's settings by a few thousandths, but are willing to adjust more frequently to compensate for seeking every single horsepower they can find. For most passenger car use, the manufacturer's recommendations (both the lash and at what temperature that lash is valid) are definitely the best.

Most books I've read (many different manufacturers) describe adjusting the valve lash with the engine off, occasionally cold although almost always HOT after driving several miles (just idling isn't really enough). There are ways to make sure each valve is at the proper low point (since otherwise you get a faulty measurement) and you adjust until you can gently slide the feeler gauge in the air gap with only a little bit of drag. Then turn the engine a certain amount, and adjust whichever valves are now on their low cam points. This technique will work with just about any engine, including old Chryslers.

Chrysler, on the other hand, specified performing a valve lash adjustment with the engine not only fully warmed up but RUNNING! Sounds crazy at first glance, since there will be a little bit of oil splashing around with the valve cover off, but actually with a really slow idle and some newspaper on the inner fender to catch drips, it's not too bad. And what better way to adjust it for "real" numbers than when the engine is in a "real" state of operation? The only trick is using a wrench to adjust something which periodically jumps up and down, and measuring an air gap which periodically slams closed and traps the feeler gauge. But during the majority of each revolution, an adjustment can be made and measured, and it's fairly easy to get the hang of it. Personally, I find this MUCH faster than trying to figure out where all the lobes are at their low points with the engine off. And it's especially easy to double-check your work.

Having said all that, I must point out that this is the recommendation for the slant 6. I do NOT know if Chrysler said the same thing for their early 273 engine, but I cannot think of any reason why this technique wouldn't work. Gotta find valve lash specs somewhere, though, and they're not in my 1964 manual since the engine was brand new mid-year. Anyone have them in a 1965 manual? It would probably be listed as "Tappets, Operating

Clearance". [Ed. Note- thanks to Gary K. for forwarding the info: slant 6 is .010” intake, .020” exhaust, while 273 is .013” intake and .021” exhaust.]

While I'm at it, let me pass along a neat trick: when installing the new valve cover gasket, use RTV goop to hold it to the valve cover, but use a thin layer of *grease* on the other side instead of goop. That way, when you take the cover off again 30k miles later for your next adjustment, the gasket easily comes right off the cylinder head and can be reused. And assuming all the surfaces are flat enough to make good contact, the grease will actually seal oil just as well as the goop.

There is nothing more dramatic than hearing the difference between an old slant 6 and one with properly adjusted valves an hour later. Purrs like a sewing machine!

For completeness, let me point out that all of this discussion assumes mechanical lifters. So what's the deal with hydraulic lifters? Easy. Unlike mechanical (often called "solid") lifters, they are built with two pieces, a little like a film canister with a lid, except that the top piece fits snugly inside like a plunger, and they've got a tiny hole in the side so oil can get in. When pressurized with engine oil, they expand slightly, to take up whatever valve lash may have been present. In other words, they self-adjust until the lash is zero. And the plunger has enough movement to be able to continue to adjust for valvetrain wear of 100k or more miles... Especially since that wear is so well minimized: there's no valve lash hammering except upon initial startup before oil pressure has done its job pumping up the lifters. Aside from making sure your engine oil is clean (so the lifters don't gum up or stick), there's essentially no maintenance, no warranty issues, and everybody's happy (except for the person who loves adjusting valves, I guess.) Cool, huh? But don't try to put hydraulic lifters in your engine if the cam is designed for solid lifters... it's not a direct swap, since the cam lobes are shaped a little differently. Ya gotta match cam and lifters for their intended purpose.

And to answer the next question before it's asked... why would people be so interested in Overhead Cam engines? Well, remember that this Overhead Valve arrangement requires a fair bit of linkage, and all of it weighs something. By placing the camshaft directly (OK, nearly) on top of the valve stem, you can eliminate the inherent inertia of pushrods, and the engine can rev to higher RPMs with greater ease. There's also less power wasted to move linkage back and forth, and therefore more available to propel the car. There's still a little bit of linkage, and it still uses something similar to lifters, but since now they're being pushed down instead of up, they're called cam followers. The only real problem is that the camshaft is quite a bit farther away from the crankshaft, so you need a much longer chain to drive it. And given the problems (and expense) of installing and tensioning a long chain, it becomes easier to simply use a toothed rubber belt, even though it requires more maintenance. But automakers have gotten around those issues pretty well, and unlike some of the first timing belt cars, modern ones can easily run 100k miles before needing a belt replaced. Overall, OHC is a pretty efficient setup.

That's all for now. If I left anything out, I’m sure someone will let me know. :)

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Erik Ievins