What's Down with the Lifter?

BY **ERIC BAKKE**

What is the purpose of a valve lifter?

Valve lifters, sometimes called cam followers or tappets follow the profile of the cam lobe and produce a reciprocating motion within the valve train. The OHV applications use a pushrod to transfer motion whereas the OHC applications are typically fitted directly between the valve tip and the cam lobe.

Lifters are either hydraulic or solid with either a flat heel or roller on the camshaft contact area. Since the conception of the internal combustion engine, we have always needed a method to transfer the motion of the cam to the valve. Without the lifter, we would have no method to open and close the valve.

Now keep in mind, we are not discussing lash adjusters that react against fulcrum type followers that are common in OHC engines. Those lash adjusters are stationary and do not follow the lobe profile, have differing wear characteristics and deserve a different discussion of function and service.

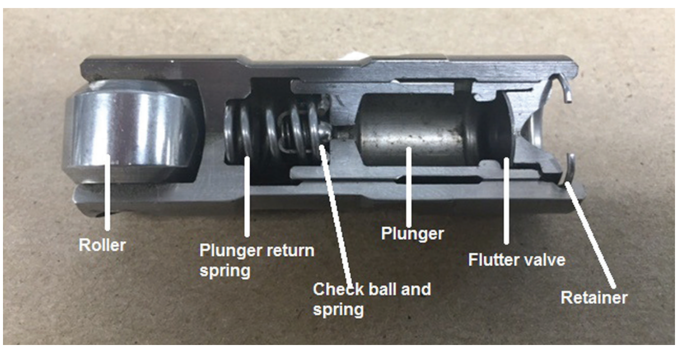
The hydraulic lifter advantages vs. mechanical lifter

- Elimination of periodic valve adjustment
- Elimination of noise
- Longer valve and cam lobe life by elimination of pounding caused by required mechanical clearance
- A smoother running engine due to more precise control of the valve timing
- Automatic adjustment of the valve train to compensate for thermal expansion and contraction.

How does the lifter work?

The internal parts of typical hydraulic roller lifter:

- Roller
- Pushrod seat
- Snap ring or retainer
- Plunger spring
- Plunger
- Check valve and ball



The lifter is in the block on a OHV application or as we stated earlier, directly between the valve tip and cam lobe. Individual lifter bodies must be supplied oil from a major oil galley to operate correctly. Oil enters the lifter body from the galley when the lifter is on the base circle of the cam thru the feed holes on the outside of the lifter. At this point the lower cavity below the plunger fills with oil as the cam rotates to the highest point of lift, the oil is forced against the check ball, sealing the oil below the plunger. The lifter, at this point, acts as a relatively solid unit. Now that all the load of the valve train is being stabilized by the lifter, a predetermined volume of oil can bleed by the lifter body and the plunger. This is called leak down and this leakage may provide lubrication to different areas of the valve train.

As the lifter returns to base circle, oil fills the cavity once again and the process starts all over. As the temperatures changes the valve lash must change. The leakdown in the lifter along with the movement of the plunger allows for correction as needed, by changing the location of the plunger. If the lifter is adjusted incorrectly, noise will occur or the valve will be held open. A good rule of thumb is .080 off the plunger wire, when the lifter is on base circle. If the plunger doesn't have enough clearance it will contact the retaining clip and dislodge the clip.

Advancement in lifter technology

Current expectations and regulations for fuel consumption and emissions has driven advances in lifter technology. One popular solution was to develop a way to cancel cylinders under different load conditions. This got some traction in the early 80's when manufactures developed a hydro mechanical system to deactivate the valves. They tended to be more complex and unreliable, but well ahead of the times.

The latest designs use solenoids to raise oil pressure enough to disengage lock pins and allow the plunger to drop in the body of the lifter. The valve no longer opens and the fuel distribution is controlled by the ECM. Some down falls of the system are the sudden internal pressure changes within the lifter during engaging and dis-engaging of the lifter. This has been causing mechanical failures. These failures may include but are not limited to:

- Roller failures
- Camshaft lobe failures
- Internal springs of lifter breaking
- Valve train failures
- Reports of timing chain breakages

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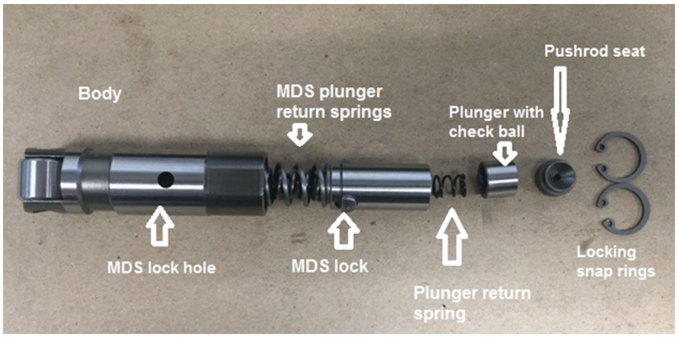
Below is the exploded view of a HEMI MDS lifter. All parts function the same as a conventional lifter, with exception of the MDS lock.



• In the normal mode, the MDS lock will be engaged into the MDS lock groove of the body

• When the oil pressure is raised at the lifter, by the means of a solenoid, the pressure will enter the hole in body, filling the groove on the inside of the body, depressing the MDS lock buttons.

• The MDS lock will drop into the bore, preventing the valve from opening. The roller will still contact the camshaft and disable the cylinder mechanically and the ECM will control the fuel delivery.

• When commanded by the ECM based on duty cycle requirements of the engine, the pressure will drop at the lifter, and the nested springs will push the MDS lock back in position.

As most of you reading this article are aware, there are some slight variations with over OHV applications such as the LS GM platform but the objective is the same.

How can I diagnosis lifter noises?

First you must determine if all other engine functions are working correctly.

- Make sure the noise is not coming from a different location, exhaust leak, valve cover on incorrectly, etc.
- Does the engine have good oil pressure?

If these functions are all working correctly, the valve cover can be removed to check for physical defects in the valve train, broken springs, incorrect valve movement, incorrect oiling. If these items are okay, pressure can be applied to the rocker arms with engine running one at a time. If the noise changes the suspect cylinder can be isolated. Parts would need to be removed and checked for wear or damage. Sometimes a defective lifter can be isolated by pushing down on the pushrod checking for excessive bleed down. You can have a lifter that has failed due to the foot of the lifter being worn. In this case the camshaft would need to be replaced and more than likely other components have been contaminated and likely damaged.

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What could be causing the noise?

As we have discussed, there are several small parts internal of the lifter. Failure of any of these parts in addition to any other worn valve train components can cause noise.

- Number one cause of noise is dirt, causing the check valve ball to not seat
- Any lack of lubrication between the rocker arm and the pushrod
- Lack of lubrication on the rocker and end of the valve
- Worn cam lobes
- Loose valve seat
- Excessive clearance between the lifter and the bore and the block
- Broken valve spring
- Incorrectly assembled lifter new or remanufacture
- Incorrect valve adjustment

Can a Roller lifter be remanufactured?

The answer would be yes. With good cleaning process and testing verification, here are some of the processes:

- Sorting by types, multiple designs over the years, for the same applications.
- Inspect lifters for defects, crack in body, rust on roller.
- Complete disassembly keeping the major wear components together.
- The body and plunger are the 2 major wear components; other parts are interchangeable as per design
- Pre-Soak lifters to remove grease and debris
- Use a buffer to remove any debris and inspect for cracks
- Each roller is checked for axial/radial wear with a dial indicator with a max tolerance of .003" movement
- Parts are again cleaned and protected from rust.
- Parts are reassembled with calibration fluid
- Test on lifter tester for correct bleed down rate over a given time/distance

Flat Tappet Remanufacturing

Flat tappet lifters are more difficult to rebuild due to grinding of the foot of the lifter. The foot is the contact area that rides on the camshaft. For the lifter to operate it must spin in the lifter bore. The cam is ground with a tapper on the lobe and likewise, the lifter is ground with a convex surface. This relationship causes the lifter to rotate during the opening/closing event. If the lifter will not turn, it will fail, typically destroying both the cam and lifter.

When a flat tappet is remanufactured it first must be:

• Sorted by type and style

• Check for height due to wear and discarded if under limits

• Next they are processed thru a centerless grinder that removes .0002-.0004 from the OD of the lifter body then to a polisher. This is all done on one machine.

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- If the lifter will not clean up at a minimum spec it will be discarded
- The lifters then go to a surface grinder and clamped in a vertical position up to 100 lifters at a time, are ground flat on a special designed clamping table.
- Next they are taken to a specially designed profile grinder where one at a time they are ground on the end to a convex shape. The amount of convex is around .0008" measured at 4 different points around the circumference of the heel/foot. A slight chamfer is also applied to the edge to remove any burrs that can impact installation or cause pre-mature scuffing or wear.
- Each lifter is dissembled and typically ultrasonically cleaned.
- The lifter body bore is brushed to remove burrs or debris from cleaning. Each plunger to body fit is hand tested for fit after brushing. If plunger fails to move freely it is discarded.
- New check balls and springs are used to eliminate the possibility of missing something that cannot be depicted visually. Each check ball is manufactured to a tolerance measured in micro-inches/microns. Therefore; making typical measuring practices impractical and inaccurate.
- During and after assembly each lifter is loaded with calibration fluid and as stated above, tested to ensure correct bleed down rate.

Conclusion

Today's market brings us many challenges. It is growing more difficult to source parts for the older products because of volume. The technical advancement of the newer products slows them entering the aftermarket or drives us to find means for cost reduction. Both challenges present an opportunity to educate ourselves about the function of components that are often discarded which could translate into re-use or rebuilding more of them.

Eric Bakke is an automotive machinist with over 35 years of experience in the automotive industry. He has spent the past 16 years with Jasper Engines and Transmissions in various roles including customer service, quality control and engine failure analysis (team leader). For more information, please email Eric.Bakke@jasperengines.com.