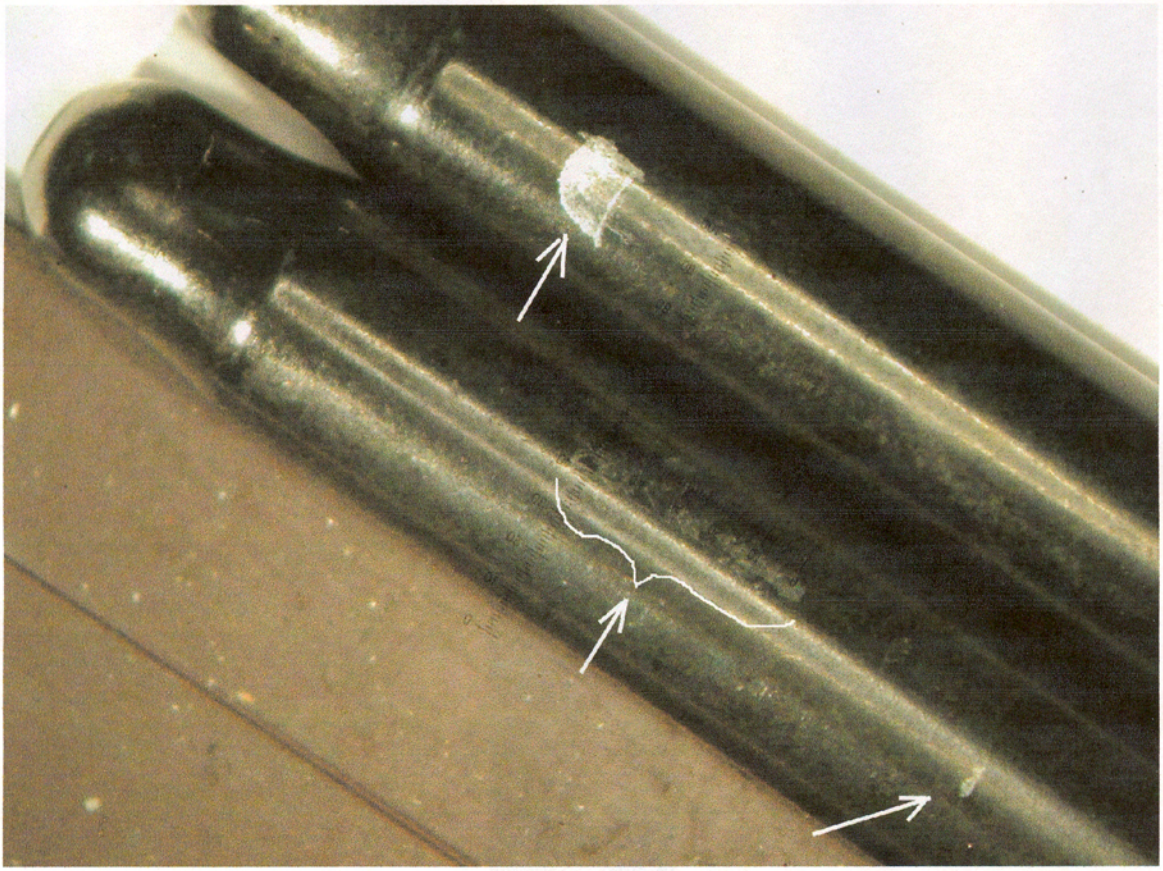
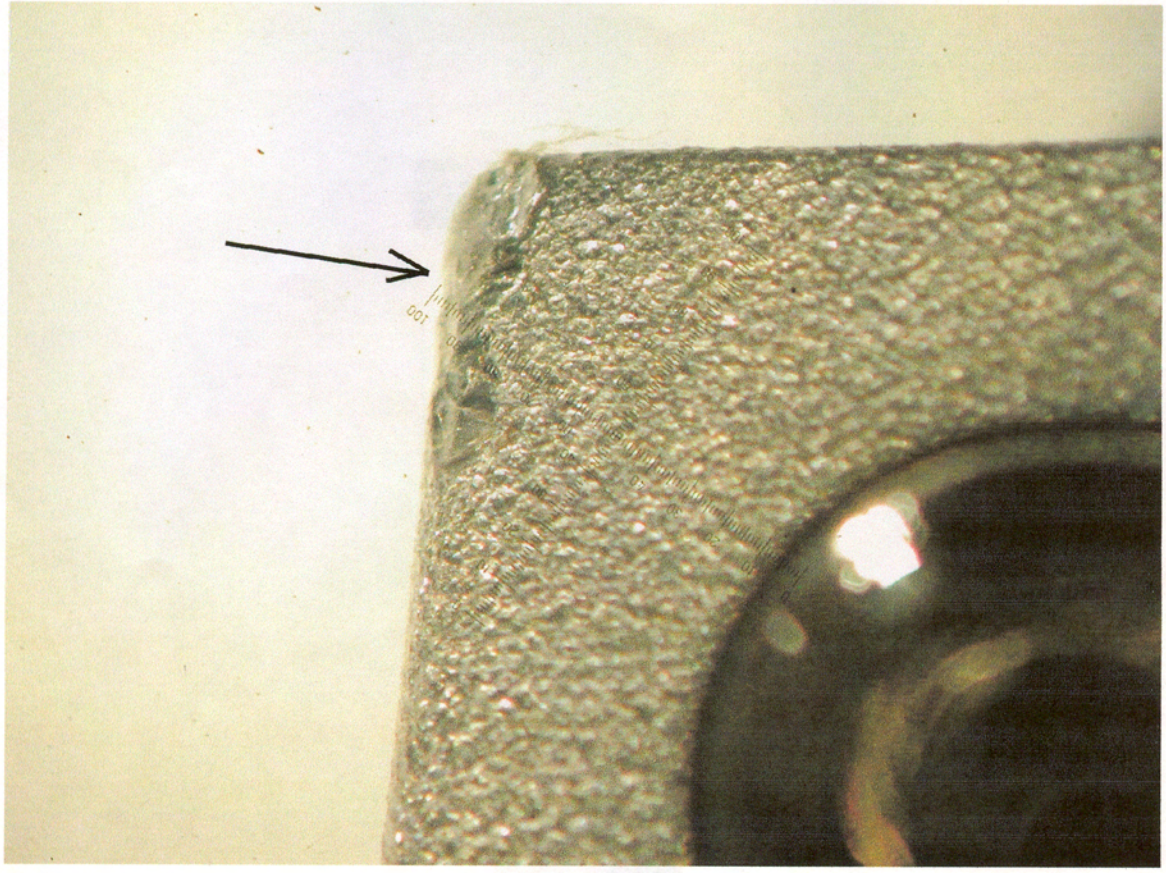
F1112S01



This photo shows two pushrods with marks caused by aluminum. These marks are typical of a pushrod being jammed against the cylinder head when a part breaks or something else goes wrong. Only one broken rocker was submitted but there was another rocker with a suspicious mark in the tail, presumably jammed together when the pushrod jumped out of the rocker (photo F1113S01). The amount of separation needed for this to happen is very excessive and indicates a valve train that is uncontrolled.

Another observation regarding the pushrods is that 3/8 pushrods are not stiff enough to operate a 300# seat pressure spring. This by itself can be a reason for not being able to control the valve train. Inadequate pushrods act as a spring and throw the valve train apart shortly after the valve opening event. The ensuing crash is held as a major reason for total destruction of many different valve train components because the forces transmitted are enormous.

F1113S01



This shows the tail of another unbroken rocker. It appears that at some point the pushrod had jumped out of the adjuster and dinged the aluminum. This happens when the valve is lofted and there is no pressure on the individual parts.

Conclusions:

A number of observations were made here, all of which are worthy of consideration as they all are contributors of valve train failures.

The object of assembling components into a high speed valve train is to arrive at a combination of parts that work together to perform the job. When done correctly, a system can be built that does not go into significant bounce until past the design RPM. It must also not generate spring surge as surge is the cause for destruction not only of valve springs but many other parts in the valve train. All successful valve train systems share this trait of their individual components being compatible.

Surge and Bounce

Two different but equally destructive phenomena are spring surge and bounce. Surge is a product of the spring frequencies and acceleration. Acceleration in the system is produced by the camshaft primarily but there are other important contributors. At high speeds and high loads there is deflection of every part of the system. When these parts are deflected, they later spring back to original shape and contribute their own acceleration to raise the total acceleration. What this means is that spring health is not just a matter of compatibility between the cam grind and spring natural frequency but the stiffness of other parts (especially the pushrod and rockerarm) all add their own effects. This total acceleration is what excites the spring and if the frequency is close enough to the spring's natural frequency, the spring will resonate and vibrate wildly. This action is known to lift the entire spring off the cylinder head and to make it crash so violently that it breaks parts and cooks the spring instantly.

Valve bounce is based on the above factors but is also more critical of additional things like component weight vs. spring pressure. The timing of the camshaft accelerations are very critical to bounce. Pushrod deflection, because it has the ability to add acceleration, is a very large factor. Its arrival time will change with RPM giving the 'in and out' behavior of valve bounce. Worth noting is that street cams, although they have always been known to be 'mild' are not at all mild anymore. Many OEM passenger car cams have accelerations found only a few years ago in Pro Stock cams. The aftermarket performance cams for lightly modified street engines can be more drastic yet.

To avoid spring surge and valve bounce, you should carefully select a cam profile, valve spring, rockerarm and pushrod that will work together. Choose a spring realistically. There is no need to use a spring designed for 10,500 RPM drag use for a component in a mild application, especially where endurance is key. Pushrods have basic requirements. The heavier the valve train components, the stiffer the spring and the higher the RPMs, the bigger and heavier of a pushrod is needed. Inadequate pushrods are the worst culprits in problematic valve trains in general. Don't try to save weight here. If there are problems physically fitting them in a cylinder head, find a way to make room or else back off on spring pressure, cam acceleration, RPM, etc. You simply cannot build a high speed system without a pushrod stiff enough to overcome these things mentioned above.

Spintron work is the best way of predicting compatibility but short of that, there are signs of problems like those shown in this report. After selecting the components, they must be set up correctly. A valve spring is most successful if it runs very close to coilbind. The close stacking of the coils during each valve cycle acts to dampen spring vibrations by not allowing the spring coils to move much. A spring set up far from coilbind does just the opposite by giving the coils room to oscillate back and forth.

General Practices

In rockerarm use, there are a couple of things that are more important than they seem. Choose the options that are needed for a successful valve train. With high spring pressures or high RPMs, use needle rollers rather than plain. The plain are designed for less demanding applications. The same applies to rocker stand bolts. With high spring loads, high cylinder pressure, violent cam or system accelerations, you will have to use high grade bolts. Hardware, like all mechanical components have design limits.

Lastly when adjusting lash, firstly make sure the adjuster is not out from locked position more than 1-1/2 turns. This geometry may not seem critical but side forces on the rocker tail and adjuster go up dramatically as the adjuster is turned further out. When locking the adjuster nut, use a torque wrench. The threads in the aluminum rocker body have a definite strength limit. If you exceed this, the rocker probably will fail.

Pay attention to careful assembly practices and upon disassembly, look for unusual signs like the ones shown in this paper. When there is a problem in your engine, the parts will tell you if you're paying attention.