Damping

WHEN SOMETHING GETS wet in the rain, it has been "dampened." But when we refer to the hydraulic circuits in our forks and shocks, we talk about "damping"—meaning the controlled hydraulic resistance to spring compression and extension that's necessary to keep our motorcycles from bouncing out of control on bumpy surfaces.

There are essentially only two hydraulic control circuits in use on the majority of motorcycles: drilled holes in which the size of the hole creates a range of control, and cartridge valves in which stacked shims that cover separate compression and rebound passages on both sides of a valve body must be alternately forced open by hydraulic flows. And even cartridge forks use a small drilled hole for low-speed control (meaning low flow speed, not road speed), while standard damping adjusters simply use a threaded tapered needle to vary the effective size of these holes.

When oil flows through a simple hole, its resistance to increasing flow rates will rise exponentially. At some point the orifice cannot effectively accommodate any more flow. If this is the only form of damping control (as in a damper rod fork), this is where its action will feel "harsh" to the rider. At lower rates of flow, the same size hole will offer very little resistance, reducing control, and the suspension will lack the best possible feel. This compromise can be sensed in virtually every damper rod fork. However, with careful design, damper rod forks can be made to work adequately and are cheap to produce. But for the ultimate in wheel control and front end feel, the cartridge design is a major improvement.

The range of control offered by cartridge valves is almost inexhaustible. A variety of shim sizes and thicknesses, stacked with more shims of varying sizes and thicknesses, configurations of hole sizes in the valve bodies and details like digressive valving, which uses shims held in a pre-dished condition to open more rapidly, can be made to give virtually any damping curve you can imagine.

We recently had an interesting talk with Adam Lambert of Penske Racing Shocks at the NHRA World Finals in Pomona, CA. Penske's shocks, one of many items which have created the team's famous "unfair advantage" in car racing, first appeared in 1988. Since then, their use in the top ranks of professional racing has grown rapidly. Nine Formula One teams use them, virtually the whole field in

both IRL and NASCAR, and Penske is currently expanding into drag racing.

Although Öhlins is the name most closely associated with top-quality motorcycle suspension, I had a Penske shock on my 2003 FZ1 Yamaha that was very impressive; giving the same superb ride quality over minor surface irregularities and plush control over large bumps as any Öhlins in my experience.

As the technology of shims and valve bodies is common to all top-quality shocks, I asked Adam what made the difference for Penske's customers. He indicated that quality parts and super accurate clearances are the difference between mass-produced and hand-built shocks. A perfect fit between the piston and the hydraulic cylinder (which is critical to the thousandth of an inch), will reveal its greatest advantage in low speed/high amplitude damping. A quicker response time, lower running friction, less hysteresis and better piston seal all work to provide greater grip at the tire. Beyond that, Penske's dedication to racing (it doesn't make mass-produced shocks) and its one-on-one customer support spell the difference between winning and losing.

While we are comfortable with the process of tuning suspension, which has to be one of the least difficult and most rewarding things you can do to improve the performance of a motorcycle, getting the most out of a top-flight racing machine can get considerably more complex.

During the development stage, it's normal to have the suspension fitted with travel measuring transducers that record the velocity of suspension movements. GPS-based systems will then allow the various sections of the racetrack to be matched with what the suspension is doing. Although this will allow technicians to calculate what sort of changes might help, at its Reading, PA, headquarters, Penske has a computerized simulator that can calculate the effect of suspension changes on lap times at various racetracks without repeatedly disassembling and rebuilding shocks to test damping curves.

Still, even with these resources, the behavior of the tire carcass, which forms the all-important junction between the suspension and the road, is a variable that resists easy simulation. Those of you who closely follow motorcycle road racing are aware that braking "chatter," a resonant deformation of the front tire tread, is a huge problem for many race teams. At the rear, similar problems happen, reducing tread contact under braking and acceleration, leading to slides and high-sides.

A tire's "vertical spring rate" is one measure that helps explain this behavior. But the only tires that are marked with their spring rates are NASCAR tires to the best of my knowledge. And motorcycle tires with their very short sidewalls are, as race tires go, some of the stiffest.

Working with scientists at Cambridge University in England, Penske has patented a new technology that may transform suspension as we currently know it. It's called the Inerter, because it provides an adjustable inertial resistance to suspension movements. We got to handle the device at the SEMA show in Las Vegas, just the week before we met with Adam.

The way it works is that compression of the shock causes a weight to be turned inside the shock's upper housing; rebound turns it the other way. This inertial resistance apparently absorbs energy that would otherwise cause tread deformation. The result is shorter braking distances, better traction and reduced tire wear—all vitally important to racers. It really works.

As Scott and I walked away from our interview, we both found ourselves wishing that Penske would work with Ducati's MotoGP team, so Nicky Hayden and Valentino Rossi might finally banish their handling gremlins and give Honda's dominating Casey Stoner some real competition for the 2012 Championship.

I'm also proud to report that Penske's shocks are 100% made in the USA.

Dave Searle

—Dave Searle
Editor